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POLICY STUDY

Agricultural policy and the environment in Syria: An examination of impacts and suggestions for policy reform

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EXECUTIVE SUMMARY

This study was concerned with investigating the impact of current agricultural policy on the environment of Syria. The aim of the work was to identify aspects of current policy and practice which may have a negative impact on the environment and to make suggestions for developing policy which could have at least a neutral, and at best a beneficial impact on the environment. These recommendations are made with the primary intention of seeking enhanced environmental management, but they take cognisance of other policy objectives such as food production, equity and efficiency.

The study identified 5 aspects of the environment for specific consideration, water resources, the Syrian Steppe (Al Baddia), soil conservation, forestry and biodiversity. While these are dealt with separately in much of this report there are many issues which cut across these separate areas, and also across Ministries and Directorates. So while a single policy may effect several aspects of the environment, like soil, water and biodiversity, so too a single problem, like soil erosion, may need many changes of policy in order to achieve better environmental management. (NB: This work was not explicitly concerned with irrigation, rather with overall water supply and water quality. Issues of irrigation are dealt with in a separate report by Varela-Ortega & Sagarday (2001)).

Water

Water availability and use
The amount of water available in Syria is not well quantified, and one water balance developed in 1995 suggested that while demand almost equalled supply in the Barada and A'wag basin, there was still considerable capacity to increase use in some other basins. However by 2001 all basins, apart from Euphrates and the Coastal Basin, show negative balances. The long term average of water supply is above the water poverty level of 1000 cumec/hd/yr. However, the variation in supply between years is problematical. Estimates of future demand suggest annual demand growth of around 2% over the next 20 years, this is lower than projected population growth, but would still require 51% more water to be abstracted by 2015 than was abstracted in 1997

Agriculture is currently a major user of water. About 710,000 ha of crop land is irrigated from well pumped water. 187,000 ha is irrigated with water pumped from rivers and springs, and 378,500 ha from public irrigation systems. There are about 125,000 ha of irrigated trees across Syria. Unfortunately many of the irrigation systems are inefficient and 90% of all irrigation is surface irrigation. New projects are developing pressurised systems, metres and hydrants. The use of these new technologies should increase efficiency from the current level of around 50% to 75-80%.

Wells provide the irrigation water for the majority of the land and a large proportion of these wells are illegal. The amount of land irrigated from ground water almost doubled in the period 1990-2000, with the estimated volume from ground water increasing from 260,299 cumecs in 1990 to 437,296 cumecs in 1999, an increase of 68%. The total volume of water abstracted from ground and surface water increased

by 42% over the same period, while the irrigated area only increased by 68%. Uncontrolled pumping occurs from wells and some surface supplies, and while good long term data on ground water levels are scarce, it is clear that ground water levels are decreasing by around 1m/yr in many areas.

The use of water in agriculture is affected by the centralised cropping plan which determines how much of seven so-called 'strategic crops' each farmer can grow (wheat, barely, cotton, sugar beet, lentils, chickpeas and tobacco). The crops grown on farms vary between agro-ecological zones which are characterised by the amount of rainfall received. This cropping plan is a major determinant of the land use in cultivated areas and impacts on many issues of input use and farm management.

Salinity

Generally wells in the west are the least saline, and there is a gradual deterioration eastwards. Tadmor in Palmyra is among the worst areas where salinity is up to 6000mg/l. Salinity in surface waters of the peri-urban Ghouta region of Damascus has increased dramatically in recent years, and may be having adverse impacts on crop growth.

Sewage and waste water

The treatment of sewage and urban waste water is still underdeveloped in Syria. A waste water treatment plant only began running in Damascus in 1998, and is still being upgraded. Sewage treatment plants are planned for all major cities in Syria over the next 10 years. Untreated sewage water is used in some areas for irrigation, and treated sewage water is used for irrigation of crops in the Ghouta region of Damascus. This brings problems of human health and contamination of soil, food and groundwater with heavy metals, pesticide and disease organisms. Currently there is no policy on the use of treated solid sludge, but this may have value as a soil conditioner, and could safely be used around forest trees and in green belts.

Evaluation and policy interactions

There are no incentives to use water sparingly and/or efficiently, nor to allocate water to crops that cause least environmental damage. In theory the imposition of a centralised cropping plan does not necessarily lead to inefficient water allocations, but in practice the absence of environmental data means that such inefficiencies will occur. The functioning of the irrigation systems themselves may be inefficient in terms of the time and amount of delivery of water, and the nature of many of the irrigation delivery mechanisms leads to undue losses of water in transport. Technical advice available to farmers on irrigation management may be limited and the lack of meters on water delivery systems severely restricts management options. The drainage systems over much of the irrigated lands are ineffective. This is particularly important in the Euphrates basin and other areas where salinisation is likely.

Policy recommendations

Government should continue to support the on-going project to upgrade irrigation systems and put meters on all irrigation water sources. A system of quotas and fines should be developed where farmers are allocated a certain amount of water according to some criteria and fined for overuse of water. This system is most definitely not a water pricing system, it is simply a penalty system for misuse of water, which is a common resource. Resources should be invested in establishing adequate drainage in all soils which are currently affected by salinity, or are at a high risk of being affected. All new irrigation projects should have adequate drainage systems designed into them.

As regards water quality the Government should continue to develop sewage treatment plants as planned, and seek to enhance the treatment of ensure it meets international standards of cleanliness. Effort should also be put into separating industrial pollution from domestic waste and transporting treated waste water down closed pipes, not open channels. Consideration should be given to providing drinking water for Ghouta from non-contaminated sources and to consider the use of sewage sludge in non-hazardous ways such as being applied to forest trees and greenbelts. Finally, management of both water quantity and quality would benefit from enhanced monitoring programmes.

Al Baddia

The Baddia comprises 55% of Syria's land mass. It totals 10.2 Mha and receives less than 200 mm rain p.a. Pasture comprises 70% of Al Baddia and this provides a grazing resource for 6-7 months of the year. There are between 900,000 and 1.5 million people in Al Baddia, of which about 500,000 are settled. Deterioration of the rangeland has been related to overgrazing in early summer. In 1950 there were 2.6M sheep now there are 10-12M (the maximum number of sheep in Al Baddia has been 15 M).

<u>Evaluation and policy interactions</u>

The lack of property rights over the land in Al Baddia provides no incentive for long term management and leads to a classic 'tragedy of the commons'. This situation is exacerbated firstly by the provision of increased numbers of wells which enable sheep to remain on the Baddia longer into the summer, and to return earlier, than was historically the case, and secondly by the provision of subsidised feed that enables the maintenance of stocking densities above that which could be supported by the natural environment alone. The problems of overstocking and poor management are not helped by the prohibition on slaughtering female lambs and sheep under 7 years old and a largely closed export market. Efforts to rehabilitate the Baddia have included a banning on cultivation, the establishment of grazing protectorates and the revegetation of large areas with native plants. Unfortunately these efforts have been undermined in recent years as the grazing protectorates have been opened to sheep.

<u>Policy recommendations</u>

Property rights should be redesignated, and groups should be given responsibility to manage given pieces of land for the good of their group. This will encourage good grazing management and by necessity good management of the steppe. It may not be best practice for these groups to be based on current cooperatives, rather some amalgamation of the current cooperatives should be possible, perhaps reducing the number of grazing groups to less than 100. Penalties for utilising land outside a herders' specified 'area' without agreement should be strongly enforced. This system could be enhanced by providing incentives for good management. This could be achieved by getting each group to develop a 'Management plan' for their area, specifying activities to be undertaken by the group. Adherence to this plan would attract some financial support. Other recommendations are to cease provision of further water for stock, remove the subsidy on feed, and consider fixing the amount of feed given to any one herder so as to not permit expansion of his flock beyond the current size. Finally, the removal of slaughtering restrictions and relaxation of export restrictions would encourage a lower stocking density.

Soil management

The soils of Syria suffer from water and wind erosion, salinisation and chemical pollution. Wind erosion effects the greatest area (1.6 Mha) of these three, and chemical degradation the least. In total 17.3% of Syria is affected by some form of degradation. Of the 125,000 ha affected by salinity, 72% is in the highest class of degradation (EC m moh/c.m > 16), 20% is moderate (EC m moh/c.m 8-16) and 8% is only slighted salinised (EC m moh/c.m 4-8). The areas most affected by salinisation are the Euphrates and Khabour valleys, an area south east of Aleppo and an area in the extreme east of the country, north of Albo-Kamal. Problems of salinisation are accentuated by the insufficient and inefficient drainage that exists on most cultivated land. Reclamation of land of high salinity (EC > 16) is undertaken, with some success, but no best method of reclamation has been devised.

Evalaution and policy interactions

There is no specific policy for the soils of Syria. Soil degradation is occurring because of the impact of policies related to water use on cultivated areas and resource management of the Baddia. Many of the soil related issues have been dealt with as part of the recommendations relating to these topics. It is clear that soil conservation is an important long term issue for Syria, and needs to be dealt with effectively. This basically means transferring existing knowledge from projects in Syria, and elsewhere, and making these happen over the majority of Syria's cultivated land.

Policy recommendations

Rehabilitation of the Baddia should continue, at least at current levels, if not increased. In order to aid this work consideration should be given to redirecting resources currently given to forestry and land clearing to combating desertification. Drainage should be improved in irrigated areas and some consideration should be given to the costs and benefits of developing cropping systems that minimise soil erosion through the use of non-cropped strips and windbreaks in cultivated areas. Further work should be undertaken on the best methods of rehabilitating salinised land, and a network of monitoring sites for soil quality and erosion across should be established across all agricultural systems in Syria.

Forestry

Historically Syria would have been far more forested than it is presently. Current forests cover 2% of the land area, down from about 32% at the beginning of the 20th century. The causes of natural forest loss have varied, and include extensive land clearing for human settlements and agriculture, grazing by goats, sheep and other animals, illicit felling, burning for charcoal production, fires and inappropriate agricultural practices. Substantial afforestation and reforestation programs have been launched to increase forest areas. Forest reserves have been declared in Syria. Work on sand dune fixation, green belts, roadside plantations and urban forests has been intensified. The rate of afforestation in Syria has increased from 159 ha/year during 1953-70 to more than 24,000 ha /year during the 1980s. These measures have been sufficient to slow, but not arrest deforestation.

Evaluation and policy interactions

Rigid adherence to the planting plan may be inefficient as so many trees fail to establish. The requirement of each Governorate to meet set targets tends to force them to plant on land which may not bring the highest return nationally. Many species of tree are planted, including species not native to the country or region. The introduction of exotic trees can become a future environmental problem. Many of the protected areas are forested, but they are not well managed. More forestry effort could go into managing these areas. Most tree planting is on State land. There may be environmental benefits in planting more trees on private lands, especially of agroforestry and/or multipurpose trees. Forest fire is not a major problem, but better forest management may reduce losses. Poorly motivated forest guards do no protect the forests very well. The policy of land clearing and planting trees has been successful, but from an environmental point of view such land clearing is not a priority. The resources could be better spent on preventing erosion. Policy in the citrus sector seems to have been successful, and the sector seems responsive to environmental concerns, but it is hindered in its biocontrol by the bureaucracy and processes surrounding the import of biocontrol agents.

Policy recommendations

The forestry planning system should move from a system of area based planting targets to one based on survivorship targets. Good treatment of seedlings in nurseries, careful planting and good after-care can significantly improve the survivorship of tree seedlings, and thereby save resources. The plan should also ensure that areas to be planted would be those that provide the greatest national environmental benefit. Of particular national concern is the need to combat desertification, which is not a common problem across all Governorates. Similarly planting around existing protected areas may serve to benefit local people and relieve exploitative pressure on these natural forests. Consideration should be given to the species planted, and particularly the role non-native trees should play in the planting plans. Consideration may be given to the use of sewage sludge in forestry and greenbelt projects. Benefits may accrue from increasing planting on private lands, perhaps as part of erosion control schemes, and an evaluation of the costs and benefits of such a strategy would be useful. Finally mechanisms should be developed for encouraging biocontrol in citrus, grapes and other sectors, and in particular on streamlining the import processes of biocontrol agents for citrus.

Biodiversity

The biodiversity of Syria is poorly recorded, however existing data suggest Syria has many species of international importance. Declines have been reported for numerous species over the last 50 years. Species particularly affected by these declines include many mammals (eg gazelles, onagers, wolves, wild buffalo). The cause for many of these declines is believed to be over hunting and habitat degradation. There is an unusual diversity of ecosystems occurring over relatively small spatial scales in Syria. The geographic situation of the country makes it an important area for migratory birds. For this reason some of Syria's habitats, particularly its wetlands, are of real international importance. Syria has a rich culture of agro-biodiversity, which is worthy of conserving for potential future use.

Currently there are 13 recognised protected areas in Syria covering 0.6% of the land area. This is one of the lowest percentages of total land area in protected areas of any Mediterranean country. These protected areas have been recognised by law over the last 30 years. Despite the national legislation these protected areas are not well developed and none of them are recognised by international standards. There are no marine protected areas in Syria.

<u>Policy interactions and evalaution</u>
The protected areas are not particularly well managed, and this sends the signal that biodiversity is not an issue of major concern to the Government. This signal is reinforced by the lack of protection given to certain forests and grazing protectorates. Current agricultural policy does not incorporate any incentives to conserve biodiversity. This is despite the excellent example set by the biocontrol strategy in the Citrus sector. The relative paucity of environmental education in schools, colleges and Universities leads to the population of Syria having a relatively poor level of environmental awareness. This is a real hinderance to furthering environmental objectives in the country. Environmental education is not helped by the absence of any public zoos and botanic gardens in Syria. Recent development of the Biodiversity Unit within the Ministry of State for Environment is a positive step, and its recent reports on biodiversity in Syria are useful starting points for further work.

<u>Policy recommendations</u>
All land currently designated as a protected area is owned and run by MAAR while MSE has responsibility for achieving international biodiversity objectives. This situation of shared responsibility may cause difficulties in the future, and it may be useful to review administrative procedures and consider whether the balance of responsibilities and authority for actions within Government are appropriate. The major priority for conservation work is to develop and enhance existing protected areas and this may require prevention of further degradation, establishment of 'buffer zones', planning control, and work with local communities to develop sustainable management plans. In terms of species conservation, support should be given to developing and enacting species action plans, enforcing laws which prohibit the illegal shooting and trapping of wildlife and undertaking an education programme on the importance of not shooting or trapping wildlife.

Prioritisation of policy recommendations
From an environmental point of view all the recommendations should begin as soon as possible. However, resources are constrained and this is clearly impossible. For this reason the recommendations are grouped according to the time scale for action. The groupings are made according to a combination of criteria which include, ease of initiating the policy, logical groupings of recommendations within a subject area, their relevance to on-going plans and their importance. These groupings are shown in the Table A below.

Within each grouping certain policies are of higher priority than others, and this is indicated on a three point scale, where 1 is the highest priority and 3 the lowest. The priority of a policy indicates its importance, and suggests that it should be addressed as soon as possible, and perhaps be worthy of more resources than other lower priority recommendations.

Table A. Time scale and priority for initiating policy recommendation. Some of these recommendations are to continue with certain policies, clearly these do not need to initiated. Priority is designated on a three point scale, where 1 is the highest priority. C denotes a continuing policy. Not all the policy options discussed previously are presented as recommendations. Numbers refer to the sections in Chapter 7 where these options are discussed more fully.

a) First group, for immediate attention

Subject area	Recommendation	Priority
Water and crops	7.2 a) Metering of water use	C
	7.2 f) Establish adequate drainage	1
	7.2 g) Research reclamation methods	2
	7.2 h) Research water efficient rotations and crop intensification	1
Sewage	7.3 a) Develop sewage treatment plants as planned	C
	7.3 c) Seek to separate industrial pollution from domestic waste.	2
	7.3 d) Transport treated waste water down closed pipes, not open channels.	3
	7.3 f) Ensure use of sewage sludge is non-polluting	2
	7.3 h) Research and monitoring of treated water	2
Al Baddia	7.4 c) Restrict further provision of water for stock	1
	7.4d) Remove slaughtering restrictions	2
	7.4 e) Relax import/export restrictions	3
	7.4 f) Provision of feed	1
	7.4 g) Maintain cropping ban	C
	7.4 h) Research and monitoring rangeland condition	2
	7.4 j) Rehabilitation of Baddia	C
Biodiversity	7.5 h) Support the Talila project	3
Forest	7.6 d) Consider the use of sewage sludge in forestry	2
Soil	7.7 a) Develop cropping patterns that minimise soil erosion	1
	7.7 b) Redirect resources from forestry and land clearing to combating desetification	1
	7.7 e) Monitoring of soil degradation	2
General	7.8 b) Develop environmental impact assessment procedures for all policies	2

b) Second group.

Subject area	Recommendation	Priority
Water and crops	7.2b) Education in irrigation and water management	2
	7.2d) Establish a Quota and Fine system	1
	7.2i) Research management plans for cropping areas	1
Al Baddia	7.4a) Redesignate property rights.	1
	7.4b) Provide incentives for good environmental management	1
	7.4i) Education of extension officers and herders about rangeland management	2
Biodiversity	7.5a) Review administrative structures	2
	7.5b) Develop and enhance existing protected areas	2
	7.5 j) Education on biodiversity issues	3
Forest	7.6a) Change rationale of planting plans	2
	7.6b) Target planting areas to those giving most environmental benefit	1
	7.6 c) Consider the species planted.	2
	7.6 g) Improve management of forested areas	2
	7.6 h) Consider the benefits of land clearing	3
	7.6 i) Develop mechanisms for encouraging biocontrol in citrus and other sectors	2
General	7.8 a) Training of extension officers	2

c) Third group (to be initiated after other actions have been initiated)

Subject area	Policy recommendation	Priority
Sewage	7.3 b) Enhance the treatment of ensure it meets international standards of cleanliness. 7.3 e) Seek to provide drinking water for Ghouta from non-contaminated sources.	1 3
Biodiversity	7.5 c) Promote species conservation 7.5 d) Identify and develop new protected areas. 7.5 e) *Ex situ* conservation 7.5 f) Encourage biodiversity on-farms 7.5 i) Research on species abundance and distribution in Syria	3 2 2 3 3
Forestry	7.6 e) Planting around protected areas 7.6 f) Increase planting on private lands	2 1
General	7.8c) Development of indicators of environmental sustainability	2

CHAPTER 1. GENERAL INTRODUCTION TO THE ENVIRONMENT AND LAND RESOURCES OF SYRIA

1.1 Geography

The Syrian Arab Republic lies on the eastern coast of the Mediterranean Sea, bordered by Turkey from the north, Iraq from the east, Palestine and Jordan from the south, and by Lebanon and the Mediterranean from the west. The total area of the Syrian Arab Republic is 18.5 million hectares out of which 6 million hectares are cultivable and the remainder area is steppe and rocky mountains.

Topographically, Syria can be divided into three main regions (NCSBD 2000):

- The coast and coastal region

- The Interior Region, which itself can be split into several distinct areas, and includes the Orontes Basin, the plains of Damascus, Homms, Hama, Aleppo, Al Hassakeh, and Dara'a.

- The Steppe (Baddia), which consists of the desert plains situated to the southeastern part of the country.

1.1.1 The Coast and the Coastal Mountains

The Coast and the Coastal Mountains is an area of approximately 2,700 square kilometres. It is divided into two parts: the Western part which occupies the coastal plains, and the mountainous Eastern part. The coastal plains are approximately 200-300m above sea level. Their length is approximately 210 km and their width is between 10- 30 km.

The Eastern part of the Syrian coast is occupied by mountainous ranges i.e. Amanous Mountains in the North. These mountain ranges extend from the North East to the South West with an estimated height of 1,500 m. These mountain ranges constitute a partition, which separates the Bay of Alexandarona in the West and Al Omk Plain in the East. It is separated from Al Bayer Mountain Ranges and Al Bassit in the South by the lower drain of the Orontes River, which extends to the plain of the valley of the River Al Kabeer Al Shamali and the valley of the River Al Kandeel. The highest peak of these mountain ranges is Al Aqraa, 1,720 m above sea level. The third mountain range is the coastal mountains which extend between the Valley Al Kabeer Al Shamali River in the North and the Valley of Al Kabeer Al Janoubi in the South. The length of these mountains is 130 km from North to South and their highest point Slenfeh Mountain which has a height of 1562 m above sea level.

The land of the coastal region is comprised largely of limestone. There are cretaceous rocks, which are formed of dolomite and limestone. There are igneous rocks in specific small areas and amophic rocks, quartz and marble of continental or marine origin are also present.

1.1.1.1 The High Mountains

The High mountains constitute 5,000 m^2 in area and reach altitudes of $> 1000m^2$. This region is bounded in the southwestern part by occupied Palestine, in the East by Al Baddia (steppe) regions, in the north by the Orontes Basin and in the West by Lebanon. It is divided into four parts, the East Lebanese Mountains, the Kalamoun Mountains, Zabadani, and Mount Hermon. The East Lebanese Mountains are part of the mountains which run parallel to the Syrian-Lebanese border between Hisiah Mountain in the South West to the meeting point of the Syrian Lebanese-Palestine border in the South West. This mountain chain is 175 km long with a width of 15 being within the Syrian territories. The highest peak in the region is Moses Peak, 2,629 m.

The Kalamoun Mountains include a number of parallel mountains with heights between 1500 and 2,000 m. Mount Hermon is situated in the south west of Syria (height- 2,814 m), and is the highest point in Syria. Topographically Zabadani forms a link between the East Lebanese Mountains and the Kalamoun Mountains in the northeast and Mount Hermon in the southwest. The Barada River flows from Zabadani constituting a narrow and deep drain.

1.1.2 The interior region

This region is quite varied in character and includes the Orontes basin, the south western region around Dara'a, Aleppo and surrounding areas and the Euphrates valley.

1.1.2.1 The Orontes Basin

The Orontes Basin is located to the East of the coastal mountains, and extends longitudinally, parallel to the coastal mountains, from the North at the Syrian- Turkish border to the South at the Syrian-Lebanese border, meeting the Aleppo hills and plains in the East. It has an area of 16,300 km^2.

The Orontes Basin is a continuation of the rift occupied by Al Omk and Al Ghab plains in Syria and Beka'a Valley and Jordan Valley and the Dead Sea to Al Aqaba Bay in Jordan. The Orontes River, which flows from the Lebanon, runs through these basin and heads northwards in the Syrian territories to Quatina Lake in Homms. It then flows through Al Omk plain before turning westwards passing through Antioch and to Souedie Bay in the Mediterranean.

The Orontes runs through conglomerated rocks, limestone, sandstone and marl. These rocks are covered with fertile soil which appears mainly in the plains near the end of the Orontes River .

There are number of mountains and various topographic formations in this basin such as Al Zaweiah Mountain with a height over 800 m and Jeser AI Shagour and Darkosh heights from 500-600 m, and the Knirdish Mountain (Kurd-Dagh) and Samaan Mountain, 870 m.

1.1.2.2 The South Western Region

The South Western Region is situated in the South Western part of Syria. It runs parallel to the Syrian-Jordanian border in the South, the Syrian-Palestinian border in the West, Al Baddia region in the East and the lower end of the East Lebanese Mountain and related mountains in the North. The area of this region, which is approximately 12,500 km^2, is formed from hills and plains with an approximate height of 650 -850 m in Jabal AI Arab (Al Arab .Mountain). It is below sea level in Al Hima area (-212 m) and Al Yarmouk valley (-156 m). This region is divided into four main parts, i.e. Damascus Basin, Jabal AI Arab, Horan and the Golan. Igneous rock is frequent in this region varying in thickness from a few metres to 1,500 m. Other areas of this region are covered with sedimentary formation of marine or continuous origin, which are mainly formed from sedimentary rocks, conglomerates, sand, and clay.

1.1.2.3 Aleppo Hill and Plains

This region extends to the east of the Orontes Basin to the Euphates Valley. It also extends from the Syrian- Turkish border in the north to Somareah Mountain Ranges and Ralaas Rishri in the south. The lands of this region are mostly hilly plains with an approximate height of 350-450 m. The height increases towards the north, 650 m and the west 850 m (Al Zaweiah Mountains 850 m). Some lowlands and salt marshes such as Al-Matkh and Al-Jabboul etc. appear in this region. These lowlands and marshes receive the waters of the rivers which run seasonally such as Quaik River, Al Dahab River and the water of the valleys which come from the nearby hills and mountains such as Al His Mountains (550 m) and Sheib Mountain (450 m).

1.1.2.4 Al Jazerah and the Euphrates Valley

This region is situated in the northeastern corner of Syria between the Tigris and the Euphrates. It has an area of 51,000 km^2. It is divided into three geological areas: The Upper Jazerah, the Lower Jazerah and the Euphrates Valley. The lands in this region are mostly plains with an approximate height of 350 m above sea level. The lowest area is Al-Bawara, a salt marsh and the highest is the peak of Abdul Aziz Mountain which is 950 m above sea level. This mountain, together with Sinjar Mountain and Tawal Al-Aha Mountain, form the dividing frontier between the Upper Jazerah and the Lower Jazerah. Al-Khahour and Blekh Rivers, which are the tributaries of the Euphrates in Syria, run through these mountainous areas. There are some hills and other mountains such as Korah Shouk Mountain (769m), Kawkab Mountain, Matkhar Al- Gharhi and others. The area situated between Al-Khahour River and the Iraqi border is characterized by clay lowlands, plains with no drainage, and salt marshes. These areas are poor in natural vegetation.

The stone layers in this region are mostly made up of limestone, gypsum and clay. In the lowlands, they are mostly sedimentary formations which date back to the Biliosene. The thickness of this Euphrates layer is approximately 1,500 m. It is made up of sand and clay rocks, limestone and gypsum especially in Deir Ez Zor area. Some areas of the Euphrates Valley, Khabour and Blekh are covered with sedimentary formations (newer than Neogene). Igneous rocks are present in some areas. Most of these rocks are made up of Basalt. Syrian oil reserves, which date back to Kretesi and Teryasi times, are present in this area.

1.1.3 Al Baddia

Al Baddia covers the dry and semi-dry areas in Syria. This region extends from the Syrian-Jordanian-Iraqi borders in the South, Palmyra Mountains in the North, Euphrates valley in the East, to Jabal AI Arab and Damascus Basin in the West. Mountain series are frequent in the Northern frontiers of this region, such as Palmyra Mountains which are separated from Ralas Mountains and Shomeriah by the closed Doh Basin which has a length of 90 km and a width of 10 -15 km and an estimated height of 550 m. This region consists of structural lowland covered by sedimentary formations carried by waterfall valleys coming from the nearby mountains. Yet, this region has a desert soil which is poor in biological resources and is exposed to water and sand erosion.

The peak of the Ghantous Mountains is 1,406 m, and extends south of the Palmyra Mountains and Bishini Mountains, and is divided into two parts, Al Hamad in the south and in the west AlI Gheedat in the north and in the east. These two areas are separated by a rocky mass called Trat Al Alab. Al Hamad is higher than Al Gheedat. Dry desert valleys spread in this area such as Al Raeer (Camel) Valley, Seventh Wells, Al Sham. The Al Gheedat area is characterized by its steep slope towards the Euphrates Valley. It has a height of 500 m in the west and 200 m in the east. Longitudinal valleys spread in this area, such as Al Hil Valley, Srayam, Sawab and many others. Wide lowlands and salt marshes also spread in this area, such as Al Mooj Salt March in Palmyra Basin and the remains of Palmyra Lake.

1.2 Climate

The climate of the Mediterranean prevails in Syria characterized by its rainy winters and dry and hot summers. The two seasons are separated by two short transitional seasons. From the climatic point of view, Syria may be divided into four regions according to the rainfall. The rainfall is affected by the Syrian mountainous ranges and the Western Lebanese mountains. The coastal area is characterized by its heavy rainfall in winters and moderate temperature and high relative humidity in summer. The interior area is characterized by its rainy winters and hot and dry summers, and the large daily differences between the maximum and minimum temperature. The mountainous area with an altitude of 1000 metres or more is characterized by rainy winters where rainfall may exceed 1000 mm and with a moderate climate in summer. The desert region is characterized by a small amount of rainfall in winter and hot dry summers.

1.2.1 Temperature

The daily differences between the maximum and the minimum temperatures are generally quite high in most of the country. This difference sometimes reaches 23 ^{o} C in the interior region and around 13 ^{o} C in the coastal region. The fluctuations in temperature are greater in the interior and desert regions compared with the more moderate areas on the coast or in the mountainous areas of high altitudes.

December and January are the coldest months of the year while July and August are the hottest. In winter the temperature frequently falls below 0 ^{o} C (in all regions except for coastal areas) but rarely under -10 ^{o} C (North Aleppo and North Hassaka), while in summer it may rise frequently up to 45 ^{o} C (Al Baddia and Al Hassaka).

1.2.3 Precipitation

During winter, snow falls over all regions with an altitude exceeding 1500 m above sea level. Regions with an altitude of 800-1500 meters are subject to both rain and snow. Other regions with lower altitudes are subject to rain, and occasionally snow, except desert regions where sufficient rain seldom falls. Frequently thunderstorms accompanied by heavy showers occur during winter and the intensity of such showers reaches 75mm in 24 hours in some regions.

The mountainous and coastal regions are the regions of heaviest rain (Figure 1.1). Second in order are the northern regions (North Aleppo, Kamishly and Malikieh). Most of these rains are due to depressions accompanied by fronts coming from the Mediterranean. When they meet the mountains they are forced to rise and precipitate as snow and rain over these regions and the interior. The southeastern and the desert regions are the parts with the least amount of rain. From time to time, the country is subject to dry seasons and the rain shortage leads to a great decrease in agricultural production.

1.2.4 Relative Humidity

Except in the coastal area, the Syrian weather is characterized by high relative humidity during winter and low relative humidity in summer. In the coastal area, due to the effect of the sea, the contrary is normally the case. The desert and semi desert areas have the lowest relative humidity. During summer, the rate of humidity in the interior region varies from 20-50% and in the coastal region it varies from 70-80%. In winter it varies from 60-80% in the interior region and from 60-70% in the coastal region.

1.2.5 Wind

During winter, the prevailing winds in the eastern part of the country are easterly and in both the northern and northwestern parts are northerly. While other parts of the country are subject to westerly and southwesterly winds. During summer the prevailing winds in the northeastern part of the country are northerly and the remaining parts of the country are subject to westerly and southwesterly winds.

Some local winds blow over a number of regions during both summer and winter for limited periods only. Thus northeasterly winds are observed over the north eastern region and south eastern regions. Southeasterly winds blow over the middle of the desert. During summer the coastal region is subject to the sea winds which are westerly in the day and become reversed at night. Damascus region, in particular, is subject to northwesterly winds that blow continuously every afternoon.

Figure 1.1. Distribution of rainfall in Syria (mm contour bars).

During winter, Syria is subject to the influence of the high atmospheric pressure front formed at the centre of Siberia and also to the low-pressure front formed in the Mediterranean (or approaching from the north east). The Siberian fronts can cause snowfall if they happen to meet the air masses coming from the Mediterranean. The latter air masses are largely responsible for the rainfall in winter. In summer, Syria is simultaneously under the influence of the extended low pressure area of the Arab Gulf and the Red sea pressure front, thus dry territorial winds predominate. The winds are very hot when they blow from the Arabian desert or from the western desert in north Africa. There is little or no rainfall during summer.

1.3 Land Use

A large proportion of Syria's land is either steppe or uncultivable (Table 1.1). Given the annual population growth rate of 2.4%, this places increasing pressure on the cultiveable land to provide increasing food resources. However, the amount of cropped land has decreased over recent years (Table 1.2), largely due to losses erosion and salinisation (Chapter 4). Only 3% of land in Syria is classified as forest, and again despite reforestation efforts this area is under pressure (Chapter 5).

Table 1.1 Basic land classification in Syria

Land type	Area (ha)
Cultivable land	5,987,000
Uncultivable land	3,727,000
Pasture and Steppe land	8,283,000
Forests	521,000
Total area	18,518,000

Table 1.2. Balance of land use 1989 –1998 (‘000 Ha) in Syria (source: MAAR, Agricultural economics department)

Years	Total cultivated land	Fallow	Area under crop	Non-irrigated: Under crop	Non-irrigated: under tree	Irrigated: under crop	Irrigated: under tree
1989	5502.9	107.1	5395.8	4117.3	608.4	551.9	118.2
1990	5626	160	5466	4138.2	634.9	574.5	118.4
1991	5576.2	722.8	4853.4	3408.7	656.3	668,4	119.9
1992	5554.2	432.9	5121.4	3545.8	669.2	771.1	135.2
1993	5425.7	487	4938.7	3376.9	548.5	889,3	123.9
1994	5486.7	617.4	4869.3	3221	566.2	955.6	126.5
1995	5501.8	520.2	4981.6	3306.2	586.6	964	124.9
1996	5469.8	827.7	4642.1	2915.6	600.3	998.4	127.7
1997	5521.2	718.1	4803.1	3008.3	627.2	1039.4	128.2
1998	5484	615.9	4868.2	3014.1	641	1078.7	134.4

1.4 Agricultural Settlement Zones

For administrative purposes the total area of rain-fed land (3,636,000 ha) is divided into five settlement (agro-climatic) zones. The boundaries are mainly drawn on the basis of the rainfall patterns (Figure 1.2). About (28-29%) of the cultivable land is located in the first agro-climatic zone, and (31-32%) in the second agro-c1imatic zone. 86% of the pastoral area is in the fifth agro-c1imatic zone, while 60-61% of the forest area is in the first agro-climatic zone. A description of the five zones is given below:

First Settlement Zone

This zone has an average annual precipitation greater than 350 mm. The total area of this zone (2,071,000 ha) represents 15% of the total area of the country. It is subdivided into two sub-zones:

- A sub-zone with rainfall greater than 600 mm where rain-fed crops are grown without any risk;
- A sub-zone with rainfall between 350 and 600 mm where crops are secure in two seasons out of three. According to the traditional agricultural plan (Chapter 2) this zone can be mainly cultivated with wheat, legumes, and summer crops.

Figure 1.2. The agro-climatic (settlement) zones in Syria, designated as I, II, III, IV and V.

Second Settlement Zone

This zone has an average annual rainfall between 250 and 350 mm. On average rainfall is adequate in two out of three seasons. Its total area (2,473,000 ha.) represents 13% of the total country's area. The main crops grown in this area are barley, wheat, legumes, summer crops and fruit trees.

Third Settlement Zone:

This zone has an average annual rainfall greater than 250 mm in more than half of the seasons. The total area of the zone is 1,306,000 ha representing 7 % of Syria' s total area. The main crops in this area area maize, lentils, and chickpeas.

Fourth Settlement Zone

This zone has an average annual rainfall between 200 and 250 mm in more than half of the seasons. The area under this zone is about 1,833,000 ha representing 10% of the total country's area. The actual cultivated area in 1993 reached 592 thousand ha, out of which 7 thousand ha were planted with trees and 585 thousand ha were planted with field crops (maize, wheat, barley, lentils, and chickpeas).

Fifth Settlement Zone

With average annual rainfall of less than 200 mm in more than half of the seasons this area is considered as rangeland and steppe. It covers 10,208,000 ha representing (about 55% of the total area of the country. This zone is not suitable for rain fed cultivation.

Within each settlement zone, the ideal crops and cropping patterns are determined centrally after extensive consultation between the local civil authorities and the respective bodies in the farming community. The decision is based not only on strict agro-climate factors but also on other criteria related to national objectives and policies, such as self-sufficiency in staple food commodities and, adequate supplies or raw materials for existing agro-processing plants.

It is also worth noting here that traditionally there has been a limit on land ownership across all of Syria. The permitted amount varies with location, and generally the worse the land, the more an individual can own. Current laws for Dara'a (in the south east) limit ownership to 140Ha, while in Ghouta, around Damascus, it is 15Ha.

1.5 Structure of this report

This study was concerned with investigating the impact of current agricultural policy on the environment of Syria. The aim of the work was to identify aspects of current policy and practice which may have a negative impact on the environment and to make suggestions for developing policy which could have at least a neutral, and at best a beneficial impact on the environment. These recommendations are made with the primary intention of seeking enhanced environmental management, but they take cognisance of other policy objectives such as food production, equity and efficiency.

The study identified 5 aspects of the environment for specific consideration, water resources, the Syrian Steppe (Al Baddia), soil conservation, forestry and biodiversity. Each of these are dealt with separately in the following chapters. However, while the structure of the report requires these issues to be treated separately, there are many issues which cut across these separate areas, and also across Ministries and Directorates. So while a single policy may effect several aspects of the environment, like soil, water and biodiversity, so too a single problem, like soil erosion, may need many changes of policy in order to achieve better environmental management. (NB: This work was not explicitly concerned with irrigation, rather with overall water supply and water quality. Issues of irrigation are dealt with in a separate report by Varela-Ortega & Sagarday (2001).

The final chapter of the report (Chapter 7) presents some policy recommendations which are aimed at enhancing the environmental resources of Syria. These are offered for consideration individually, and not as a package, and different policy options can be selected as appropriate.

1.6 Comment on Environment policy in Syria

A recent internal exercise within the Ministry of Environment considered the causes of environmental degradation within Syria and identified the three main reasons for the environmental degradation to be:

1) Government policies
2) Institutional problems

    (a) weak structure of institutions
    (b) lack of legislation
    (c) lack of environmental awareness
3) Lack of investment in environmental projects

Against this background it is highly appropriate that this report considers the impact of agricultural policies on the environment. However, it is important to stress the importance of addressing the other two main issues also.

For example, with regard to legislation, it is clear that there are many existing laws and regulations which could be applied to protect the environment within Syria, but these are generally poorly enforced. More widespread and consistent enforcement would be highly desirable. This should be possible after a draft environmental law, which is currently under discussion by the Cabinet, is finalised. This law had been agreed by the previous administration, but now needs to be amended. Under this law it should be possible to create Environmental Inspectors who will be responsible for upholding environmental law. If appropriately empowered, these inspectors should be able to fulfil an important role in environmental regulation and management.

There would also be undoubted benefits from increased environmental awareness in all layers of Syrian society. Poor environmental awareness is common across many Arab countries, and can only be addressed through education. In order to improve this situation it is necessary to introduce environmental education to all levels of education: elementary schools, high schools, colleges and Universities. When considering environmental education at University level it is important to note that widespread environmental awareness cannot be brought about by simply be setting up undergraduate or Masters level degrees in environmental subjects. Rather environmental issues should be stressed to a range of degree topics such as engineering, business studies, politics, public administration and agriculture. In addition there could be benefit in increasing the level of environmental training for Government officials across a range of Ministries. Despite this call for training of Government staff, it must be stated that many of the staff within the various Ministries interviewed during this work were well aware of the environmental problems of Syria, and had good technical knowledge of the relevant issues. Still, more widespread training within Government and industry should bring widespread benefits.

Interest in environmental issues has increased in Syria in recent years. Of particular note is the production of a National Environmental Action Plan (ERM 1998a) and a second related document detailing Environmental Action Plans for each river basin (ERM 1998b). Although written in 1998 these plans have yet to be accepted by the Government, and amendment continues. The documents themselves cover all the environmental issues relevant to Syria (including agriculture), and implementation of the plan would undoubtedly bring about major improvements in the Syrian environment. However, while the documents comprehensively list relevant environmental issues, and state potential solutions, these solutions are not laid out in detail, and many of the policy issues related to agriculture are largely ignored. So while there may be some overlap in the issues discussed in this report and in the National Environmental Action Plan, this report differs in its focus on agriculture and in particular on policy issues.

In addition to the National Environmental Action Plan, several other reports concerned with environmental issues have been commissioned in recent years. These include the Biological Diversity National Report (published by the Ministry of Environment, UNEP and Global Environmental Facility in 2000), and a Review of Fresh Water Quality (1997) completed for the Ministry of Irrigation. There are also numerous environmental projects being conducted with international agencies like UNDP and FAO that have recently commenced, or are about to commence. A move to real 'on the ground' action is to be welcomed as it became apparent during the completion of this report that there was an element of 'consultant fatigue' in some areas of Government, with a real desire in many Directorates to see some concrete action on the environment. Thus reflecting the third issue identified by the Ministry of Environment (MoE), the lack of investment in environmental projects.

CHAPTER 2. WATER RESOURCES AND CROPPING

2.1 Water Supply

Neither the supply of, nor demand for**,** water in Syria are well quantified, although several estimates have been made over recent years (one such example is shown in Table 2.1). The water balance presented here was developed in 1995 and suggests that demand almost equalled supply in the Barada and A'wag basin, while there was still considerable capacity to increase use in some other basins. Due to increased demand from domestic and agricultural uses, the balance has changed by 2001 such that all basins, apart from Euphrates and the Coastal Basin, show negative balances. For this reason areas planned to receive new irrigation schemes in 1999/2000 concentrated on the water of the Euphrates (4 out of 18 schemes) and Lake Al Assad (6 out of 18), with the majority of the others coming from other existing dams and wells.

Estimates of future demand suggest annual demand growth of around 2% over the next 20 years, this is lower than projected population growth, but would still require 51% more water to be abstracted by 2015 than was abstracted in 1997 (ERM 1998a). Syria is not alone in facing increasing water shortages, these problems are common to many Arab countries (Figures 2.1 and 2.2). Currently, though Syria is in a better situation than many other Arab countries, and the average supply of water in Syria is 1200 cumecs / human / yr. The long term average is above the water poverty level of 1000 cumec/hd/yr. However, the variation in supply between years is problematical. This variation in supply is related to variation in precipitation, both in Syria and in Turkey, which is the source of many of the rivers flowing through Syria (Appendix 2.1).

Table 2.1 Water Balance in Syrian (end of 1995). Total groundwater hard to determine, estimate as 2.5 x renewable amount. (Source: Directorate of Irrigation\MAAR).

Description			Basins								Notes
			Barada & A'wag	Yarmoug	Al Badia	Al Asi	Coastal rivers	Al Khabour &	Euphrates &	Total	
Water Sources Million cubic meters	Spring + Surface		578	182	209	1110	1557	417	6930	10983	Out of which 6623 m cu m/yr (temporary share of Euphrates)
	Underground - Renewable		272	265	182	1607	741	3225	1646	7938	
	Total		850	447	391	2717	2298	3642	8576	18921	
	Sewerage and industrial water		257	50	8	214	0	36	130	695	
	Agricultural sewerage		75	29	14	192	47	315	600	1272	
	Total available		1097	459	256.6	2715.5	1540.7	3628.8	9134.5	18832.1	Including lakes evaporation
Water uses Million cubic meters	Agricultural irrigation	ha	74384	37240	13871	239459	63684	408550	347603	1184791	
		million cubic meters	748	292	63	1915	473	3145	4100	10736	
	Household use	million people	4.089	0.943	0.113	2.528	1.829	0.669	4.105	14.276	Drink water of Aleppo are not from the Euphrates
		million cubic meters	275	61	10	170	123	45	270	954	
	Industry		67	5	1	116	24	3	84	300	
	Evaporation loss		6	36	15	115	15	51	1500	1738	
	Total use		1096	394	89	2316	635	3244	5954	13728	
Balance			1	65	167.6	399.5	905.7	384.8	3180.5	5104.1	

2.1.1 Surface Water

Rivers provide about 23% of Syria's water (Table 2.2), a large proportion of which comes from the Euphrates (mean flow = 1037 cumecs) and other rivers flowing from Turkey. This is an issue of some sensitivity, and it is believed that should they so chose, then the Turks could reduce flow in the Euphrates to zero (indeed some informants suggest they did stop it for 3 months in 1993/94). In 2000 the flow of the Euphrates was down by 25%. The current international agreement is for Syria to release 500 cumecs to Iraq, but in October 2000 it was 150 cumecs (cubic meters per second). This reduction is due to the decreased inflow from Turkey.

There are also numerous lakes and 165 dams (Tables 2.3 and 2.4). Of these dams 77 are for irrigations purposes, 19 are for the supply of drinking water, 34 for livestock and 34 are multipurpose. Of these dams 6 are classified as large, 56 as medium size and the rest as small.

Figure 2.1. Rainfall distribution in the Arab region (from ACSAD 1999a).

Figure 2.2 Aquifer productivity in the Arab Region (from ACSAD 1999b)

Table 2.2. Supply of water from different sources in Syria (billions of cubic metres)

Source	Volume	% of total resources
Rain	45.8	68
Rivers	15.1	23
Springs	3.9	6
Groundwater	2.1	3
Total	66.9	100

Table 2.3. The most important lakes in Syria (Source: Office of the Prime Minister, Central Bureau of Statistics, Statistical Abstract, 1998).

Lake	Location	Area km^2
Al Assad	Al Thaura/ Al Rakka	674
Jbool	Aleppo	239
Katteenah	Homs	60
Alotaibeh	Damascus	11
Khatounieh	Al Hassakkeh	3
Mzaireeb	Daraa	1
Al Baath	Al Rakka	27
Masaadeeh	Al Qunaitera	1

Table 2.4. The most important dams in Syria (Source: Office of the Prime Minister, Central Bureau of Statistics, Statistical Abstract, 1998).

Basin	No. of dams	Storage capacity (billion cubic metres)
Euphrates	2	14190
Barada & Al Aawag	4	7
Al Asassi	16	279
Al Badia	11	47
Al Sahel	6	268
Degleh & Al Khabour	10	409
Al Yarmoug	21	155

2.1.2 Groundwater

Syria is divided into 7 basins (Figure 2.3, Table 2.5), and the amount of ground water available has decreased in all of these basins over the last 10 years due to over-pumping. There has been a depletion in the depth of aquifers by 25-30m over 20-25 years. Thus depletion is occurring all over Syria, and near Damascus it is several m/yr while in Aleppo it is decreasing by 1m per year. One well studied area in Atareb showed an annual decline of 1.44m, as well as intra-seasonal variation, over a 15 year study of the static depth of the water table in Tal Hadya, 10km from Atareb (Rodriguez *et al* 1999). In Salamiyah there was uncontrolled pumping and for 10 years they had vegetable and trees, then the water ran out and there is very little agriculture left. In recent years farmers have been extracting more groundwater than previously, both because of the drought and also because they are being encouraged to use supplementary irrigation.

Figure 2.3. The seven water basins of Syria

Table 2.5 Sources of surface and ground water in Syria (Surface water for Euphrates & Aleppo includes the inflow of the Euphrates). Ground water includes wells and springs. (source: MAAR)

Basin	Area (km^2)	Rainfall		Population size	Average annual water resources (M cubic metres)		Total
		mm	Mm^3		Surface	Ground	
Barada & Awaj	8630	268	2297	3,505,683	20	830	850
Al Asi	21624	403	6822	3,197,110	1110	1607	2717
Coastal	5049	1294	6603	1,641,623	1557	778	2335
Dejla & Queboor	21129	402	8493	1,207,570	788	1600	2388
Euphrates & Aleppo	51238	208	10,691	5,160,867	478	371	849
Yarmoog	6724	287	1930	1,005,679	180	267	447
Al Badia	70786	138	9800	591,658	163	180	343
Total	185180	-	46636	16,310,191	4296	5633	9929

Several estimates of aquifer capacity have been made, starting with a Russian study in 1972-1980. Currently ACSAD is undertaking basin specific studies in order to estimate groundwater resources, and then model the impact of alternative water use scenarios on groundwater availability. The aim is to lead to water demand management for the future.

2.1.3 Wells

There are about 140,000 wells in Syria (licensed and unlicensed) (Table 2.6). Around 40% of wells are not licensed and illegal wells are still being dug, their number nearly doubling in the last 15 years. As from August 2000, illegal wells could be licensed as long as they were not near sources of drinking water, State wells, source of spring, Al Badia or areas of poor water supply.

Table 2.6. Number of wells in Syria 1986 – 1998 and the total area irrigated by these wells (source: MAAR)

Type	Year			
	1986	1990	1995	1998
Total wells	62,826	89,901	125,669	139,899
Licensed wells	26,677	42,879	74,559	73,729
Unlicensed wells	37,156	47,022	51,110	66,120
Area irrigated by wells	315,987	34,195	67,127	723,696
Area irrigated by licensed wells	-	-	53,030	559,706
Area irrigated by unlicensed wells	-	-	14,096	163,990

2.2 Current Water Use

Agriculture is currently a major user of water (Table 2.7), with nearly all this water is used for irrigation. About 710,000 Ha of crop land is irrigated from well pumped water. 187,000 Ha is irrigated with water pumped from rivers and springs, and 378,500 ha from public irrigation systems (Table 2.8). There are about 125,000 ha of irrigated tree across Syria.

Table 2.7. Current and projected water demand in Syria (source ERM 1998)

Sector	Current use	% of total demand	% in 2015	Growth per year
Domestic	852	9	14	4.2
Industrial	115	1	2	5.9
Agriculture	8,875	90	83	1.7
Total	9,842	100	100	2.0

Table 2.8. Irrigated land distribution in Syria by water source and Governorate of 1999-2000 (hectare)

Governorate	Source			Total
	Wells	Rivers and springs	Public irrigation system	
Damascus	473	989	0	1462
Rural Damascus	57371	16596	0	73967
Kuneitera	1938	92	2485	4515
Daraa	8308	955	19500	28763
Sweida	391	0	630	1021
Homs	25,379	5854	23073	54306
Hama	46,615	4849	8309	59773
Al Ghab	16,040	93	58858	74991
Idleb	35558	1897	6854	44309
Tartous	8757	3833	15668	28258
Al Ghab	4295	2270	37309	43874
Aleppo	84,901	22011	41622	148534
Al Assad	0	0	16927	16927
Al Rappa	46,137	41071	61859	167067
Euph. Basin	0	0	16308	16308
Deir ezzor	42,503	57246	8097	107846
Hasakeh	314,050	29073	60952	404075
Total	**710,716**	**186,829**	**378,451**	**1,275,996**

2.2.1 Irrigation Systems

Currently 90% of irrigation is surface irrigation. This is about 50% efficient. Sprinklers are 70-75% efficient and drip > 90% efficient. Water is conveyed to farms by Ministry of Irrigation systems. However some of the old irrigation systems use open channels, which are only 50-55% efficient. New projects are developing pressurised systems and hydrants. The use of these new technologies should increase efficiency to 75-80%.

The amount of water received by farmers, and the timing of its arrival, is set according to the plan according to crop, location and time of year. A certain volume/hr is assumed and the Government provide a given number of hours of water supply. However, the flow rate down the pipe and the time over which it is provided can vary. This reduces efficiency to about 80%. Farmers are responsible for maintaining the irrigation equipment on their land. But the Irrigation Directorate will provide support for them in this action. In particular they will help with clogging - which can be a problem.

Generally irrigated crops are poorly monitored. The introduction of on-farm gauges would aid management. This is indeed a Government aim and farmers are being encouraged to install water gauges. All new projects have water gauges fitted and all old ones will be fitted too.

Wells provide the irrigation water for the majority of the land in Syria (Table 2.8), being particularly prevalent in the Governorates of Hassakeh, but absent in Al Assad and the Euphrates basin. A large proportion of the well water used to irrigate the land is pumped from illegal wells which have increased in number over recent years (Table 2.6). Indeed the amount of land which has been irrigated from ground water almost doubled in the period 1990-2000, with the estimated volume from ground water increasing from 260,299 cumecs in 1990 to 437,296 cumecs in 1999, an increase of 68% (Table 2.9). The total volume of water abstracted from ground and surface water increased by 42% over the time period, while the irrigated area only increased by 68%.

Uncontrolled pumping occurs from wells and some surface supplies. Within irrigation projects the pumping is controlled. The amount of water supplied is negotiable with the Project management, but the baseline assumption is that the amount of water is supplied according to the needs of the crop rotation.

There is a Government commitment to introduce new methods of irrigation in order to improve efficiency e.g. sprinklers and drip irrigation. The target is to replace the old technology with new within 4 years. The budget for this is SP1000,000,000 in year 2000/2001 (US$ 2M). The Government will provide long term loans with no interest to farmers to help them achieve this - the cost of replacement is about SP100,000 / ha (US$ 2000/ha). This project started in Autumn 2000, but based on these budget and cost estimates it seems unlikely that all the irrigated area in Syria could be upgraded in 4 years without a significant increase in the annual expenditure.

2.2.2 Impacts of Future Water Shortage

The impacts of future water shortage would include:

- Reduced agricultural production / ha
- Reduced amount of agricultural land
- Reduced total yields
- Decreased availability of drinking water
- People spending more time travelling to get water
- Increased risk of water borne disease
- Poorer water quality in flowing water as dilution effect will be reduced

Each of these impacts brings economic costs, the severity of which will depend on the actual level of decline. The National Environmental Action Plan (ERM 1998a) suggests that the three most vulnerable basins to future water supply are the Barada, the Orantes and the Aleppo, and the estimates for costs of supplying alternative water to these areas over the next 15 years are shown in Table 2.10.

Table 2.9 Irrigated area and volume of irrigated water from all sources 1990-2000 (MAAR)

a) 1990-1995

Variable	Year				
	90-91	**91-92**	**92-93**	**93-94**	**94-95**
Area irrigated from groundwater (ha)	281,024	341,423	44,627	518,117	583,349
Area irrigated from surface water (ha)	335,593	337,081	347,008	398,029	419,861
Area irrigated from mixed sources (ha)	101,036	87,387	86,562	75,062	59,238
Total irrigated area (ha)	717,653	765,891	87,984	991,208	1,062,448
Water volume from mixed sources (cumec)	145,239	112,359	136,906	142,522	107,498
Water volumes from ground water (cumec)	260,299	312,714	466,195	512,236	571,052
Water volume from surface water (cumec)	422,871	457,416	58332	585,497	603,862
Total volume (cumec)	828,409	882,489	661,433	1,240,255	1,282,412

b) 1995-2000

Variable	Year				
	95-96	**96-97**	**97-98**	**98-99**	**99-2000**
Area irrigated from groundwater (ha)	601,987	60,946	599,992	609,942	553,726
Area irrigated from surface water (ha)	409,524	476,593	552,581	562,211	57,801
Area irrigated from mixed sources (ha)	7,475	74,786	7,318	7,534	75,429
Total irrigated area (ha)	1,086,261	1,160,839	1,225,753	1,247,493	1,207,165
Water volume from mixed sources (cumec)	129,439	140,838	134,042	112,366	109,314
Water volumes from ground water (cumec)	552,823	450,732	473,562	483,351	437,296
Water volume from surface water (cumec)	584,744	594,485	642,821	66,516	635,455
Total volume (cumec)	1,267,006	1,186,055	1,250,425	1,260,877	1,182,065

Table 2.10 Probable water resource shortfall in key basins and the costs of alternative supply (source ERM 1998a)

Basin	**Year**	
	2005	**2015**
Expected deficit (MCM / yr)		
Barada	193.75	223.20
Orantes	248.50	454.25
Aleppo	47.95	62.25
Total	**490.20**	**739.3**
Cost of alternative supply (SP M /yr)		
Barada	5810	6700
Orantes	7450	13630
Aleppo	1440	1870
Total	**14700**	**22100**

2.2.3 Payment for Water

Farmers pay an average of SP3500/ha of irrigated area. This payment covers the operation and maintenance costs of the irrigation network. The cost varies between irrigation projects, but it may be constant within projects regardless of the crop being irrigated.

Domestic users pay for water according to the following annual tariffs.

Households - 1-60 cumec - SP2.6
Households - 61-90 cumec - SP3.9
Households - 91-180 cumec SP11.25
Households - >180 cumec - SP15.30 / cumec
Industrial trade - SP180
Government - SP70

One interpretation of this tariff scheme is that the sliding scale does not represent water pricing, even though it appears to be a system where payment varies with quantity. Rather it is a means of supporting the poor - who do not use a lot of water. So the tariff covers operation and maintenance - with the poor getting their water subsidised by the rich.

2.3 Crops, Cropping Patterns and Water Demand

Syria has adopted a system of centralised agricultural planning whereby crop, and to some extent animal production targets are set centrally according to national priorities. Particular attention is given to planning the so-called strategic crops: wheat, barley, cotton, lentils, chickpeas, tobacco and sugar beet. Together these crops occupy about 75% of rainfed and irrigated land under cultivation. Wheat and cotton account for 96% of the total area of irrigated land planted to the strategic crops, and barley and wheat for 92% of the rainfed land. The Government affects prices in the domestic marketing chains for the strategic crops through direct intervention in the market by state establishments, through the setting of prices at which private sector enterprises are required to trade, through indirect taxation, and through policies that affect domestic supply and demand. Given that agriculture is the largest sectoral user of water in Syria, and also that the amount of land planted to individual crops is to a large extent planned centrally, this is a key area of policy – environment interaction. For this reason the details of the planning process for the strategic crops is described here. A more complete analysis of the cropping sector in Syria is given in Westlake (2000) and of the irrigation situation in Varela-Ortega & Sagarday (2001).

2.3.1 The Strategic Crops

Syria has a total of approximately 6.0 million hectares of potentially cultivable land of which about 5.5 million hectares have been cultivated in recent years. In 1998/99, some 4.6 million ha of this land were actually under cultivation with 960,000 ha left fallow. Some 28% of this cultivated land was irrigated. The seven strategic crops occupy about three- quarters of the 4.6 million hectares under cultivation, with the majority of the remainder being occupied by tree crops.

Wheat occupies 70% of the irrigated land that is devoted to strategic crops and cotton a further 25%. Barley, which is grown almost exclusively on rainfed land, accounts for some 55% the total of rainfed land planted to the strategic crops; wheat accounts for a further 37%. Together, wheat and cotton account for 96% of the irrigated land planted to strategic crops, for 79% of the irrigated land planted to all annual crops and for 71% of all irrigated land under crops. Barley and wheat together occupy similar percentages of rainfed land.

The per-hectare value of wheat, and especially barley, is relatively low compared to the main tree and horticultural crops. Thus, while the strategic crops still account for over half the total value of all crop production, they are less dominant as a contributor to value than as users of land. Within the strategic crops group, the farm-gate value of wheat is of the same order of magnitude as that of cotton, about five times that of lentils and of chickpeas and about 10 times that of sugar.

Cotton production is the largest employer of labour within the agricultural sector, providing more than twice as many person-days of work than wheat. Sugar beet and tobacco production are also labour intensive, together providing one third the combined employment of wheat and barley on less than 2% of the area. Lentils and chickpeas are the most labour intensive rainfed crops, providing more employment on rainfed land than wheat and barley combined, despite occupying less than one tenth of the area.

<u>2.3.1.1 Wheat</u>

A major policy objective of the Government is to seek self-sufficiency in wheat. This is a policy objective driven largely by issues of national security. This policy has been achieved in recent years, 1994 being the last year of major wheat imports, by a combination of (a) the accumulation of national strategic stocks and (b) the planting of sufficient land to wheat to ensure that national production is in line with demand.

About 60% of total production is hard, durum, wheat with and soft wheat comprising the remainder. The total area of irrigated wheat increase between 1987/88 and

1997/98 from 229,000 ha to 690,000 ha. However, the area of rainfed wheat has fluctuated around 1 million ha depending on rainfall conditions. In 1999/2000, the drought conditions and the resulting low output from rainfed land resulted in about 80 percent of total national production deriving from irrigated land.

The main wheat marketing organisation is the General Establishment for Cereal Processing and Trade (GECPT), which is responsible for the public marketing of wheat and also of barley, lentils and chickpeas. Two state-owned companies under the GECPT are responsible for milling and for baking: the General Company for Mills (GCM) and the General Company for Baking (GCB). Public wheat storage is undertaken by the General Company for Silos, Feed Mills and Seed Plants GESILOS).

The GECPT operates 140 collection centres for the purchase of wheat and barley from farmers which it classifies deliveries on the basis of foreign matter, defects and specific weight. About 70% of all production is currently sold to the GECPT with the remainder being sold to private mills or used for on-farm consumption or the local production of crushed wheat.

All but a small proportion of grain storage is owned by public sector establishments. Total covered storage capacity is some 3.35 million tons. In addition to this covered storage, large amounts of grain are also stored in the open in bags, especially in the immediate post-harvest period.

2.3.1.2 Barley

Barley is used in Syria principally for animal feed. A series of good harvests from 1993 to 1996, culminating in a record mean national yield of 1.07 tons per hectare in 1996, led to an export surplus over and above the domestic demand for feed and seed. Syria exported a total of almost 2 million tons of barley between 1993 and 1997. Over 99% of all barley is produced on rainfed land, mainly in agro-climatic zones 3 and 4. The area planted to barley fell progressively during the first half of the 1990s, from 2.89 million hectares in 1988/89 to 1.96 million hectares in 1994/95. There was a further sharp fall to 1.55 million hectares in 1996, after the banning of the planting of barley in zone 5 in 1996. After 1996 the national barley areas stabilised at approximately 1.5 million ha, before falling further to 1.33 million in the drought-affected 1999/2000 crop year.

The reliance of barley production on rainfall results in annual yields and production varying sharply from year-to-year. Barley output has been hit particularly hard by the recent drought. National yields have fallen in each year 1996, and by 1999 the yield was only 301kg per ha. In 2000 it fell further to only 98kg per ha.

Farmers now have a range of options for the disposal of their barley. They can retain it on farm for their own livestock, they can sell to neighbouring farmers, traders or private feed millers, or they can sell to the GECPT, which continues to act as a buyer of last resort. The means of acquisition by the GECPT is identical to that described above for wheat. In drought years, much of the barley produced is retained on farm, with the majority of the remainder being sold to private-sector buyers. The small crops in 1999 and 2000 have forced Syria to revert to importation. In 1999, 723,800 tons of barley were imported, all of it by private traders. With continued drought and low production in 1999/2000, the Government has again relied solely on the private importation of barley to meet the deficit. Private imports in the year to 31st December 2000 are expected to amount to between 800,000 and one million tons. All barley held by the GECPT is sold to the General Establishment for Feed (GEF), which either sells it directly to livestock farmers or uses it in its three feed mills. Both the GEF purchase price from the GECPT and the GEF ex-store selling price are set by the MSIT.

2.3.1.3 Lentils and Chickpeas

Lentils and chickpeas are winter crops that compete principally with wheat and nearly all of these crops currently grown on rainfed land. The majority of lentils and chickpeas is by small-scale farmers on their own land.

The amount of land planted to lentils and chickpeas is affected markedly from year to year by rainfall conditions, and for this reason no clear trend is evident in the area planted to either lentils or chickpeas over the past decade. Although the national yields per hectare are unstable from year-to-year, due to variations in rainfall, Syria normally produces an annual export surplus of these crops. Over the 11 years from 1989 to 1999, exports were equivalent to 61 percent of lentil production and to 32 percent of chickpea production.

The marketing of these crops has differed from the other strategic crops in that there has always been a significant amount of private trade in lentils and chickpeas. Here the GECPT effectively acts as a buyer of last resort. Both the GECPT and private buyers are permitted to export. Lentils and chickpeas are on-sold to the General Establishment for Consumption (GEC), which retails them at prices set by the MSIT. These retail prices are in theory applicable to private sector sales as well as to sales by the GEC, but in practice they are not systematically enforced.

2.3.1.4 Cotton

Cotton is a summer crop that requires irrigation. Some 98% of Syria' s cotton is produced on private farms, principally small farms that typically have about two hectares of cotton and rely principally on family labour. MAAR encourages farmers to adopt standard wheat/cotton rotations that result in cotton typically being planted once in every three years on suitable irrigated land.

The area planted to cotton has expanded substantially over the past decade from 156,000 ha in 1990 to a peak of 75,000ha in 1998. This has principally been the result of large increases in the total area of irrigated land in Syria. The recent drought, and the associated shortage of irrigation water, has forced reductions in the area planted to cotton. This area fell to 244,000 hectares in 1999 and 236,000 hectares in 2000.

Yields per hectare have increased substantially over the past two decades, rising from 1,625kg/ha in 1970 to a record of 4,180kg/ha in 1997. There are very large differences in yield between and within governorates, and between farms in the same locality. Individual farm yields typically range from 2,500 to 6,000 kg per hectare.

Farmers must deliver their cotton either to a CMO buying centre or to a CMO ginnery, where its quality is tested. Farmers receive a price that is paid at a premium or discount over a base price depending upon quality and delivery period. Early deliveries receive premium prices to encourge early planting. The CMO currently sells about 30 percent of its cotton fibre output to domestic spinners and exports the remaining 70%. After oil, cotton fibre is Syria's most important export commodity. Exports are sold at competitive world market prices through agents based in importing countries. Domestic buyers are required to pay cost-plus prices set by the MSIT. In the most recent 1999/2000 marketing year, domestic spinners were required to pay roughly 52 percent above the effective ex-ginnery price realised by exports. The CMO similarly sells cotton seed at cost-plus prices set by the MSIT .

Syria is able to export raw cotton because the CMO sells at international prices. Yarn and cloth manufactured in Syria from Syria cotton cannot be exported profitably at present because of the policy of selling cotton fibre to the domestic textile industry at cost-plus prices. Although cloth cannot be produced competitively, the high labour intensity of garment manufacture and the low wage rates in Syria mean that clothing can be exported at a profit, even when made from cloth produced from Syrian cotton. However, such exports are less profitable than if Syrian cotton were priced to the domestic industry at export parity.

2.3.1.5 Sugar

Sugar beet is produced on a small proportion of Syria's (2.3%) irrigated land, principally in the area from Homs northward to Idleb and Aleppo. Most production derives from small- scale farms. Planting is spread over three periods in the autumn, winter and spring with the aim of maximising the amount of beet that can be processed by factories in the vicinity of farmers by extending the harvest season for as long as possible.

The area planted to beet increased in the first half of the 1990s, peaking at 34,000 ha in 1994, and then declined to an average of about 27,000 ha in the years from 1996 to 2000. Yields in traditional producing areas range from 50 to 130 tons per hectare and those in the new areas from 20 to 80 tons per hectare. There are also significant differences in the yields obtained by individual farms within each governorate. There has been no obvious trend in yield since 1992. Yields in 2000 were reduced substantially by the impact of the drought on the water availability.

Farmers must sell their entire marketed crop to the General Organisation for Sugar (GOS). The GOS has seven sugar factories located in the main sugar-producing governorates, six of which currently process beet. Due to a mismatch between the location of beet production and the location of factory capacity, the GOS has to transfer about 30% of beet from the factory to which it is delivered to a factory in a different governorate. This leads to beet being transferred up to 10 times the total distance normally considered as the feasible maximum. In addition to the additional cost of transportation, this also leads to a significant loss in the sucrose content of the beet.

FARMERS ARE PAID AN OFFICIAL BASE PRICE ADJUSTED BY A PREMIUM OR DISCOUNT THAT DEPENDS ON THE SUCROSE CONTENT OF THEIR BEET. THESE PREMIUMS AND DISCOUNTS DO NOT REFLECT THE FULL PROPORTIONATE DIFFERENCES IN VALUE THAT RESULT FROM DIFFERENCES IN SUCROSE CONTENT. AS A CONSEQUENCE, IT IS IN THE INTEREST OF FARMERS TO MAXIMISE THE WEIGHT OF BEET THAT THEY PRODUCE PER HECTARE RATHER

THAN THE PER-HECTARE EFFECTIVE SUCROSE OUTPUT. THIS HAS RESULTED IN FARMERS OVER-APPLYING NITROGEN FERTILISER, CAUSING A DROP IN THE PERCENTAGE SUCROSE CONTENT TO 12% FROM THE 15.5% ACHIEVED IN THE 1980S. WESTLAKE (2000) RECOMMENDS THAT SUCROSE DISCOUNTS AND PREMIUMS BE SET AT LEVELS THAT ACCURATELY REFLECT THE FULL GAIN AND LOSS TO THE GAS OF DEVIATIONS IN SUCROSE CONTENT FROM THE BASE PERCENTAGE. IF THIS IS DONE, AND IS SUPPORTED BY AN EFFECTIVE EXTENSION CAMPAIGN, FARMERS WILL SEEK TO ADOPT OPTIMAL LEVELS OF FERTILISER APPLICATION WITHOUT THE NEED FOR ADDITIONAL ADMINISTRATIVE CONTROLS.

2.3.1.6 Tobacco

Syria produces a range of tobacco types on both rainfed and irrigated land. The irrigated area comprises less than one third of the total. However, irrigated yields are about three times those achieved on rainfed land, with the result that irrigated production exceeds rainfed.

Over the past decade the total area planted to tobacco ranged from 11,820 to 17,81 0 hectares, stabilising in the period from 1997 to 1999 to within the 15,000-16,200 ha range. There has been a marked increase in yield. Mean yields per hectare from 1995 to 1999 were some 35% higher than from 1989 to 1994.

Farmers must sell all their output to the General Organisation for Tobacco, which has processing and cigarette manufacturing plants in Latakia, Hama, Aleppo and Damascus. The majority of production is consumed in the domestic market, with a proportion exported, principally in the form of leaf. Domestic sales are made through distributors that receive a commission of 1.5% to 3% and licensed retailers who earn a further commission of 6%.

2.3.2 Producer Price Setting

The Government sets producer prices for the seven strategic crops, but does not intervene in the pricing of other crops. These prices are all set on the basis of unit costs of production. The objective is to ensure that a farmer who employs recommended agricultural practices is able to cover his costs and make a specific level of profit. Price setting does not explicitly take account of unit market value. Indeed, one explicit aim of government intervention in pricing is to isolate farmers from market forces.

TECHNICAL WORK ON COSTS OF PRODUCTION IS CENTRED ON THE MAAR DIRECTORATE OF AGRICULTURAL ECONOMICS. EACH YEAR THE DIRECTORATE PREPARES AN ESTIMATE FOR EACH STRATEGIC CROP OF THE NATIONAL PRODUCTION COST PER HECTARE. IT SUBMITS THESE COSTS TO A TWELVE-PERSON COST CALCULATION COMMITTEE THAT IS CHAIRED BY THE DEPUTY MINISTER FOR AGRICULTURE AND RURAL AFFAIRS. THIS COMMITTEE REVIEWS THE DIRECTORATE'S COST OF PRODUCTION ESTIMATES AND DECIDES FOR EACH CROP UPON A FIGURE OF NATIONAL YIELD PER HECTARE. FOR EACH CROP, THIS IS USED TO CONVERT THE PER

HECTARE COST TO A SINGLE FIGURE OF NATIONAL COST OF PRODUCTION PER UNIT OF OUTPUT. THE COMMITTEE THEN SUBMITS ITS UNIT COST ESTIMATE TO THE SAC TOGETHER WITH ITS RECOMMENDATION FOR THE OFFICIAL BUYING PRICE.

Until 1995/96, the SAC announced the producer prices at the end of the summer, in advance of the start of the new planting season. However, prices have subsequently been announced immediately prior to the harvest. Given the lack of price change for five years, farmers now reportedly assume that prices will again remain unchanged unless they hear to the contrary prior to planting.

THE DIRECTORATE OF AGRICULTURAL ECONOMICS AIMS TO PROVIDE THE COST CALCULATION COMMITTEE WITH A WEIGHTED PER-HECTARE COST THAT TAKES ACCOUNT OF THE VARIOUS NATURAL CONDITIONS AND PRODUCTION TECHNIQUES ENCOUNTERED IN PRODUCING AREAS THROUGHOUT SYRIA. SINCE ACCURATE UP-TO-DATE REGIONALLY-BASED SURVEY DATA ARE NOT AVAILABLE SYSTEMATICALLY FOR THIS EXERCISE, IT RELIES PRINCIPALLY ON AVERAGING THE PER-HECTARE COSTS GENERATED BY A DETAILED SET OF MODELS FIRST DEVELOPED BY MAAR IN 1994 WITH TECHNICAL ASSISTANCE FROM FAO/UNESCW A. OVER TIME, THE DIRECTORATE HAS ADAPTED THESE MODELS AS REQUIRED TO REFLECT CHANGES IN PRODUCTION METHODS, SUCH AS THE ADOPTION OF A NEW PLANTING TECHNIQUE, AND TO TAKE ACCOUNT OF CHANGES IN INPUT COSTS.

Next to the exchange rate of the Syrian Pound and the base interest rate, the producer prices for major agricultural commodities are probably the most important variables in the Syrian economy. They affect a wide range of other key variables, including the level and distribution of farm incomes, rural/urban income distribution, the profitability of farming and agricultural investment, the relative profitability of producing crops and therefore the pattern of land use, and the extent to which planned crop area and production targets are met.

The average national unit cost of production gives little indication of how a particular price influences these variables in any particular year. This is because unit costs of production vary enormously between governorates, between regions within governorates, between villages and between farmers within a particular village. Moreover, for each farmer, unit costs vary from year to year, especially on rainfed land, principally as a result of weather-induced variation in yield per hectare.

Efforts to use pricing to meet objectives relating to welfare, income distribution and, agricultural investment must take account of how costs vary between farm families and how they change from year to year. Efforts to use pricing to meet objectives relating to resource use must take account of how the relative unit costs of producing different commodities vary between farms and between years. Moreover, they must focus on marginal rather than average costs.

THUS, TO COME TO A WELL-INFORMED JUDGEMENT ON AN APPROPRIATE LEVEL OF PRICE, IT IS NECESSARY TO EMPLOY

INFORMATION ON VARIABILITY IN UNIT COST BOTH OVER SPACE AND OVER TIME. THUS, THE PRESENT SYSTEM OF SEEKING TO ARRIVE AT AND BASE DECISIONS ON A SINGLE AVERAGE UNIT COST OF PRODUCTION IS INADEQUATE. THERE IS NO SINGLE IDEAL MODEL THAT CAN BE EMPLOYED FOR PRICE SETTING. GIVEN THE LARGE NUMBER OF FUNCTIONS THAT PRICES PLAY, ANY ATTEMPT TO SET PRICES IS NECESSARILY HIGHLY PROBLEMATIC AND CONTENTIOUS. THE INTERACTION BETWEEN PRICE AND ENVIRONMENTAL IMPACT IT ALSO IMPORTANT, AS PRICES HIGHER THAN A MARKET PRICE MAKE ANY POLICY SEEKING TO IMPROVE THE ENVIRONMENT MORE EXPENSIVE THAN IS NECESSARY.

2.4 Annual Planning

The aim of the annual plan is to steer farmers towards a particular pattern of land use that the Government perceives as best able to meet national objectives. The plan also serves the important secondary objective of providing a framework at the start of the crop year for the provision of credit, inputs and other services to individual farmers.

2.4.1 The Annual Planning Cycle

The annual plans for agriculture are prepared between April and September for crop years that commence on 26th September. The planning cycle commences with MAAR preparing an indicative plan that shows the national target area to be planted on rainfed and irrigated land to each of 8 annual crops and 7 tree crops, together with targets for yield and production. The plan also shows target livestock numbers, animal productivity. This is used as a basis for the preparation by village committees within each governorate of provisional production plans for each village. These are then progressively aggregated, with a limited degree of modification at each stage of aggregation, into national totals of crop areas, yield and production that are reviewed by MAAR. Any revisions deemed necessary are agreed back down to the level of the village. MAAR then submits its consolidated production plan to the Supreme Agricultural Council, which normally approves the plan without modification.

This planning process is summarised below:

- April: Indicative planning figures are sent by MAAR to its governorate-level office.
- June: Each such office returns its tentative plans to MAAR in July.
- July: MAAR consolidates and modifies these plans in consultation with the governorates.
- August: MAAR submits a national plan to the Supreme Agricultural Council (SAC) for approval. September: Licences are issued to farmers.
- September (26th): The agricultural year commences.
- October to December: Winter field crops are planted.

Crop licences are issued to farmers in September prior to formal commencement of the official Agricultural Year on 26th September. Possession of the requisite licence enables to farmers to plant specific areas of rainfed and irrigated land to specific crops, and to obtain credit for inputs such as seed and fertiliser from the cooperatives. In relevant areas the licence should also signal the irrigation requirements of crops.

Licences must be obtained by all farmers with over one hectare of land purchase inputs. Farmers are legally bound to comply with the planting programme specified on their licence, although reports of farmers flaunting this requirement do occur. Farmers with less than one hectare may also apply for a licence so that they can also have access to state-provided support. The right to government support is withdrawn if farmers deviate from their licensed areas by significant amounts without good reason.

Within each village, all farmers must allocate the same percentages of their irrigated land to specific crops. In the case of rainfed land, the village is divided into sectors, each of which is allocated to a particular crop group or to fallow. Farmers must grow the crops specified for the zones into which their rainfed plots fall (ie barley in zone 3 etc).

The plan is monitored in two ways. First, the plantings of farmers relative to those on their licence are monitored by Plan Monitoring Committees that operate at the level of individual extension units. Second, MAAR undertakes comprehensive random sample surveys of planted area and of yield in collaboration with the Central Bureau of Statistics. These cover wheat, barley, lentils, chickpeas and cotton. Less formal assessments are made for minor field crops.

Yields per hectare have tended to be substantially over-estimated in annual plans in the period from 1989 to 1999 for all the strategic crops other than cotton and tobacco. Average cotton yields have been similar to those planned, while tobacco yields have averaged 16% above planned levels. Westlake (2000) suggests that this over-estimation may be the result of planners not taking sufficient account of the low yields achieved in drought years. The end result of the combination of area and yield biaises is that the annual production of each strategic crop frequently differs significantly from that planned. Other than for cotton and tobacco, the relative planned and actual yield data are consistent with this phenomenon. Yields have indeed been higher than those planned in some years, but in such years they have exceeded the planned levels by only relatively small percentages. Yields in poor growing years, on the other hand, have been well below those planned.

2.4.2 Five Year Plans

These annual plans lie within a five year plan. The five-year plans for agriculture have the overall objective of meeting a growth target for the sector set by the State Planning Council. For the current 8th Five- Year Plan, the target growth rate for domestic agriculture is 5.9%.

Plan development necessarily involves a series of compromises and trade-offs, and requires an iterative process that ultimately results in a set of relatively small planned changes to the status quo. The five year plans that emerge from this process contain annual national implementation targets and specify policies that will be adopted to help meet these targets and other plan objectives. Plan implementation targets include targeted annual growth rates for the area, yield and production of twelve major crops and production and yield targets for livestock products. The five-year plans for agriculture now employ notional rather than actual data for the base-year, in recognition of the fact that variations in annual weather conditions make data for a single year unsuitable.

IN THE 8TH PLAN, THE AREA AND THE YIELD OF ALL THE TWELVE MAJOR CROPS ARE TARGETED TO INCREASE, OTHER THAN FOR THE AREAS OF SUGAR AND TOBACCO. THE RESULTANT TARGETED ANNUAL PRODUCTION INCREASES RANGE FROM 2% FOR RAINFED WHEAT, BARLEY, LENTILS, CHICKPEAS, SUGAR AND TOBACCO TO 16% FOR OLIVES AND 16.5% FOR PISTACHIOS.

In practice there are major differences between the annual targets for each year contained in the five-year plans and the targets in each annual plan. This reflects principally the need to make adjustments to take account of unanticipated climatic and economic circumstances. The greatest differences have been for lentils and chickpeas for which the targeted production contained in the annual plans has averaged over 50% more than in the five-year plans.

Over the past decade, there have been substantial differences between the areas contained in the five year plans and the areas actually planted. In the case of rainfed land these differences are principally the result of the extent of planting being a function of rainfall. The deviations between planned and estimated crop areas on irrigated land are harder to explain. The general apparent over-planting could possibly be simply a result of an upward bias in the measurement of planted areas. Alternatively it could be due to farmers 'stretching' their irrigated area to make maximum use of publicly supplied water.

2.5 Three Case Studies on the Impact of Agricultural Practice on Water Resources

2.5.1 A Case Study from Atareb

RODRIGUEZ *ET AL.* (1999) HAVE ANALYSED THE AGRICULTURAL SYSTEM IN THE ATAREB VILLAGE, IN THE ATAREB DISTRICT OF ALEPPO, NORTHWEST SYRIA WITH THE AIM OF UNDERSTANDING THE RELATIONSHIPS BETWEEN AGRICULTURE, USE OF IRRIGATION WATER AND GROUNDWATER RECHARGE.

ATAREB IS LOCATED IN THE MORE HUMID PART OF THE ALEPPO PROVINCE, AND IS PART OF THE AGRICULTURAL STABILITY ZONE 1, BUT NEAR THE DRIER AGRICULTURAL STABILITY ZONE 2. THE MAIN CROPS ARE CEREALS (WHEAT, BARLEY), FOOD LEGUMES (CHICKPEA, LENTIL, FABA BEAN), FRUITS (OLIVE, PISTACHIO), IRRIGATED VEGETABLES (POTATO, ONION, GARLIC, TOMATO, ETC), AND SUMMER CROPS (MAIZE, SUGAR BEET, COTTON). GROUNDWATER RECHARGE IN THIS REGION DEPENDS ON RAINFALL, ROCK OUTCROPS AND MORPHOLOGY. RECHARGE RATES OF AROUND 15-20% OF ANNUAL RAINFALL MAY BE ASSUMED FOR THE WESTERN, MORE HUMID PART OF THE AREA (WAGNER 1997). THE SOIL TYPE IN ATAREB IS MAINLY A FINE CLAY THERMIC, CALCIXEROLLIC XEROCHREPT, WITH DEPTH BETWEEN 1.5 AND 2M.

The average seasonal water use of 25 of the villages' 83 farmers is shown in Table 2.11. When these data were considered alongside meteorological and hydrological data it was estimated that in 15-20% of the rainfall is potentially rechargeable, which equates to 47-63mm of the 315mm of rain that fell in the 1992/93 season. As farmers applied an average of 532mm irrigation from groundwater, then the recharge rate of 63mm is insufficient to maintain the groundwater levels, and an 88% deficit is produced. At these rates the estimated size of the catchment which would be needed to supply the 25 irrigators studied and their 221 ha of land with a truly sustainable water supply (ie non-declining with time) would have to be between 1870 ha and 2493 ha. This is about the size of the basin in the Atareb village, but this basin currently supplies 83 irrigators! In other words current use of irrigation water in this basin is entirely unsustainable.

If efficiency of water use for the crops grown in Atareb could be increased by 25% then the deficit could be reduced from 88% to 84%. While this may be achievable for winter crops, it will be very difficult to achieve this for summer crops.

2.5.2 Water use in Khanasser Valley (R Hoogeveen and A Bruggerman ICARDA *pers* comm.)

A SECOND STUDY UNDERTAKEN BY ICARDA REVEALS AN ANALGOUS SITUATION. THE KHANASSER VALLEY WHICH IS SOUTH OF ALEPPO. IN 1960 THERE WERE 7 WELLS IN THIS AREA. THE NUMBER OF WELLS SUNK INCREASE IN THE INCREASED IN THE 1990S, WITH THE NUMBER OF NEW WELLS / DUG /P.A. PEAKING IN 1993. 160 WELLS HAVE BEEN SUNK IN THE STUDY AREA IN THE LAST 10 YEARS AND DEEPWELLS WERE SUNK FOR THE FIRST TIME IN 1993.

Table 2.11 Irrigated land use (ha) in Atareb village, northwest Syria, by 25 irrigators during April-October 1993. (adapted from Rodriguez *et al*. 1999).

	April		May		June		July	
	Total	**Mean***	**Total**	**Mean***	**Total**	**Mean***	**Total**	**Mean**
Summer								
Sugar beet	31.8	3.2 (10)	30.3	3.4 (9)	34.3	3.1 (11)	23.8	2.6 (9)
Potato	25.2	1.7 (15)	30.3	1.7 (18)	27.3	1.7 (16)	1.4	0.7 (2)
Maize	7.4	0.9 (8)	8.4	0.9 (9)	12.0	1.0 (12)	11.5	1.0 (2)
Garlic	3.3	0.8 (4)	3.8	0.9 (4)	2.8	0.9 (3)		
Soybean					3.0	1.0 (3)	15.1	2.2(7)
Bean							4.7	0.7 (7)
Summer Potato							54.6	2.5(22)
Veg**	5.6	1.1(5)	6.2	1.0(6)	7.0	0.7(10)	11	0.8(14)
Total Summer Crops	**73.2**	**4.1(18)**	**78.9**	**3.8(21)**	**86.3**	**3.8(23)**	**121.7**	**5.5(22)**

Winter								
Wheat	119.2	5.2(23)	99.3	5.5(18)	32.3	6.5(5)		
Chickpea	4.4	0.9(5)	1.1	0.6(2)	2.0	1.0(2)		
Faba bean	11.7	1.1(11)	6.8	1.0(7)	1.8	0.9(2)		
Lentil	0.8	0.8(1)	0.8	0.8(1)				
Black seed	6.0	2.0(3)	1.4	0.7(2)				
Barley	2.0	2.0(1)	2.0	2.0(1)				
Total winter crops	**144.0**	**6.0 (24)**	**111.3**	**5.3(21)**	**36.1**	**4.5(8)**		
ALL CROPS	**217.2**	**9.1 (24)**	**190.2**	**7.9(24)**	**122.3**	**5.6(22)**	**121.7**	**5.5(22)**
		August		**Septem ber**		**Octobe r**		
	Total	**Mean***	**Total**	**Mean***	**Total**	**Mean***		
Summer								
Maize	4.3	1.1(4)	0.9	0.5(2)				
Soybean	15.1	2.2(7)	15.1	2.2(7)	5.5	1.8(3)		
Bean	6.3	0.6(10)	6.2	0.7(9)	3.9	0.8(5)		
Summer potato	58.6	2.5(23)	59.6	2.6(23)	59.3	2.7(22)		
Vegetable s**	13.0	0.9(15)	13.0	1.0(13)	3.4	1.1(3)		
Total summer crops	**97.3**	**4.2(23)**	**94.6**	**4.1(23)**	**72.0**	**3.3(22)**		
ALL CROPS	**97.3**	**4.2(23)**	**94.6**	**4.1(23)**	**72.0**	**3.3(22)**		

Studies with the with the farmers showed that in 1997/98 there were 147 ha of barley which received three irrigations of 680mm, 248 Ha of wheat which received an average of 5.4 irrigations of 1180 mm, 113 ha of cotton which received 15 irrigations of 3400 mm. The total withdrawals from groundwaters by farmers in 1997/98 totalled 7.7 MCM.

Withdrawals in 1998/99 were substantially less, totalling 4.7MCM. These were made up of 147 ha of barley receiving 3 irrigations of 680mm, 248 Ha of wheat receiving an average receiving 5.4 irrigations of 1180 mm and 23 ha of cotton receiving 15 irrigations of 3400 mm.

Calculation of recharge rate suggest a sustainable cropping plan for the Khanasser valley may be 250-426 Ha of barley or 144-245 Ha wheat, or something in between if a combination of crops were grown. The growing of cotton does not seem to be sustainable in this area, particularly as the groundwater is becoming salinised due to intrusion of the salty water from the nearby Jaboul salt lake which has salt levels 0.40-45 m.mol, and cotton accounted for 47% of salt water intrusion in 1999, which was a low cotton year.

This example emphasises that achieving sustainable water use is not just about matching demand to supply, it is also about maintaining water quality. If water being returned to an aquifer is of poor quality, then the overall quality of the entire resource is reduced, and may eventually become unuseable.

2.5.3 Water Use Efficiency in Radwania, Syria

OWEISS *ET AL*. (2000) CONSIDERED THE WATER USE EFFICIENCY (WUE), DEFINED AS THE RATIO OF THE REQUIRED AMOUNT OF WATER TO PRODUCE A TARGET PRODUCTION LEVEL TO THE ACTUAL AMOUNT OF WATER USED FOR WHEAT, BARLEY AND COTTON IN THE RADWANIA DISTRICT IN THE AL-SAFERA DISTRICT OF NORTH WEST SYRIA. THEY WORKED WITH FARMERS IN THE VILLAGE AND DEVELOPED MODELS OF WATER USE AND FARM CHARACTERISTICS. THESE MODELS WERE THEN USED TO ESTIMATE THE WUE OF THE FARMS IN THE STUDY AREA.

The theoretically calculated levels of required water are presented in Table 2.12 alongside the actual amount of water used. The WUE of 0.61 for wheat indicates that actual water use exceeded water requirement by about 39 per cent. Barley producers similarly over-irrigate their crop, by about 55 per cent. While cotton producers exceed water requirement by 24 per cent.

Table 2.12. Actual and required amounts of water use by crop in Radwania. Actual water used includes rainfall estimated at 2,844.4 m3. WUE = Water Use Efficiency This is defined as the ration of the required amount of water to produce a target production level to the actual amount of water used. (source: Oweiss T, Shdeed K & Gabr M (1999) Economic assessment of on-farm water use efficiency in agriculture. Methodology and two case studies. United Nations New York

Crop	Irrigated area (ha)	Av. Yield (ton/ha)	Actual water used (m^3)	Required water (m^3)	WUE
Wheat	5.21	3.391	7,677.49	4,720.59	0.61
Barley	3.27	2.245	6,614.75	2,971.54	0.45
Cotton	4.35	3.636	18,229.43	13,836.81	0.76

OWEISS *ET AL*. (1999) SUGGEST THAT THE LOW RATIO OF WATER-USE EFFICIENCY IN WHEAT AND BARLEY PRODUCTION SUGGESTS THAT A WIDE TECHNOLOGY GAP EXISTS BETWEEN THE RECOMMENDED SUPPLEMENTAL IRRIGATION PRACTICES FOR WHEAT AND BARLEY AND ACTUAL WATER USE. THEY GO ON TO STATE THAT 'THIS RESULT HAS IMPORTANT POLICY IMPLICATIONS, SINCE THE SYRIAN AGRICULTURAL PLAN ASSIGNS QUOTAS OF LAND TO BE PLANTED WITH WHEAT, WHICH ACCOUNTS FOR 35 PER CENT OF TOTAL IRRIGATED LAND IN THE SAMPLE FARMS. THEREFORE, IMPROVED WATER-USE EFFICIENCY FOR WHEAT CAN

CONTRIBUTE TO THE OVERALL WATER-USE FOR THE AGRICULTURAL SECTOR. IN THIS STUDY, THE OVERALL (COMBINED) WATER-USE EFFICIENCY FOR WHEAT, BARLEY AND COTTON IS 0.621.'

2.5.4 Economic Analysis of Future Option or Water Management

Several analyses have been undertaken in an attempt to identify the best methods of coping with Syria's impending water shortage. A macro-level analysis presented in the National Environmental Action plan (ERM 1998a) suggests that interbasin transfer would be the cheapest option of coping with local water shortages in the short term. However, ERM (1998a) predict that demand will outstrip supply by 2005, leaving no resources available for such transfers. Desalination of seawater may be an option, but is expensive at US$ 1.1 / m^3. The most cost-effective action is that of increasing the efficiency of using irrigation water. For example basic flood irrigation typically has a use efficiency of less than 40% whereas improved furrows yield 50-60% at a relatively modest cost of SP2500 to 4800 (USS55- 105) per hectare per year. Sprink!er and trickle systems have higher initial capital costs but greater efficiencies again. Investments in a mix of these technologies could bring savings in water use of up to 25%, at an average cost of about SP11,000 (US$242) per hectare per year, or put another as an equivalent cost of SP 1 / m^3,(US$0.02 m^3 (Table 2.13). Such a project is already underway, and should be supported wholeheartedly through financial and human resources.

Table 2.13. Efficiencies and costs of various irrigation technologies (source ERM 1998a, using JICA and MAAR data). [1] SP80,000/ha (US$l,800/ha) capital cost plus US$400/yr.OM; annualised SP8,525+18,000 [2] SP170,000/ha (US$3,700/ha) capital cost, annualised to 15,000 (US$330) plus operating costs @10%

Irrigation technology	Water use efficiency	Efficiency gain	Cost SP /ha
Flood irrigation	<40%		0
Improved flood	40-50	25%	3,000
Tied furrow	50-60	38%	4,800
Contour furrows	50-60	38%	2,500
Sprinker	60-70	63%	28,525[1]
Trickle drip	80-90	113%	16,500[2]

A more micro approach is exemplified by the work of Rodriguez *et al.* (1999) (Figure 2.4) who analysed the price received per kg of crop and the water required to produce that crop. The analysis shows that sugar beet uses relatively little water, but also low returns, while soy beans are the opposite, high water needs and high returns. Despite its high water demand soybean would therefore seem to be a better crop to plant than maize, which had high water needs and low returns! Analyses of this type could be combined with environmental data, such as water availability, water quality and soil type in order to develop crop rotations that provide the highest returns per unit of water in different locations in Syria. This would be a good step on the road to developing more sustainable cropping systems.

2.6 Environmental Impacts of the Cropping Policies and Strategic Plan

2.6.1 The cropping plan

The current cropping policy does not include any disincentives for using poor environmental practices, nor does it include any incentives for good environmental management. In this way it could be argued that the cropping policy is environmentally neutral. This is clearly not the case as crop production in dry areas will almost inevitably have environmental impacts unless specific actions are taken to

Figure 2.4 a) Price per unit of agricultural output and irrigation efficiency and b) gross margin per water unit (150m well) with respect to area planted in Atareb 1993 (source Rodriguez *et al*. 1999, after ESCWA/FAO 1995)

REDUCE THIS PROBABILITY. THE TYPES OF IMPACT WE MAY EXPECT TO SEE WOULD BE OVERUSE OF WATER, A LACK OF CONCERN OVER WATER QUALITY, SOIL EROSION, ABSENCE OF BIODIVERSITY AND OVERUSE OF INPUTS. THE DATA PRESENTED IN THE CASE STUDIES ABOVE, AND ELSEWHERE IN THIS REPORT SUGGEST THAT THE OCCURRENCE OF THESE IMPACTS IS OCCURRING IN SYRIA, AND THE PROBLEMS FOR SYRIA OF ALLOWING THESE IMPACTS TO OCCUR IS THAT THEY BRING SOCIAL COSTS, BOTH NOW IN TERMS OF WASTED RESOURCES AND EROSION DAMAGE TO INFRASTRUCTURE, AND WILL CONTINUE TO DO SO INTO THE FUTURE POTENTIALLY THREATENING CROP PRODUCTION OVER MUCH OF THE COUNTRY.

The environmental impacts observed are not directly related to the use of a centralised cropping plan. Indeed if farmers could be encouraged to grow the crops that had the minimal environmental impact on their particular parcel of land, then the planning process could be the best way of producing crops with minimal environmental impact. For example, consider the situation were the type of analysis shown in Figure 2.4 were extended to show the value of different crops in a particular region relative to their total environmental impact, where environmental impact would include use of water, impacts on water quality, soil erosion, loss of biodiversity etc. Then for any given parcel of land it would be possible to identify the specific crops (and rotations) which maximised outputs while minimising environmental impact. Such an analysis could then be aggregated over the basin level, and constrained to only use the total amount of water the basin could provide sustainably. In order to meet this constraint it may be necessary not to crop some areas as their environmental costs would be greater than the benefits accruing from growing crops on their land. Individual farmers could then be told what crops to grow and where. The current cropping plan does reflect this philosophy to some extent as only certain crops can be grown in certain areas (agricultural settlement zones)

Such a ‘sustainable national cropping plan’ has several problems. Firstly, the amount of staple crops, such as wheat, that could be grown ‘sustainably’ may be less than is grown at the moment, and may not be sufficient to meet the current production objectives. Secondly, it would be necessary to extend the range of crops (and indeed varieties) included in the plan in order to ensure that all agronomic possibilities were considered. It would also be necessary to include summer crops in the planning process as they too use resources, even though they are not currently included in the national cropping plan. This would increase the bureaucracy and complexity of the planning process considerably, and may be counter to future policy objectives. Thirdly, in order to get the plan to work efficiently but it be necessary to have near perfect knowledge of the biophysical condition of each field on each farm, as well as the socio-economic characteristics of each farmer. This is unlikely ever to be achieved.

2.6.2 Environmental Impacts of a Free Market in Crops

Compare this situation with a system where farmers had a free choice of which crops to grow. Here farmers would grow the crops which gave them the greatest return regardless of the social costs incurred in so doing. Evidence from other countries suggests that as development proceeds in a 'free market', and population increases there is increasing use of fragile lands for cropping, and an increase in the cropping intensity. Both of these practices may result in large environmental costs such as soil erosion and over-use of water. There also tends to be a reduced productivity per labour unit on both good and poor agricultural lands. Thus adoption of a total 'free choice' could be bad for the environment and may still not meet national policy objectives relating to production of certain staple crops.

The best practical environmental option may be some middle way where Government has a role in setting the overall framework for cropping and provides incentives for good environmental management and disincentives for bad management. In Syria this may include altering the allocation of land to current strategic crops in order to reflect their environmental impacts. Thus the area of cotton may be reduced, as has been done recently, as this is a large user of water. Further, refinement of the plan could be undertaken in line with the philosophy described above in order to reduce overall water use and environmental impact. Some regulation of water use is needed so as to reduce the incentive to over use irrigation water. No such system can be put in place until metering of water input is possible, and continuation of the current policy to do this must be a priority.

2.6.3 A Vision for Sustainable Cropping Systems

In addition to developing cropping systems which only use sustainable amounts of water, consideration should be given to including in-field non-cropped strips in certain areas in order to reduce soil erosion and encourage biodiversity on farms. Trials in some Arab countries (eg Tunisia) have shown that strips (5m-10m) wide can reduce erosion. These strips could be allowed to grow naturally or could be planted with certain plants that may bring benefits in terms of fertility, eg legumes. The exact location of the strips could be moved a few metres annually so that the benefits of 'fallowing' could be accrued. Non-cropped strips planted along water courses can reduce the pollution leaching into the water from the crop, and this may also be a good idea in some places. Live windbreaks can also be useful in preventing erosion, and if the correct trees are planted they may also bring other benefits, such as provision of fruit, fodder and/or fuel wood. Many tree species are available which will grow in arid areas and have been used in similar practices elsewhere. The disadvantage of using non-cropped strips and windbreaks are that they will take land out of production and also use water. However, the protection they provide for the soil ensures long term sustainability of the system.

All of the options discussed for achieving environmental sustainability above require less land to be used for cropping than would be the case otherwise, both at the farm scale and the national scale. In order to counterbalance the production foregone from this 'lost' land it would be necessary to increase production in the remaining cropped areas. Considerable attention should be given to refining agronomic practices that improve yield / ha. This may include breeding new varieties, improved use of fertilisers and better crop management. There may also be a role for genetically modified crops which may be able to provide higher yields under arid and/or semi-salty conditions. The use of biotechnology should not be ruled out at this stage, rather it should be investigated as it provides real potential for meeting food requirements within a framework of environmental sustainability.

2.6.4 Moving Policy to Achieve Sustainable Cropping Systems

There are three basic approaches to achieving sustainable cropping systems in Syria: Government regulation, economic signals or a 'management plan' approach. Government regulation could simply 'require' farmers to plant crops according to sustainable water use as directed by a cropping plan, to include good drainage and to include non-cropped strips and/or windbreaks in their farms. The sanctions for not undertaking these activities could be a fine, or some other punishment. The problems with such an approach relate to its large bureaucratic requirement, its reliance on strengthening the cropping plan and uncertainty as to whether regulations would be upheld and transgressions punished.

An alternative approach would be to seek to internalise the externalities by pricing water in such a way as to fully recognise its scarcity and pricing other inputs such as pesticides in order to reflect the damage they cause. In this way economic signals alone would incline farmers to use fewer inputs. It is unclear how this system could be adapted to reducing soil erosion, or how it would interact with a centralised purchasing system, as currently occurs for the strategic crops. Or indeed how farmers would respond to the increased price of inputs and the impacts this may have on the price of food. Despite the attraction of such a policy to many economists, it is fair to say that such a suite of economic mechanisms would probably fit better in a 'pure market economy' than in Syria's current economic system.

A third way may be to work with farmers in order to develop a cropping system that meets the farmers' and the nation's needs. Such a system may only enable farmers in certain areas to grow certain crops, thereby managing water demand, but in addition farmers would be required to ensure adequate drainage was installed and maintained, and also that soil erosion measures where taken where appropriate. It may be unfair to expect farmers to bear the full costs of establishing and maintaining drainage and soil erosion measures, as not all of the benefits from their actions will accrue to them. Thus some reward could be given to farmers who develop 'sustainable cropping systems'. The details of the plan would vary for each farmer, within a general framework, and it would need to be drawn up and agreed with some official body like the extension service. The farmer would then get some reward for adhering to the plan. Entry to the scheme could be voluntary, with those not entering not receiving any reward.

In the European Union, such rewards come both from the State and from the market. The market rewards arise because food grown 'sustainably' is in high demand by consumers who are willing to pay a premium on the price in order to buy food from sustainable systems. While such a market oriented reward system brings many benefits, it is unlikely to be suitable to Syria's current level of development, thus any reward for good management should come from the State. This could arise either from the State paying a certain sum per hectare of land that meets the needs of the 'sustainable cropping plan' or the State could pay a premium on every tonne of food produced from a sustainable farm. The former is to be preferred as the latter may place more emphasis on increasing production at the expense of environmental management. In addition, payments per unit of production are unlikely to be acceptable under current WTO rules, whereas payments per hectare are acceptable.

2.7 Sewage Treatment and Use of Non-Traditional Water Resources

2.7.1 Water Quality

Up until recently the Government has largely ignored water quality, concentrating instead on the quantity of water available. However recently there has been increasing concern about water quality issues. The quality of ground water differs in quality with between aquifers. Data on Ghouta, the agricultural area around Damascus, show high levels of pollution in ground and surface waters, as well as in the soil and the vegetables grown in this area. This has serious impacts on human health.

The quality of water in the Euphrates is stable (0.5-0.7 ml Na). Some of the other sources of water from Turkey are of poorer quality, and many of these are effectively supplying drainage water.

There is a programme for monitoring the 140,000 wells in Syria (licensed and unlicensed). However it will take around five years to sample and test all of them. The 2000 wells in the Damascus area were tested 10-12 years ago, and are now indeed of rechecking..

2.7.2 Salinisation

Generally ground water across Syria is of medium to high salinity, although little could be considered extremely saline. The situation is getting worse as ever deeper wells are being dug, as the water from the deeper regions is naturally more saline. Generally the wells in the west, near the coast are the least saline, and there is a gradual deterioration eastwards. Tadmor in Palmyra is among the worst areas where salinity is up to 6000mg/l (seawater is 35,000 mg/l and the Dead Sea is 60,000 mg/l). The highly saline water should not be used in irrigation.

Evidence suggests that salinity in surface waters of the Ghouta region of Damascus has increased dramatically in recent years. The JICA study which was undertaken in 1997/98 reports mean salinity levels in ground water of 726 mmols/cm (SD: 221, n=6) and of 639 mol/cm (SD:1067, n=8 for surface water (Table 2.14). Recent data from the Directorate of Irrigation for Barrada and Awaj Basin on surface and well water collected in November 2000 suggest mean salinities of 1115.5 (SD: 413, n=83), which is clearly a large increase in 3 years.

The salinity of water is linked to that of soils and many of the issues concerning soils are dealt with in Chapter 4. However it is worth noting here that the most saline soils are immediately adjacent to the Euphrates and in some other low-lying areas in the north of the country. In the Euphrates region salinity increases with distance from the river bank. This pattern is related to the drainage patterns of the land. Land near the river has good natural drainage patterns, and because of this salinity is kept low. At increasing distances from the river, there is increasing dependence on man-made drainage systems, which are not well made and are often poorly maintained. These drainage systems are often surface drainage, and do not perform well. Better systems are underground pipe drainage at a depth of about 1 m, and these are being introduced in some areas.

Table 2.14 Water quality in ground and surface water in the Ghouta, 1997. COD – Chemical Oxygen Demand, SS – suspended solids, Conduc. – conductivity, GW – Groundwater sample, SW – Surface water sample. (Source: JICA Study Team).

Station	Location	COD (mg/l)	SS (mg/l)	Conduc (ms/cm)	Na (mg/l)	Ca (mg/l)	Mg (mg/l)
GW1	Barada	0	0	379	6.8	0.0	14.5
GW2	Vasraya	0	0	580	22.0	0.0	35.0
GW3	Jaramana	0	0	894	32.0	11.0	35.0
GW4	Zebdeen	0	0	996	36.0	0.0	31.0
GW5	Al-Adawi	0	0	773	26.0	9.0	47.0
GW6	Tannery	0	0	735	32.0	0.0	25.0
SW1	Barada	144	8.5	357.5	7.8	67.2	8.07
SW2	Al-Hamme	42	10.4	502.5	17.3	86.4	11.35
SW3	Keewan	50	11.3	718.5	32.2	96.0	27.7
SW4	Kabass	596	2349	1155	54.3	68.0	32.8
SW5	Zebdeen	350	2370	1108.5	53.4	76.0	32.0
SW6	Effluent	46.2	14.48	853.4	48.7	66.1	29.4
SW7	Effluent	50.75	336.02	800.4	47.0	66.0	28.7
SW8	Beit Tima (Awaj R.)	38	16.65	443.5	26.0	66.0	12.9

2.7.3 Sewage Treatment

The treatment of sewage and urban waste water is still underdeveloped in Syria. A waste water treatment plant has only began running in Damascus in 1998, and is still being upgraded (Table 2.15). Prior to this there was no treatment of sewage in Damascus and this caused problems in peri-urban areas (eg Ghouta, as discussed below). Untreated sewage water is used in some areas for irrigation, such as in Aleppo. Guidelines suggest that this water should not be used on any crop that is eaten raw, and it is largely used for cotton in summer and fodder in winter. Treatment plants are planned for all major cities in Syria over the next 10 years.

All houses in Damascus should be connected to the sewerage system which transports the sewage to the treatment plant. However, not all homes are connected and this causes some problems. The sewage system also takes surface run-off from within Damascus. A mixed sewage system, such as that in Damascus, and which also occurs over much of Europe, carries domestic sewage and urban surface run-off together in the same pipes. Pollutants from these two types of water require different treatment, and standard treatment for biological sewage does not deal well with industrial pollutants, such as heavy metals. In an effort to rectify this problem there is a plan in Damascus, which is already being partly enacted, to deal with this issue. This will be achieved either by putting some of the industrial polluters onto separate sewerage network in order to keep their waste out of the general body of water to be treated, and/or to request industries to install their own primary treatment facilities to help remove some pollutants prior to it entering the main sewerage system. There are also on-going plans to incorporate some pre-treatment of the general sewage in the main sewerage system prior to it entering the treatment plan. The sewage treatment station in Damascus can cope well with the biological issues of Biological Oxygen Demand (BOD) and Shigella / Salmonella (SS), however, parasitic worms (helminths / nematodes) and some bacteria remain problematical.

Table 2.15 Current and planned sewage treatment plants in Syria. (Source: MAAR).

Site	Water treated per day	Target BOD		Use of treated water	Status
	cumec/day	input	Output		
Damascus	485,000	250	20	Irrigation	Operational 1998
Selamia	5850	532	40	N/A	Operational 1990
Aleppo	255,000	-	20	Irrigation	to be operational end of 2001
Hama	70,000	300	30	River disposal	to be operational end of 2002
Homs	133,900	507	30	Irrigation	To be operational 2001
Daraa	21,800	232	25	Irrigation	ready for utilisation – not used yet
Sweida	18,750	290	25	Irrigation	ready for utilisation – not used yet
Idleb	30,000	395	40	N/A	ready for utilisation – not used yet
Lattatkia	100,830	327	30	Irrigation	Planned
Tartous	33,447	344	40	Sea dumping	Planned

The solid sludge from the Damascus treatment plant is enters a bio-digester and generates methane gas which enters a biogas generator and generates enough energy to provide 70% of the energy requirements of the treatment plant. To date there has not been much solid sludge generated from the treatment, as the digester copes with most of it, but the amount will increase with time. In Selamia however, there are large amounts of solid waste which are awaiting disposal. One suggestion is to air dry these wastes and distribute them to farmers as fertiliser. The nutrient content of these wastes is relatively low, but they will have some benefit as nutrient sources and soil improvers. There is much discussion about this plan, and to date MAAR have not given final permission for such disposal methods. In addition to the health and environmental hazards of sewage disposal, the transport costs are also an issue, and there is a desire to dispose of the sludge as close to the treatment plant as possible.

In the Damascus plant the liquid part of the sewage is discharged into several canals which serve to distribute the water around Ghouta, were it is used for irrigating crops. These primary canals are basically concrete ditches about 3 m wide with concrete sides about 2-3m tall. They are open topped and carry the treated water into the Ghouta. There is a 15 day cycle of distributing water between these four canals with one canal getting all the output for 4 days, then another gets the next 3 days worth and so on. Due to the open nature of these canals they are accessible to local people and there are examples of people extracting water from the canals for various uses. In an attempt to control the microbiological hazard of the treated water chlorine is applied to the water as it leaves the treatment station. The chlorine is applied at very low concentrations (0.2mg/l), and sometimes it is almost zero, this is in attempt not to have a large negative impact on crop growth.

2.8 Soil and water pollution in the peri-urban agriculture of Ghouta, Damascus

GHOUTA COMPRISES 37000 HA LYING TO THE EAST AND SOUTH OF DAMASCUS CITY WHICH SUPPORTS A POPULATION OF OVER 500,000 PEOPLE. TRADITIONALLY IT WAS AN AREA OF VEGETABLES, HORTICULTURE AND DAIRY PRODUCTION AND HAS PROBABLY BEEN UNDER IRRIGATED AGRICULTURE FOR SEVERAL THOUSAND YEARS. WATER IS OBTAINED FOR IRRIGATION FROM BOTH GROUND WATER AND SURFACE WATERS, AND DRINKING WATER IS LARGELY PUMPED FROM GROUNDWATERS AND STORED IN TANKS. OVER RECENT YEARS THE INCREASED POPULATION AND URBAN DEVELOPMENT HAVE COMBINED TO ALTER THE STANDARD OF THE ENVIRONMENT IN GHOUTA, MUCH OF THIS DEGRADATION HAS BEEN RELATED TO A DETERIORATING STANDARD OF WATER QUALITY. ONE INDICATOR OF POOR WATER QUALITY IN THE GHOUTA HAS BEEN THE RECENT EMERGENCE OF TRUCKS CARRYING CLEAN WATER BROUGHT DOWN FROM THE SURROUNDING MOUNTAINS AND SELLING THIS TO THE LOCAL INHABITANTS. AN EXAMPLE OF A REAL WATER MARKET!

Water is supplied to the Ghouta by 2 rivers which rise in the mountains in the west and flow east. The Barrada river flows through Ghouta and should terminate in the Ateibah lake, and the Awaeij should termiknate in the El Hijaneb lake. However, both lakes have been dry since 1992 and the rivers disappear before the lake, apparently due to a series of drier than average summers. These rivers collect all the residues of sewage, industry and waste. Important polluting industries include brewing, soup manufacture, detergent manufacture, petrol stations and tanning. Tanning is particularly important as it uses Zinc (Zn) and Arsenic (Ar) in its processing - both of which are then discharged into the river.

Hydrologically it is an interesting region as there are connections between surface and ground waters. However, the depth of the aquifers and the high clay content of the soils should restrict the speed of the transport. It would be expected therefore that any pollution present in the water used for irrigation would become trapped in the soil, rather than to immediately enter the groundwater. However, should application of polluted irrigation water continue then the groundwater will become polluted. This means that if polluted water were to be applied to the soil surface then a high proportion of this water will enter the groundwater aquifer, thereby introducing pollution into these waters. These polluted groundwaters could then be pumped and may pose both a direct (in drinking water) and indirect (on vegetables) health effect, and may also have an agronomic impact. For example, there is some suggestion that apricot and nut production in Ghouta are decreasing over time due to the impact of pollution. It must be noted that crops irrigated with treated (or untreated) sewage water can benefit from the increased levels of nutrients in these waters. There is a ban on direct irrigation of vegetable crops with sewage water, but this ban is probably not well obeyed.

The pollution issues in Ghouta are probably the worst in Syria, but other areas such as Aleppo, Homms and Hamas could well see an intensification of their water quality problems should the issues not be regulated very soon. There is a $300,000 project just begun with FAO aimed at water pollution across many of the areas highlighted here.

2.8.1 The problems of Ghouta

2.8.1.1 Water

Numerous studies were carried out in Ghouta, prior to the sewage plant coming on-line, but no recent data were available, it is therefore difficult to make any comment on the effectiveness of the treatment plant on water quality in the Ghouta. Detailed results of some of these studies are shown in Appendix 2.2 and some of the more pertinent results are discussed here.

Data on heavy metals clearly showed a continuing problem of heavy metals in drinking water in Ghouta (Table 2.16). Of particular concern were the levels of lead (Pb) which is known to have serious health effects. Levels of certain pesticides in groundwaters are also in exceedance of standards (Table 2.17), and these will not be effected by the sewage treatment plant, and are likely to remain a problem unless action taken to ban the chemicals and/or train the farmers in their proper use. Nitrates in surface water are a problem in some areas going up to 70-85 mg/l (eg Zenib area, west of Damascus) (WHO recommended limit is 50 mg/l). The nitrogen is coming from sewage water, not from agricultural fertilisers. Nitrates are low in the groundwaters.

The biological quality of the surface and ground water was also poor in 1998, with exceedances of faecal colliforms being recorded in groundwaters and intestinal nematodes in surface water (Tables 2.18 & 2.19). While the sewage treatment plant should significantly reduce the level of both of these sets of organisms, reports to date suggest that while colliforms are being controlled, problems still remain with control of the nematode eggs.

TABLE 2.16 SUMMARY OF HEAVY METAL SURVEYS IN GROUND WATER IN GHOUTA, DAMASCUS. SHADING INDICATES EXCEEDANCE OF WORLD HEALTH ORGANISATION (WHO) STANDARDS

Year	Study team	Location	Heavy metal tested (mg/l)				Notes
			Pb	Cr	Hg	Cd	
1995	ACSAD/ MOE (ph.1)	Zebdeen	0.16	1.17		0.05	mean of 5 samples
1995	ACSAD/ MOE (ph.1)	Jedaidet	0.01	0.002		<0.001	
1995	ACSAD/ MOE (ph.2)	Zebdeen	0.01	0.0008	0.002	<0.001	peak value of 8
1995	ACSAD/ MOE (ph.2)	Kharabo	0.01	0.0007	0.002	<0.001	peak value of 8
1996	ACSAD/ MOE (ph.3)	Zebdeen	0.006	0.006	0.0003	<0.001	peak value of 12
1996	DAWSSA / JICA	Barada	<0.001	<0.001		<0.001	1 sample per location
1996	DAWASSA / JICA	Fijah	<0.001	<0.001		<0.001	1 sample per location
1997	Univ. Damascus	Yalda	0.046 (0.087)	0.132 (0.15)	0	0	Mean (peak)
1997	Univ.	Dier	0	0.112	0	0	Mean of 9

	Damascus	Alasafeer					values
1997	Univ. Damascus	Harasta	0.114 (0.491)	0.045 (0.067)	0	0.167	
1998	Univ. Damascus	Yalda	0	0.78	0	0	Mean of 5 values
1998	Univ. Damascus	Deir Alasfeer	0.878	2.56	0	0	Mean of 3 values
1998	Univ. Damascus	Harasta	0.524	14.273 (40.39)	0	0	
1998	MOI/JICA	Barada	0.103	0.02			Mean of 6 samples
1998	MOI/JICA	Vasraya	0.173	0.021		0.027	Mean of 6 samples
1998	MOI/JICA	Jaramana	0.238	0.047		0.034	Mean of 6 samples
1998	MOI/JICA	Zebdeen	0.196	0.095		0.031	Mean of 6 samples
1998	MOI/JICA	Al-Adawi	0.151	0.021		0.023	Mean of 6 samples
1998	MOI/JICA	Tannery	0.272	0.447		0.050	Mean of 6 samples
WHO drinking water standard			0.010	0.050		0.003	

TABLE 2.17 SUMMARY OF PESTICIDE SURVEYS IN GROUNDWATER IN GHOUTA, DAMASCUS. (TETRACHLOR = TETRACHLOVENPHOS). SHADING INDICATES EXCEEDANCE OF STANDARDS

Year	Study team	Location	Pesticide tested (ug/l)							Notes
			Aldrin	Diel drin	DDT	Hepto chlor	Fenari mol	Tetra-chlor	Triflura lin	
Detection limit			0.05	0.01	0.05			0.01		
1991	BRGM for DAWSSA	Fijeh		0.014				0.02		
1996	DAWSSA (JICA)	Oumawiyin	0.25	6.00		29.24				Mean of 14 samples
1998	Univ. of Damascus	Yalda	1.34 (3.082)				18.911 (31.09)		5.128 (12.57)	Mean (peak)
1998	Univ. of Damascus	Deir Al-Asafeer	1.120 (2.532)				4.753 (15.55)		4.827 (12.23)	Mean (peak)
1998	Univ. of Damascus	Harasta	2.272 (11.83)				5.488 (9.900)		2.253 (4.680)	Mean (peak)
1998	MOI/JICA	Barada	< 0.05	< 0.05	< 0.05	< 0.05				
1998	MOI/JICA	Jaramana	< 0.05	< 0.05	< 0.05	< 0.05				
WHO drinking water standard			0.03	0.03		0.03	0.1		20.00	
Syrian drinking water standard			0.03	0.03		0.1				

Table 2.18 Microbiological content of groundwater in Ghouta, Damascus, 1998. (source: JICA Study Team)

Station	Location	Faecal colliform (# / 1000 ml)	Intestinal nematodes (#/1000 ml)
GW1	Barada spring well field	0	0
GW2	Vasraya Well field	0	0
GW3	Jaramana (village)	110	0
GW4	Zebdeen (village)	66	0
GW5	Al Adawi Well field	14	0
GW6	Tannery district	2890	0
Syrian drinking standard		0	0

TABLE 2.19 MICROBIOLOGICAL CONTENT OF SURFACE WATER IN GHOUTA, DAMASCUS, 1998. (SOURCE: JICA STUDY TEAM)

Station	Location	Faecal colliform (# / 1000 ml)	Intestinal nematodes (#/1000 ml)
SW1	Barada	4,080	0
SW2	Al-Hamme	3,740	500
SW3	Keewan	4,760	5,000
SW4	Kabass	150	20,000
SW5	Zebdeen	0	12,000
SW6	Effl. Channel:Adra	4,590	0
SW7	Effluent channel	3,910	0
SW8	Beit Tema	4,590	0
FAO irrigation water standard		10,000	0

2.8.1.2 Food

THE DATA SUGGEST THAT THESE POLLUTANTS ARE ENTERING THE AGRICULTURAL SYSTEM VIA THE IRRIGATION WATER, AND ARE THEN CONTAMINATING SOIL (APPENDIX 2.2) AND FOOD. THE DATA ON HEAVY METALS IN FOOD PLANTS (APPENDIX 2.2) IS SUMMARISED FOR *RAPHANUS* IN TABLE 2.20 AND SHOWS THAT THE HEAVY METAL CONTENT OF THIS PLANT PROBABLY EXCEEDS THE IDEAL LEVEL FOR ALL METALS TESTED. SIMILARLY THE DATA ON MICROBIOLOGICAL ENTITIES SUGGEST RELATIVELY HIGH LEVELS ON PLANT LEAVES, WITH 100% OF ALL PLANTS SAMPLED BEING AFFECTED IN SOME SAMPLES (TABLES 2.21). THESE DATA WERE COLLECTED IMMEDIATELY PRIOR TO THE SEWAGE TREATMENT PLANT COMING ON LINE, AND IT WOULD BE USEFUL TO COMPARE THESE DATA WITH CURRENT DATA.

Table 2.20 Ideal concentration for the content of metals in plant tissues (mg/kg)*4 (Raw data presented in Appendix 2.2).

Element	Observed range in Raphanus	Ideal range
Cd	0.05-1.3	0.0005 – 0.012
Cr	0.01 –5.3	0.01 – 0.05
Pb	0.26 –1.55	0.001 – 0.3
Hg	0.05 – 0.47	0.01 – 3

Table 2.21 The content of biological entities in Raphanus irrigated with water from the Barada river and associated irrigation channels in Zebdine 1995/96. . VC = viable count, TC = Total colliforms, SS = Salmonella, Shigella, FS Fecal Streptococcus.

a) Irrigation channels in Zebdine (cells/cm^2 of leaf)

Sample	Variable				
	VC	TC	SS	FS	% polluted
1					
2	501	17	0	0	25
3	550	34	0	0	50
4	1801	1900	0	0	100
5		717	0	0	75
6	1267	234	0	0	100
7	84	83	0	0	100
8	33	0	0	0	
Average	706	426	0	0	75

b) Well water in Zebdine (cells/cm^2 of leaf)

Sample	Variable				
	VC	TC	SS	FS	% polluted
1					
2	1233	134	0	0	50
3	83	209	0	0	50
4	400	133	0	0	100
5		50	0	0	50
6	733	1392	0	0	75
7	100	434	0	0	100
8	67	0	0	0	
Average	436	336	0	0	70.8

2.8.1.3 Solid waste

The water quality in Ghouta may also be effected by leaching of pollutants from household and industrial waste which is dumped in unregulated tips all over the Ghouta. In Ghouta although transfer of pollutants is possible from solid waste to groundwater, although the depth of the aquifer and the nature of the soils have limited transfer to date. However, the proximity of some illegal dumps to surface water, is a clear hazard. Such dumping is supposedly illegal, but this law is clearly being widely flouted. An EU project has just finished planning solid waste treatment in Aleppo, Latakkia and Homms.

2.8.2 Health Issues

There are feelings amongst the populace of Ghouta that several health problems are related to poor water quality, a concern backed up by health statistics (Table 2.22) . Issues which could be related include skin problems, gastro-intestinal issues and even cancer and foetal abnormalities. Chlorine is introduced to drinking water pumped from wells as soon as it is pumped in an attempt to reduce microbiological hazards, however, the application is not well monitored and there is some suspicion that over application chlorine may also lead to observed health effects in the Ghouta region.

The pollution issues in Ghouta are probably the worst in Syria, but other areas such as Aleppo, Homms and Hamas could well see an intensification of their water quality problems should the issues not be regulated very soon. For example, ERM (1998) report that diarrhoea accounts for about 20% of infant deaths.

Table 2.22. Estimated occurrence of water related diseases in Syria 1996 (source ERM 1998). Costs of treatment based on private medical costs (excluding subsidies). u5 = children under 5 years old.

Health problem	No. cases
Diarrhoea u5	740,280
Typhoid	60,954
Malaria	278
Bilharziasis	75
Viral hepatitis	26,364
Cutaneous leishmaniasis	14,008
Bricellosis	40,554
Estimated cost of treatment (US$ million)	20.8

ERM (1998) also estimated the costs of days off work in terms of lost production based on the following assumptions (cholera and typhoid 5 days, viral hepatitis and brucellosis 15 days). The total days lost off work were 761,500 per year at an annual cost of US$2.5 million dollars (assuming an average daily wage of SP 150 (US$3.3)). In total ERM (1998) estimate the total cost of ill health from these environmentally related diseases to be around SP1billion (US$22 million) per year (not including estimates of loss of life or individual welfare issues).

2.8.3 Monitoring of Water Quality

The Directorate of Irrigation for Barrada and Awaj Basin would like to undertake regular monitoring of surface, ground and spring water on a monthly basis, and failing this at least seasonally. If there is the possibility of a particularly high pollution event then monitoring is intensified. This monitoring has been on-going for 2 years, but has recently (late 2000) been transferred to MAAR.

A project began in November 2000 aimed at monitoring the quality and quality of water on 17 farms in the Ghouta. Variables to be monitored include source of water, location of farm, crop, form of irrigation, depth of wells, pH, salinity, BOD, hardness, level of Ca, Mg, As, Pb, Ni, Cr, Cd (ppb), microbiological hazard (eg colliforms, Pseudomonas, fungi). Monitoring is scheduled for every 45 days.

CHAPTER 3. THE SYRIAN STEPPE - AL BADDIA

3.1 Background

The Baddia comprises 55% of Syria's land mass. It totals 10.2 Mha and receives less than 200 mm rain p.a. Pasture comprises 70% of Al Baddia and this provides a grazing resource for 6-7 months of the year. There are between 900,000 and 1.5 million people in Al Baddia, of which about 500,000 are settled. The remainder of the population are nomads (herders without a permanent home who are always on move) and transhmance herders (people with a permanent home, who move with their sheep for some of the year). There has been a decline in the number of nomads over the last 50 years, and in 1990 there were an estimated 10,000 nomads, the rest being transhumance herders. The people in the Baddia represent 149 different cultural groups of herder. Deterioration of the rangeland has been related to overgrazing in early summer. In 1950 there were 2.6M sheep now there are 10-12M (the maximum number of sheep in Al Baddia has been 15 M) (Table 3.1).

Table 3.1 Number of milking and non-milking ewes in Syria 1985-1999. (source MAAR).

Year	Milking ewes	Dry ewes	Total
1985	7,143,857	3,849,213	10,993,070
1986	6,950,367	4,718,229	11,668,596
1987	7,624,071	5,044,764	12,668,835
1988	8,402,789	5,288,140	13,690,929
1989	8,,322,741	5,687,773	14,010,514
1990	8,927,718	5,580,890	14,508,608
1991	9,498,476	5,695,183	15,193,659
1992	9,274,674	5,390,412	14,665,086
1993	6,396,194	3,750,423	10,146,617
1994	7,144,327	4,112,296	11,256,623
1995	7,819,884	4,255,306	12,075,190
1996	8,506,611	4,612,887	13,119,498
1997	8,980,353	4,848,963	13,829,316
1998	10,074,419	5,350,298	15,424,717
1999	8993,384	5,005,076	13,998,460

Nomadic lifestyles have tended to develop in parts of the world with sparse and erratic rainfall, as this system is able to utilise vegetation in certain areas at certain times of the year, and the long return times permit the vegetation to regenerate. For example in the Syrian steppe (Baddia) the sheep graze on 2 main classes of fodder: perennial shrubs and perennial grasses. The shrubs tend to start putting on new growth in spring (end of April / May) and have completed their growth and fruit production by the end of September/October. The perennial grasses tend to flourish after the winter rains (Nov/Dec). Traditionally the herders would move their sheep away from the steppe around the beginning of May, largely because of a lack of water. The sheep then spent the summer grazing on crop residues in the north and west of Syria, and returned to the Baddia in the autumn (October/November). This system fitted in well with the biology of the fodder plants as it meant there was no grazing pressure during the summer months. This is important as the new growth, in spring and summer, is essential to the continued survival of the shrubs, which tend to store carbohydrates and other nutrients in their root stock. Summer grazing, which removes the new growth of the perennial shrubs, is extremely detrimental to the plants and will, if severe enough, kill them. Even total removal of aboveground winter biomass of perennial shrubs may not prevent successful growth and seeding of shrubs, as long as the grazing pressure is removed before shooting.

As the woody vegetation consists mainly of species of no or low palatability, dwarf shrubs are avoided until nothing else is available. In years with good, early rainfall, annuals and the perennial grass *Poa sinaica* are grazed from the time they emerge, and most shrubs may not be browsed at all. At such times, as in 1997, herdsmen have no preference for plain areas or valleys, moving just to places where new growth is sufficiently present. But in years when autumn rains fail, the shrubby vegetation in the valleys and on the plains with shallow soils becomes more significant, providing at least some roughage while animals are maintained with supplementary feeds.

In summary utilization of the range within the Baddia is governed by water and forage availability. Overall stocking density may be, to some extent, less important than the management of grazing over the year. Historically the pastoral Hema system and lack of water in the summer were probably the most effective factors for the regeneration of forage plants.

3.2 History of Relevant Land Use Legislation

3.2.1 Legal and Social Structures of Nomadic Communities Pre 1958

Traditionally pastoral communities evolved their codes of law, customs and organization of groups and subgroups based on family relationships. Each group maintained grazing rights on certain resources in its “dirah” or “manazel” as Hema, and negotiated when necessary with other groups for movement of its livestock to areas of more favourable climatic conditions during period of drought. The social structure of pastoral groups was close to co-operative organisation, and resources were close to being common property (NB: private property is managed by one individual for himself, open access is equally available to all, common property is when a certain group of individuals share responsibility for managing a resource that they share).

After World War II, the national administration attempted to settle the Bedouins thinking that Al Baddia would sustain dryland farming. Thus Government encouraged the sale of range lands, whilst simultaneously freeing the pastorals from their sheiks’ institution. Thus abolishing the tribal law in 1958 that led into the death of grazing rights (Urf). Some commentators suggest that the change of property rights that occurred at this time led to the widespread range degradation in the intervening years. Details of this legislation are given in the next section.

3.2.2 Legislation Post 1958

Ngaido (1997) presents a detailed account of legislation which is relevant to land and land tenure in the Baddia, and he suggests that the legislative process can be split into three main periods: 1958-1969, 1970-1992 and 1992 – onwards. The relevant legislation in each of these periods is briefly reviewed below.

3.2.3 1958-1969

The three earliest land laws (The 1958 land reform law (Law No.161 of 1958), Law No.88, 1968 decree (No.166)) sought to grant land to land-less and land-poor farmers, to strengthen the cooperatives and to settle the nomadic Bedouin population. According to these laws each farming family received up to 8 hectares for irrigated lands and 30 hectares for rainfed. The beneficiaries of these lands were required to work and cultivate these lands according to the plans of the Ministry of Agriculture and Agrarian Reform, and also to join the farmers' cooperatives. If they failed to satisfy these conditions, their fields were seized and granted to other farmers.

It was difficult for many of the tribes to resist the Government's policies and many tribal leaders adhered to the policy of "plough the land and settle." (Masri 1991). As a consequence there was shift from rearing camels to rearing sheep, and many of the best pastures in the arid zones (200-350 mm rainfall) were converted to crop production (Jaubert 1993). Also as very little land was confiscated from existing landowners under the land reform process, rangelands were used to satisfy land demands of new settlers.

3.2.4 1970-1992

3.2.5 The 1970 Act

In 1970 the Government of Syria attempted to seek better management of the Baddia, to cease appropriation of rangelands and ban cultivation on non-irrigated steppe lands (decree No.140). The Decree introduced:

- Prevention of further land appropriation and ownership claims in AI Baddia.
- Confiscation of equipment or animals used in illegal ploughing, and the introduction of a 200 S.P fine per ploughed hectare.
- Reallocation of rangelands under the umbrella of range improvement and sheep cooperatives (Coops) and the introduction of a fine of 2S.P for each trespassed sheep, rising to 5 S.P in case of trespass repetition.

3.2.5.1 Illegal cultivation

Although the 1970 Act sought to prevent the sale of rangelands for cultivation and prevent illegal ploughing, such activities continued. This was partly because the law was not upheld universally and the confiscation of tractors and crops was not carried out uniformly. This may because such confiscation required the local Mayor's judgement, which varied over time and space. Hence continued degradation of rangelands occurred.

3.2.5.2 Land ownership
The 1970 Act also altered land ownership and limited the ownership of non-irrigated steppe to three types of landholders:

- Those who owned registered and titled lands before July 20 1970, .
- Those on whom ownership was legally confirmed before this decree,
- Those who obtained land rights through appropriation, possession or transfer according to the 1958 land reform law (No.161).

This decree was amended in 1973 (March 19, decision No.13) in order to promote the extension of cultivation in the rangelands. Here farmers who had cultivated land on their village or city boundaries before 1970 were allowed to cultivate 10 ha; and farmers who planted trees of at least five years old on their rainfed lands were also allowed to cultivate. This amendment, and the priority given by the GOS to cropping, encouraged cultivation into the more marginal areas of the rangelands and fostered land appropriation and disputes.

3.2.5.3 Establishment of Cooperatives
The reallocation of rangelands to cooperatives required under the Act began in 1970 and attempts were made by MAAR to maintain the homogeneity of members. The cooperative Hema was mapped and demarcated on the ground. Hema were announced in a ministerial decree and the boards of coops were elected from among the farmers. The programme of cooperatives was assisted internationally by UNDP, FAO, WFP and The World Bank. In addition sheep fattening cooperatives were established to absorb feeders from the steppe during drought periods and a network of warehouses for storing feed reserves were established across the steppe.

In 1974, the cooperative union was amalgamated into the Peasant Union (PU) which was in turn connected directly to the regional peasant organization which is part of the political administration. Consequently the Cooperative Directorate in the MAAR was terminated, thus the administration of the relatively few coops was transferred to the PU. The PU sought to solve the problems of the Baddia through increased provision of feed and water and quickly grouped most of the sheep graziers into 483 cooperatives, covering most of the steppe area.

3.2.6 1974-Onwards

The continuing drive for land appropriation prompted the government to issue a presidential decree (No.31 of May 14, 1980) limiting land ownership to 140 ha in areas with less than 350 mm and 200 ha for the Hassakeh, Deir Ezzor and Rakka provinces. However, these different measures did not prevent farmers from continuing to encroach into the rangelands and ploughing large areas of land. For example, in the 1980-1981 cropping season, around 3700 individuals trespassed on around 620,000 ha, these trespasses increased to around 720,000 ha during 1983-1984 season (Masri 1991).

The use of non-irrigated steppe lands was formalised in 1987 (decree No. 96/T) by issuing licenses to grow cereals on 80% and shrubs on 20% of their lands. This decree introduced the possibility to rent state owned non-irrigated steppe lands, and led to more appropriation of rangelands. The issuing of new cultivation licenses and new extensions on non-irrigated steppe lands was stopped in 1988 (September 17, 1988 notification No.15). The objective behind this legislation was not related to any environmental concerns, but rather with the control of cultivation according to the agricultural plan.

In general, this period marked an extension of cultivation into the rangelands (Figure 3.1) and the individualization of common range resources. The promotion of agricultural production in the rangelands was based on agricultural plans, which committed 30% of the rangelands to cultivation. These policies contributed greatly to the degradation of rangelands. Overstocking and land appropriation reduced natural pastures. The per-capita area of pasture land available to sheep decreased from 7.9 ha per sheep in 1961 to 2.6 ha per sheep in 1993. This decrease in pasture availability was also accompanied by the decrease in the quality of the pastures.

3.2.7 1992-1997

New policies promoting rangeland conservation and protection were enacted in 1992, and the Prime Minister's decision (No.17) requested governors "To observe strictly the prohibition of the cultivation and growing the non-irrigated steppe lands, which will remain dedicated for natural and planted rangelands and shrubs. All deterring measures will be taken against transgressors as per the provisions of laws and by-laws in force" (Art. 1). Article 3 stipulates that "The areas whose use is regulated under the provisions of the Law of the Steppe Protection will be transferred gradually to be planted with pasture shrubs within five years as from the 1992/1993 cropping season."

To enforce these new measures, the GOS issued a circular (September 20, 1993 No. 2/MD) which doubled the charges on appropriated lands. In the case of the Baddia these charges amounted to SP20 on rainfed area. However, these low charges did not prevent people from continuing to appropriate and cultivate large areas of land, and on December 6, 1994 (Circular No. 4553/1), the GOS banned cultivation on rainfed steppe lands *"to* protect the natural vegetation in the Syrian Steppe and stop its degradation because natural vegetation is an essential source for grazing." In addition, the Prime Minister requested that all governors "take all measures to stop illegal cultivation in the steppe lands and to arrest and take all preventive measures against the trespassers." Finally, on December 3, 1995, the GOS took the decision (No.27) to also terminate irrigated cultivation in steppe lands. All the licensed wells were authorized to continue cultivation until December 3, 1997 while non-licensed wells were forbidden.

Figure 1. Evolution of cultivation and livestock in Syria (1961-1994)

The Situation in 2001

3.3.1 Cooperatives

Although there are 483 cooperatives extant in the Baddia (est.1974) and in theory these coops have responsibility for given parcels of land, in fact their main role is to provide credit / feed to the Bedouin and they play no role in land management. The coops are strongly linked to the Peasants Union, a powerful political force in Syria, who are largely in favour of maintaining the Baddia as open access, and have suggested that current degradation is due to climate change and not to land tenure of poor rangeland management (Masri *pers. comm*.).

3.3.2 Provision of Livestock Feed

Livestock feed (barley, cotton seed cake, cotton seed husks, wheat bran) are provided to the Bedouin from the coops at a subsidised rate. The subsidy is relative to the price of barley in Syria, but may be above the world price for barley (see Cummins 2000) (current prices of feed sold by Coops to herders is barley SP7 / kg, cotton husk SP4.5/kg and seedcake SP8/kg). The feed is distributed according to the number of sheep in each flock and a fixed amount is given per head eg in 2000/2001 it was set at 42kg/hd/yr, but in fact due to the drought this amount has been given 3 times (ie 126 kg/hr/yr). Approximately 80% of the food intake of sheep on the Baddia comes from feed grain (Masri *pers.comm*.).

3.3.3 Export of Livestock

The import / export market for sheep is restricted, despite high demand in the Gulf for Awassi sheep. Until late 2000, importation of sheep was only permitted when the internal price for sheep meat was considered high. At this time the Government allowed importation of sheep, which are usually Merinos from Eastern Europe

(Bulgaria and Romania). This meat is not of the highest quality but poorer people will buy it if the price is right. At the same time exporters were permitted to export 1 Awassi sheep for every 2 imported (the so-called 2 for 1 policy). These are exported to the Gulf were they command a high price. Export was only possible if the requisite imports can be proved. In addition it is illegal to export live female Awassi at any time. The '2 for 1' policy was repealed in late 2000, but at the time of writing it was unclear exactly what the new policy permitted.

Female Awassi sheep under about 7 years cannot be slaughtered in official slaughter houses This is supposedly to ensure maintenance of stocks. Official slaughterhouses have state veterinary surgeons who certify the meat, and thus regulate the policy. However Cumins (2000) states that only about 50% of meat is killed in official slaughter houses. Even if ewes are barren, injured, one-teated or bad mothers they cannot be slaughtered until they are 7. By this time they may have had 5 or 6 lambs over their life time.

3.3.4 Access to Water

Al Baddia's main water resources are below ground aquifers, and wells are dug to access these resources to provide water for humans and animals. The quality of the water varies with location. There are ancient wells in the Steppe which are really forms of collecting run-off. They were dug in areas of natural run-off. Historically they were managed by tribes. Recently wells have been dug at the request of the coops / herders and according to a Government plan to provide a network of wells across the Baddia. The Department of Baddia identifies the sites for wells and the excavation and maintenance and excavation is done by the Ministry of Irrigation. The Government appoints labourers / guards to look after wells. The water, which is supposedly only for sheep to drink, is pumped into small reservoirs. It is a real open access resource as any one can use it, - even herders outside the coop. Despite the availability of wells, almost all herders transport water in large tankers to the Baddia.

3.3.5 Grazing Protectorates

There are currently 33 grazing Protectorates designated within Al Baddia which comprise 400,000 Ha. These protectorates are marked in some way, such as with an earth fence, and the sheep should be excluded from these areas. After 3 years of no grazing, grazing would be permitted twice a year (April & October) in the protectorates. Rehabilitation of the rangeland has been tried in the Protectorates. Standard sowing drills have been used to plant seeds in some areas, but the major activity has been the planting of seedlings. This requires 'cultivation' with large bulldozers and rippers, which break up the soil and the use of irrigation to establish the plants. This programme is supported by seven centres which produce seeds and seedling for the rehabilitation and 13 nurseries for growing grazing shrubs. The plan is rehabilitate 16, 000 Ha a year with seeds / seedlings and 50 tonnes of seed are sown over Al Baddia a year. The aims of the protectorates are multiple: rehabilitate grazing, biodivesity, reduce erosion. They may also act as a grazing reserve for times of drought. None of the Protectorates are currently closed (2000/2001), rather all are open in order to help the herders in this time of drought. Even when they are closed the fines on graziers for entering protected areas very small at SP5.

3.4 Evidence of Degradation

Deterioration of the Syrian Steppe has been documented in many reports (FAO Project document 1995, Telahigue 1994, Masri 1994). Most of these reports have been based on visual signs of the presence of soil erosion such as soil hummocking, pedestal plants, sheet and gully erosion. In addition changes in the composition and abundance of plants have been noted, particularly the increasing dominance of less palatable species and disappearance of the more desirable plants. These reports suggests that degradation is caused largely by overgrazing, but other causes of degradation include removal of shrubs and use of motor vehicles. Unfortunately quantitative evidence documenting biophysical changes in the Baddia over the last 40 years are absent as no long term monitoring has occurred. Although some range land monitoring has now began in Palmyra as part if project (GCP/SYR/003/ita) further work is needed. Some of the evidence available to date is described in the next sections.

3.4.1 Qualitative Evidence of Degradation

Personal testimony of several observers suggest that prior to World War II flocks of gazelles were seen on the Syrian Baddia, now there are none (see chapter 6 on biodiversity). Similarly Bedouin herdsmen have noticed changes in the vegetation of the Baddia over recent decades (Heemstra 1997). These changes include the disappearance of palatable species and a decline in overall plant cover, allowing increased water erosion. Heemstra (1997) reports that Bedouin commented on the disappearance of important range plants, in particular 'Rotha' *(Salsola vermiculata),* a species which was of major importance, but it is now rarely encountered. Other species the Bedouin mentioned which have declined included 'Sheeh' *(Artemisia herba-alba),* 'Naitoun' *(Haloxylon articulatum),* "Bakhtari' *(Erodium cicutarium)* and 'Kuraita' *(Plantago ovata).* These are not always palatable plants and some of them are still common, but apparently they were species that were dominant in the past and their lower abundance is considered noticeable. Some quantitative evidence backs up these observations and suggests that around Palmyra patches of unpalatable shrubs, such as *Pegamlm harmala and Anabasis syriaca,* were found to constitute about 70 to 86% of the vegetation cover (Mirreh *et al*. 1997, Al- Jundi *et al.* 1998 1999, 2000).

The herdsmen have gradually been obliged over time to use more concentrate feeds, as substitutes for declining rangeland resources. The range livestock was almost dependent on range plants until 1958 when concentrate feeds were introduced for the first time. The rate of feed use has increased by the 25, 50 and 75% in the 1960s, 1970’s and 1980’s respectively (Masri *pers.comm.*).

Estimates of the use of feed by cooperative members suggests that 46% of herders use concentrate feed for between 3 and 5 months of the year, 41% use it for between 6 and 8 months, while 7% use concentrates for between 9 and 12 months. Aproximately 4% of herders do not use concentrate feed at all. These figures are in line with those of ICARDA (1994-95) which estimated that the steppe, fallow and mountain areas provide the sheep with 8.6%, of their feed ration while 91.4 comes from concentrate feed and aftermath.

3.4.2 Quantitative Evidence of Degradation

The impact of over grazing on vegetation and soil is evidenced from comparative range conditions studies between sites on control and uncontrolled sites. These clearly indicate the positive effect of range rehabilitation and management under controlled sites and the negative effect of poor range conditions in the other.

Several studies reflect the impact of over grazing on the biomass on the outskirts of Palmyra. For example, a Soviet study in the mid 1980's estimated the current dry biomass to be less 200 kg/ha in the Eastern part of the Baddia. While an ACASAD study in 1981 estimated the average spring and autumn biomass for 17 sites west of Palmyra to be 194.32 kg/ha. The GCP/SYR/003/ITA project has taken biomass samples in July and August 1994 and showed that at the Tallila reserve, where *Haloxylon salicornicum* shrubs (palatable to camels but not to sheep) dominate the major areas and dry weight areas from 87.5 to 1,112 kilograms per hectare. Outside the reserve the dry weight varies from 224 to 120 kg/ha.

In autumn 1999, when severe drought was prevailing, Masri documented by video film the private ranches in Hama, Aleppo and Roqua and showed that on the private ranches the density of shrubs to be sufficient to hide small lambs, whilst on the neighbouring area the site almost bare. In an FAO study in 1994 by Masri stated that "typical estimated land cover on the major part of Tallila reserve reads the following percentages: 34% bare soil, 20% exposed rocks, 12% gravel, 28% herbs, 12% *H. salicornicum* , 1% *Artemsia herba-alba* and 3 % *Poa*. While in similar associations outside the reserve (Arak location) 77% bare + 12% herbs,10% *H. salicornicum* and 1% *Poa*. Also in Abassieh location outside the reserve the % of land cover was: 57% bare, 27% herb, 8 % shrubs and 8% *Poa*.

Further evidence of overgrazing comes from observed changes in plant species composition. Amongst the perennial vegetation, the unpalatable species of poor forage value such as *Peganum* and *Anabasis* are dominating the vegetation cover. These species were found to constitute about 70 to 86% of the vegetation cover in the project area (Mirreh *et al*. 1997, Al- Jundi et al. 1998, 1999, 2000). Absence of the highly preferred species of *Sabola plantago* in the perennial vegetation is an indicator of reduced site productivity for grazing animals The project studies also demonstrate the dominance of low grade annuals in place of the high nutritious annual legumes that constitute only 5%.

At Lajoun range station in Jordan studies have estimated that the carrying capacity per ha 0.06 unmilked ewe under the current open grazing, could be increased into 0.45 under management and even to 0.65 under rehabilitation by planting.

3.4.3 Establishing Monitoring Sites Around Palmyra

Some data documenting the impacts of grazing on the steppe are available from reports of project GCP/SYR/003/ITA. As part of this project five sites around Palmyra, which represented the main vegetation types, were selected for monitoring. Within each of these 4 200m x 200m exclosures were established. These were fenced using chain-link so that grazing was excluded. In each location a similar site was selected immediately adjacent to the exclosure, which was left open to grazing. These exclosures were established in 1996 and results from spring and summer 1997 are shown in Tables 3.2 and 3.3. These show that the average percentage cover of annuals in exclosures was 60.72%, whilst under normal grazing it was 56.38%. Further the mean cover of perennials was 9.39% inside the exclosures and 6.45% outside the exclosures. Pictures taken in December 2000 also show clear differences in vegetative cover inside and outside the exclosures (Figure 3.2).

Table 3.2. Percentage cover recorded along permanent transects for annual plants measured in April 1997 in 5 pairs of range sites. (from Mirreh *et al.* 1998). 'In' and 'Out' refer to inside and outside the grazing exclosure.

Plant form	**Site**									
	1		**2**		**3**		**4**		**5**	
	In	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**
Annual grasses	4.3	0.7	3.3	8.7	12.7	7.3	44.7	40.0	22.0	27.3
Annual forbs	51.3	41.3	79.3	60.0	12.0	28.7	20.7	23.3	32.0	33.3
Legumes	1.3	0.0	2.0	0.0	5.3	2.0	6.7	7.3	60	2.0
Bare ground	29.3	40.0	14.7	31.3	62.0	54.7	28.0	29.3	40.6	37.3
Stone & Gravel	14.0	16.7	0.0	0.0	7.3	6.7	0.0	0.0	0.0	0.0
Total vegetation	56.9	42.0	84.6	68.7	30.0	38.0	72.1	70.6	60.0	62.6

Figure 3.2 Vegetation inside and outside a grazing exclosure in the Talila project, Palmyra. Photograph taken December 2000. (Photo by G Edwards-Jones).

a) out side the exclosure

b) inside the exclosure

Table 3.3 Percentage cover recorded along permanent transects for perennial plants measured in April 1997 in 4 pairs of range sites. (from Mirreh *et al*. 1998). 'In' and 'Out' refer to inside and outside the grazing exclosure.

Plant form	**Site**							
	1		**3**		**4**		**5**	
	In	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**
Anabasis syriaca	5.95	5.17		1.91	0.60	0.33		
Peganum harmala	0.00	0.14	0.93				1.69	9.04
Seidizia rosmarinus			2.08	1.44				
Haloxylon salicornicum			3.41	2.83			0.63	
Chenolia arabica			0.30					
Artemsia herba alba			0.61	0.51	0.83	0.02	6.43	0.61
Achillea conferta			0.01					
Achillea fragantissima					14.09	3.81		
Total	5.95	5.31	7.34	6.69	15.52	4.16	8.75	9.65

3.4.4 Removal of Shrubs

Shrubs and trees are pulled up by local people for fuel and medicinal uses. The perennial shrubs are uprooted according to fuel desirability and include: *Haloxylon articulatum, Salsola vermiculata, Artemisia herbaalba, Haloxylon salicornicum, Noea muccconata*. These plants are pulled up by their roots, thereby preventing any possible recovery of the plant, and also enabling erosion. The fuel is used for five main purposes; tea making for 3-4 times daily, baking bread twice a day, cooking once a day, seasonal winter heating and seasonal milk processing. The amount of shrubs used is rated as 1,2,3,3 and 1 for tea, bread, cooking, heating and milk processing respectively.

Such uprooting is an ancient practice and the amount of shrubs uprooted per capita is generally decreasing due to availability of Kerosine, methane and gas and also due to improved standard of living. However, increased population densities mean that the overall level of uprooting is not decreasing, and may even be increasing. A survey undertaken by the Talila project (GCP/SYR/003/ita) suggest that 4.1 ha of land is cleared of shrubs annually per family.

3.4.5 Motor Vehicles

Large trucks are increasingly used to transport sheep and water around the Baddia. This serves to break the soil surface which again leads to erosion. The situation is worsened as the frequently used routes often become impassable due to the development of soft sand or mud. The drivers of the vehicles then drive around these areas, thereby increasing the area effected. On occasions areas up to 1km wide have been affected by vehicles to the extent that they are now impassable to them.

3.5 Why Does Range Degradation Matter?

Fundamentally range degradation matters in the short term because the loss of good quality vegetation will mean increasing reliance on purchased food stuffs, thereby reducing profitability, but also continued loss of vegetation, and consequently the soil, will reduce the rangeland to a desert of little agricultural or biodiversity value. Such an occurrence would have severe economic impacts on the country. It should be noted that experience from around the globe suggests that preventing an environmental problem from occurring in the first place is usually a lot less costly in the long run, than seeking to re-establish an equilibrium after a disaster has occurred.

3.5.1 Annuals Versus Perennials

Perennial dwarf shrubs and annuals constitute the vegetation of the Baddia and their management is crucial to enable management decisions about stocking rates, grazing management systems and response to drought years. These issues have been discussed in detail in Mirrah *et al*. (2000), and a discussion of the major points is presented here.

Annuals, particularly the grass *Poa sinaica* constitute a major part of the diet of grazing sheep and long term studies carried in areas of similar vegetation to that around Palmyra, eg in the Hammad of Saudi Arabia have shown that in terms of dietary preference more than 87 % of the diet is derived from annuals (Mirreh 1998). Should these annual plants be scarce for some reason, ie overgrazing or drought, then sheep tend to graze more on the perennial plants. These perennials can withstand heavy grazing over winter, but once they begin to grow in the spring, heavy grazing tends to have an extremely detrimental effect on the plant, and can lead to its death. Sublethal effects of overgrazing on perennials can lead to reduced seed production, reduced groundcover against erosion and diminished site productivity if stock adjustment is not made.

Perennials plants serve to stabilize the soil and create micro-habitats for growth of annuals. Minor differences in the condition of the top soil have a dramatic effects on the growth of annuals (Zohef 1973, Thalen 1979, Mirreh 1986). Further heavy grazing pressure on perennials results in erosion pavements, which are not conducive for germination of either annuals or perennials.

Other impacts of loss of vegetation cover relate to wind erosion and continuing desertification. The movement of large amounts of sand from the Baddia can cause problems in urban areas and on roads and railways. Maintaining good vegetative cover in the Baddia is vital in order to combat desertification.

3.5.2 In Relation to Quality

Annuals are nutritionally better than perennials, as perennials are generally low in energy. Perennial plants however are an important supplement to balance nutritional needs of grazing animals because of their longer period maintaining high crude protein level (Mirreh *et al*. 1990). Nutritional adequacy for grazing animals in the Syrian steppe can be divided into production, maintenance and sub-maintenance phases. The production phase constitutes the short spring period between February to April when the nutritionally rich annual forbs, grasses and legumes are available for grazing. The maintenance phase is the period of availability of green perennials from May to October. The period between November to February is for sub-maintenance when animals graze dry perennials as bulk feed. This period of low nutrition coincides with the critical lambing and nursing period. The major weight loss of range-based animals occur in the winter dormancy when the nutritional quality of the range is poor. Dry ewes with average weight of 50 Kg can loose up to 20 % of their body weights in the winter while lactating ewes can loose 20 to 30% of their body weight in the winter (Mirreh *et al.* 1991). Availability of nutritious annual vegetation after the winter dormancy results in quick weight gain of grazing animals. Spring grazing restore weight lost during the winter and animals enter the breeding season in good condition in a normal year. A normal year followed by a poor year of rainfall results in weight loss even during the spring period (Mirreh *et al*. 1991).

3.5.3 Rangeland Quality and Stocking Rates

Fixed stocking rates are not well adapted to the growth patterns of Baddia plants, which vary spatially and temporally according to local patterns of rainfall. Therefore animal numbers in any one location must be continuously adjusted according to the prevailing environmental conditions. Such a system is at the heart of the nomadic lifestyles practiced by Bedouins for centuries. Nevertheless if management plans have to be suggested, it is necessary to provide indications and estimations of appropriate number of animals that can be fed on Al Baddia rangelands at different times of year. Unfortunately the absence of good long term monitoring data on the interactions between weather, vegetation and herding are absent for much of the Baddia rangelands. This absence renders scientific establishment of grazing patterns extremely difficult.

Through comparative analysis of other rangeland systems, and through some relatively recent biological work Mirrah *et al*. (2000) have estimated that in a normal year in the Syrian Baddia approximately 200 Kg of dry matter per hectare are produced, and this is approximately sufficient to support 0.5 sheep per ha per year. The Directorate of the Baddia currently suggest, in their sheep production stations, a stocking rate of 3 sheep units/ha for a period of 4 months divided into 2 months in the winter (November- December) and 2 months in the spring (March -April (MAAR 1995). This is equivalent to an approximate stocking rate of 1 sheep unit/ha/yr. The estimated population of animals for Syria in 1998 was approximately 15 million sheep, which is equivalent to a stocking level of range based ruminants of 1.4 sheep units/ha (Mirrah *et al*. 2000). Best guess estimates therefore suggest that a sustainable stocking level would be three times lower the current stocking level.

However, overall stocking rates are not the only factor to be considered when devising a sustainable rangeland management scheme. The timing of grazing is also extremely important. The main growth season for the perennial shrubs are in the late spring and summer and grazing at this time may be extremely harmful as the removal of new shoots will serve to deplete the carbohydrate reserves of the plants, which are stored in the roots. Thus early grazing tends to effect plant growth processes and may result in low production over the year, thereby reducing the amount of forage available in the autumn. In the worst cases, repeated, severe early grazing may kill the perennial shrubs. The early grazing also reduces the amount of energy available within the plant for reproduction, hence fewer seeds are shed and this in turn leads to grazing being concentrated on fewer and fewer shrubs. Hence the feedbacks in the system continue.

3.6 Rehabilitation Efforts

3.6.1 Why Rehabilitiate?

Active rehabilitation of rangeland is needed as observations on several situations have not shown natural rehabilitation occurring over medium time scales. For example on deserted ploughed lands in the Baddia unpalatable plants invaded first, and there is no evidence yet of more palatable plants replacing these unpalatable shrubs. Further observations on enclosures in Wadi Alzib range station showed that associations of *Noea musronata,* which are thorny plants, remained without changes for more than a decade.

3.6.2 Preferred sites for Rehabilitation

As rehabilitation success is greater in areas with favourable biotic conditions, especially water, then in the first instance rehabilitation operations should be focused on sites of extra run-off, such as denuded flood plains.

3.6.3 Previous Experiences

The Baddia directorate has been undertaking rehabilitation over the last 30 years. The methods have generally been based on the plantation of seedlings, which have been bred in nurseries. This method can require the use of large machinery, which themselves can cause erosion, and field irrigation. This method has been successful in certain areas, such as in the Aleppo Baddia (rainfall 175mm).

The Talila project (GCP/SYR/003/ITA) is situated in an area of 127mm average rainfall. Work on this project has demonstrated that plants can easily be established from direct reseeding under rainfed conditions without using heavy duty equipment and without using irrigation. Seedling germination of 4 plants/m^2 has been achieved with this method, and seedlings had a survival rate of 25%. However, as herders may mistakenly graze in the reseeded area, as there are no to clear features demarcating the site, it is recommended to plant some seedlings, especially on the boundaries of the site. Work on rangeland rehabilitation on an FAO/WFP project in Jordan demonstrated that rehabilitation by desert reseeding cost only 5% of the seedling method.

CHAPTER 4. SOIL CONSERVATION

4.1 Soils of Syria

The soils of Syria are spread over five orders of the 1975 United States Department of Agriculture Soil Taxonomy (Ilaiwa *et al.*). The distribution of these soils is shown in Figure 4.1 and a summary description of the soils is given below. A more detailed description is given in Appendix 4.1.

1) Aridisols cover 47.5% of the country (Figure 4.1). They generally occur where the annual rainfall falls below 250mm, and are thus the dominant soils in the Badia, but also occur around Damascus. They are mostly characterised by Calcic or Gypsic horizons close to the soils surface, weak structure and relatively light texture, which predisposes them to erosion.

2) Inceptisols are the second most extensive soils covering about 21.7% of the country. They are the prevailing soils in the rainfed areas in the north of the country and also in the areas to the east of the coastal mountains around Homs, Hama and Edleb. They are mostly characterised by Calcic horizons, heavy texture and moderate to strong structure.

3) Entisols are relatively young soils, occupying about 16.9% of the country. They are mainly found as shallow soils over the coastal and central mountain or as alluvial soils in river terraces. They are the predominant soil in the Euphrates valley.

4) Vertisols are heavy textured cracking soils which occur over only 2.1% of Syria's land mass. They mainly occur as associated soils with the Inceptisols and are most common in the north of the country between Aleppo and the Turkish border.

5) Molllisols have a dark surface layer and well-developed structure, and only occur over 1.2% of the land. They are mainly confined to the coastal region.

4.2 Soil Degradation

The soils of Syria suffer three main types of degradation:

- Water erosion
- Wind erosion
- Chemical degradation

Wind erosion effects the greatest area of these three, and chemical degradation the least (Table 4.1), and in total 17.3% of Syria is effected by some form of degradation.

Figure 4.1. Distribution of main soil types in Syria

Figure 4.2. Distribution of degraded soils in Syria (source: (Ilaiwa *et al*.). Key: Water erosion is the blue shading, top row in key below, light blue (extreme left in key) is low, mid-blue is medium and dark blue (extreme right on the key) is high. Wind erosion is the three shades of buff to brown (middle row in colour key below) going from low to high from left to right, chemical degradation is the bottom row, shades of yellow to red, again going from low to high from left to right.

The distribution of this damage can be mapped and The Human- Induced soil degradation map of Syria (Figure 4.2) (Ilaiwa *et al.*) was prepared following GLASOD guidelines (an FAO methodology). This required the 1985 soil map of Syria to be divided into 68 physiographic units, each of which were then evaluated through a combination of literature based analysis and field survey. (N.B. The GLASOD methodology has 4 classes of degradation, however as no areas of 'very high' degradation were found this class was omitted from the analysis). Figure 4.2. map shows the distribution and severity of water erosion, wind erosion and salinisation.

4.2.1 Water Erosion

The areas most effected by water erosion (the blue shading in Figure 4.2 light blue (extreme left in key)is low, mid-blue is medium and dark blue (extreme right on the key) is high) are the coastal mountains and the mountainous regions in the arid /semiarid areas. The area of plateaus and plains remains largely unaffected.

Table 4.1. Area of degraded soil. Total area of Syria is 18.5 M ha of which 6.15M ha are in agriculture and 8.2 M ha in are in pasture (source MAAR, cited in ERM 1998a)

Degradation type	Degree of degradation (000 ha)			Total area 000 ha	% of country affected
	Slight	Moderate	Severe		
Water erosion	902	127	29	1,058	5.7
Wind erosion	1210	380	30	1,620	8.7
Sand accumulation	11	267	130	408	2.2
Salinisation	15	20	90	125	0.6
Total	2,138	794	279	3,211	17.3

4.2.2 The Coastal Mountains

The steep slopes, shallow soil cover, heavy rainfall (800-1500mm) and frequent rain storms mean that once vegetation is removed from these areas they are naturally susceptible to water erosion. The natural vegetation of the region would probably be forest, however forest fires (deliberate and accidental) and forest clearance for agriculture have both served to reduce vegetation cover in the area. This inevitably leads to severe water erosion, and areas effected may never be recoverable. Some estimates for the coastal mountains suggest soil losses from this cause of up to 20 tonnes /ha/ yr (ERM 1998a).

4.2.3 Mountainous Areas in the Arid /semiarid Regions

Again the natural vegetation of these areas would probably be forest, but continued forest clearance for agriculture and timber has reduced this cover to a fraction of its former area (NB natural forests have gone from covering 30% of Syria to covering about 2% over the last 100 years). Again water erosion ahs occurred exposing the bare rock in many places.

4.2.4 Plateaus and Plains

These areas have not suffered much water erosion as the are flat, and even where rainfall is relatively high the soils tend to have good structural stability.

4.3 Wind Erosion

Wind erosion is the most serious form of soil degradation in Syria, and even though no regions of very high degradation are marked on the map, this does not mean that they do not occur, rather they were too small to be mappable as single units. Estimates of soil losses to wind erosion suggest that up to 12t/ha/yr are lost in the Badia (ICARDA *pers. comm.*) or taken as an aggregate for the whole country 570,000t of soil / day are lost to wind (ERM 1998b).

Not only does wind erosion cause loss of soil from the source point, it can also cause problems as it is carried on winds, and at its sink. For example, (Ilaiwa *et al.*) report that in 1988 the action of moving sand grains was harmful enough to prohibit the growth of annual grazing grasses across large areas of the Badia. The frequency, duration and severity of such dust storms varies tremendously between regions and years, and reports suggest that these storms have been getting worse in recent years (although no hard data were available to corroborate this observation). Two case studies (from Iliawa *et al.*) described below provide evidence on some of these issues.

4.3.1 Southern Mesoptamian Plains

The area most effected by wind erosion is the area to the north east and south of the Euphrates. A few years ago the area between the Balikh river north of Rakka in the west to the Khabour river in the east was amongst the best grazing lands in the Badia. However, mechanised cultivation of rainfed barley initiated soil erosion in the 1950s. The windspeed in this region is generally greatest around September, when it ranges from 16m/sec to 27 m/sec in September. The minimum wind speed required to transport soil particles is about 5 m/sec. Thus the removal of the natural vegetation and the breaking up of the soils surface during cultivation inevitably led to wind erosion.

The wind carries the soil long distance in these flat areas and in some villages in the Governorate of Deir Elzzhor sand can reach to the roof level of houses. Similarly a 40km stretch of the railroad is severely effected by sand and sand removal from tracks is needed every two to three days, and sometimes even daily during summer months.

A final impact of wind erosion in this area is that it may expose previously covered layers of soil with extremely high gypsum levels (usually more than 70%). Where the soil cover is greater then a few centimetres production of annual grasses may be possible. However, further reduction in soil cover will render many areas as barren and unusable.

4.3.2 Bichri Mountain

A similar situation has occurred in Bichri mountain in the eastern part of the country. Traditionally this was a grazing area, but rainfed barley cultivation was introduced into the area in the 1950s. The soil has a high erodibility due to its weak structure and coarse texture. Wind erosion has increased in recent years, as evidenced by an accumulation in depression, sand hummocks and large amounts of sand being trapped by shrubs and other barriers.

Bichri mountain is located in the central part of the Badia and has large flat divides sloping east. For these reasons it is believed to be a major source of wind moved sand. Wind transports sand eastwards over long distances, for example shrubs over 1 m tall in areas with no cultivation have been covered in sand in areas over 100km from the mountain. Similarly to the northwest, sand moving from the Rasafa plains has seriously affected extensive grazing areas, and the layer of accumulated sand can be more than 30 cm deep.

A recent project between ACSAD and GTZ has sought to investigate the best means of managing a pilot area of the mountain in order to reduce erosion. A range of techniques were tried, and the most promising results were obtained with direct drilling of seed of certain steppe herb and shrubs. The project is over now, but considerable capacity has been developed on this topic, and this capacity should be used to seek to reduce erosion on the Bichri mountain and elsewhere in Syira.

4.4 Chemical Degradation

Chemical degradation of soils is of two main types in Syria: salinisation and industrial pollution. Sailinisation is discussed here, while the main industrial pollution is discussed in Chapter 2, under the sections on pollution in Al Ghouta.

4.4.1 Salinisation

Salinisation in Syria is considered in 4 categories:
- No salinity problem (0-4 mmol/cm EC)
- Low salinity (4-8 mmol/cm EC)
- Medium salinity (8-16 mmol/cm EC)
- High salinity (> 16 mmol /cm EC)

If EC is greater than 8 then agricultural productivity becomes low, and generally only barley will grow in these areas. If EC > 16 then no crops will grow.

The areas most affected by salinisation are shown in Figure 4.3. These include the Euphrates and Khabour valleys, an area south east of Aleppo and an area in the extreme east of the country, north of Albo-Kamal. The severity and extent of the salinisation is shown in Table 4.2. The areas outside of the river valleys are generally low lying and to some extent are natural salt pans.

Table 4.2. Severity and extent of land impacted by salinisation in Syria (source MAAR)

Salinity class	Area effected in 1000 ha.	EC m moh/c.m	% of total
Very severe	90	> 16	72
Moderate	25	8 - 16	20
Slight	10	4 - 8	8

Irrigation in the Euphrates valley began between 4000 – 3000 BC, and soil salinisation was first noted in the 1940s when large scale irrigated agriculture became possible using diesel driven pumps. The process accelerated when cotton was introduced in the 1950s. The problem was caused by a combination of factors: the misuse of irrigation water and the absence of effective drainage systems led to a rise in the groundwater level. Evapotranspiration then led to salt accumulation in the root layer. So great was the impact that by the mid-1960s large areas of this land had been abandoned. A survey carried out in the early 1970s showed that the electrical conductivity of soil paste extract was 8 dS / m over 50% of the 123,000 ha surveyed. Soil salinity increases with distance from the river bank. This pattern is related to the drainage patterns of the land. Land near the river has good natural drainage patterns, and because of this salinity is kept low. At increasing distances from the river, there is increasing dependence on man-made drainage systems, which are not well made and are often poorly maintained. These drainage systems are often surface drainage, and do not perform well. Better systems are underground pipe drainage at a depth of about 1 m, and these are being introduced in some areas.

Land in the second Euphrates terrace, near Rakka, was brought under irrigation in the 1970s, and a survey undertaken in 1980 showed that severe salinisation (>16 dS/m had occurred in about 24% of the area. This was largely due to the absence of good drainage systems within the project area.

Drainage on most private farms is generally insufficient and inefficient. Drainage has been of 2 types: surface and covered. Covered drainage uses permeable cement pipes at a depth of 1 m (+/- 20cm). The covered drains are used on state farms, but surface drainage has generally been used in the Euphrates region. Vertical drainage has been used alongside surface drainage in some areas. Here deep holes are drilled and water was pumped out and then moved away via the surface drains.

Currently policy allows for reclamation of land of high salinity (EC > 16) to be undertaken. This requires improvement of drainage systems (ie introduction of buried drains), better water management and the growing only of barley for two years. There are no scientific trial data available on the reclamation method, but experience to date suggests that within 2 seasons EC can be reduced from 16 to 8 EC. After reclamation barley needs to be grown for at least 2 years, before any other crops could even be considered.

4.5 Costs and Importance of Soil Degradation

The combined costs of soil degradation in Syria US$319 million /yr, with salinity having the greatest cost per hectare and the greatest overall cost (Table 4.3). These costs are projected to rise to SP17,700,000,000 by 2005 (ERM 1998a). These estimates make soil degradation the most costly of the environmental problems considered (the others being water quality degradation and water depletion, air quality degradation, urban degradation, loss of biodiversity, damage to cultural heritage). Soil degradation was also ranked as the main issue of concern by stakeholder groups interviewed by ERM (1998a) during the development of the National Environmental Action Plan.

Table 4.3. Estimated costs of land degradation in Syria in 1997. (source ERM 1998a).

Type of problem	Area affected (ha 000)	Cost/ha/yr (SP)	Total cost per yr (SP million)
Water erosion – coastal area	1058	2675	2,830
Wind erosion – steppe	1620	1370	2,219
Salinity	90	105,390	9,485
Total			14,534 (US$ 319)

4.6 Desertification in Syria and its Impact on Development

Taken together the bio-physical process of soil degradation can lead to desertification, which has increased in Syria over recent years. The causes of soil degradation in Syria include: overgrazing of the Badia, pulling of perennial shrubs for heating and cooking, digging wells in the Badia which enables more sheep to be kept, increased use of motor vehicles and development of roads in the Badia., deforestation and lack of environmental protection in the areas of mineral extraction. Many of these issues are dealt with in some detail elsewhere in this report are will not be reanalysed here. However, it is important to note that the causative processes of 'desertification' relate to the interaction of humans and the environment, and are therefore potentially influenced by policy.

The evidence of desertification can occur in several forms:

1- Pasture degradation:
  - Scarcity of grazing plants
  - Increased prevelance of less valuable grazing plants
  - The transference of many grazing areas of good and long-lived plants into seasonal, annual pastures, then the degradation of annual pasture and its desertification.
  - Noticeable aerial and water erosion features as well as dunes and sand accumulation.

2- Land degradation :
  - Degradation of agricultural lands.
  - Salinisation in agricultural soil.
  - Soil drifting.
    Sand accumulation
    Increased sand /dust storms

As noted previously in this chapter, the nature of Syria's geomorphology and soils has exacerbated the desertification process, which began through mismanagement driven by social and economic forces.

4.6.1 Stages of desertification

There are several stages in the desertification process:

<u>Light desertification</u>
Signs of spots environmental deterioration, represented in changes in quantity and quality degradation of the components of the plant cover and soil in specific regions. The main reason for these light desertification changes is human practice, such as the salination on Euphrates banks due to the misuse of irrigation.

<u>Moderate desertification</u>
This moderate stage of environmental deterioration is reflected in a decrease and a change in the plant cover, erosion and light drifting caused by wind and water. This driftage causes dunes such as Al–Kasra dunes spot in Deir Ezzor. These dunes became a danger threatening the train-track of Al-Raka and Al-Hassakeh.

Intense desertification
A decrease in the number of useful plants that are replaced by less valuable or even harmful plants. The salinity increases to a point that land cannot be planted by conventional methods.

Extreme desertification
This is the most extreme stage of environmental degradation, where land becomes barren such as Al-Hamad in Al Badia where land became totally unproductive because the land itself became dunes, as did Al–duffa, Al- Muthalath, and Al–Kasra areass in Deir -Azzor or Malahat in Al–Jabol and Palmyra.

4.6.2 Impacts of Desertification

The impacts of desertification clearly include reduced agricultural productivity, land abandonment, loss of biodiversity and environmental services and damage to infrastructure. The consequences of these impacts may include increased emigration from the countryside to the city which will bring increased pressures on cities whilst severely impacting the social and economic fabric of the countryside.

4.6.3 Control and Prevention of Desertification

Control of desertification requires that the biological, physical and chemical characteristics of soil are maintained. This requires prevention of its erosion and degradation whether from salinisation, industrial pollution or domestic waste. In this way both agricultural and natural vegetative cover will continue and erosion will be minimised.

Once desertification has begun then it becomes necessary to try and limit erosion and sand crawl. This requires that shifting dunes are fixed, through the development of plant cover (grazing and /or forestry). It is also desirable to establish forested areas (or greenbelts) around marginal areas and urban and infrastrucutre that may need protection from wind driven sand. If possible it would also be beneficial to revegetate the degraded areas, and thereby reduce the source of the sand.

Such control measures are useless if the causes of desertification are allowed to continue. So it is important to also seek to address the causes of desertification, which in the case of Syria include overgrazing of the Badia, deforestation and removal of perennial shrubs for fuelwood.

4.6.4 Response of the Syrian Government to Desertification

The response of the Syrian Government to desertification is evident in a number of ways. For example, at an international level Syria has ratified the UN convention recommendations concerning desertification in 1977. At a more practical level it has sought to control desertification through implementing a range of projects and policies. These include:

1- Reclaiming 100,000 hectare of saline lands in the lower Euphrates basin and bringing it back to agriculture in order to be use in the agricultural fields.

2- Expansion in seedling production in all Governorates and increasing the area of fruit and forest trees.

3- Establishing animal, vegetative and environmental protectorates in certain regions such as Balas and Talila protectorates in order to develop pastures and breed wild animals.

4- Maintaining soil from deterioration, drifting and prevent throwing solid and industrial wastes in the agricultural lands .

5- Draining bogs in various governorates according to a schedule and then utilizes these bogs in grazing and agricultural activities.

6- Establishing a State ministry for environmental affairs to preserve environment and control pollution and desertification.

7- Using educational and advertising programs to highlight the importance of environmental protection and control of desertification.

A range of Ministries have been involved in developing and implementing these responses to desertification, and details of some of these and the official description of their associated projects are described in Appendices 4.2 and 4.3.

CHAPTER 5. FORESTRY, TREE CROPS and LAND RECLAMATION

5.1 Introduction

Historically Syria would have been far more forested than it is presently. Current forests cover 2% of the land area, down from about 32% at the beginning of the 20th century. The location of the remaining natural forests, which total 232,840 ha are shown in Figure 5.1, and their size is shown in Table 5.1. This area comprises:

- 25% is nearly covered with forests. 70,000 ha are coniferous or semi coniferous. Most of these are located in Lattakkia.
- 50% is covered with scattered forest scrub without significant trees in Damascus, Aleppo, Homs, Hama, Edleb, Sweida and Lattakia
- 25% are called forest areas, but are really in a severe state of deterioration. These areas are in Al Balaas Mountain, Abdul Aziz Mountain and some parts of the Syrian side of East Lebanese Mountain ranges (NCSBD 2000 p 185).

The causes of natural forest loss have varied, and include extensive land clearing for human settlements and agriculture, grazing by goats, sheep and other animals for thousands of years, illicit felling, burning for charcoal production, fires and inappropriate agricultural practices have now virtually exterminated the natural forests. However, arguably the greatest loss occurred during World War I, when the best trees from Lebanon and Syria were felled to construct and operate the Hejaz railways. More recently the continued search for new agricultural land has led to the clearing of forest areas on sloping terrain, causing severe soil erosion in the mountainous regions of Syria.

Substantial afforestation and reforestation programs have been launched to increase forest areas. Forest reserves have been declared in Syria. Work on sand dune fixation, green belts, roadside plantations and urban forests has been intensified. The rate of afforestation in Syria has increased from 159 ha/year during 1953-70 to more than 24,000 ha /year during the 1980s (Ministry of Agriculture, Syria, 1996). These measures have been sufficient to slow, but not arrest deforestation.

Table 5.1. Area of natural forests in Syria by dominant tree type (ha) (Source: Forestry Directorate, Damascus)

Dominant tree species in natural forests	Area (ha)
Oak	135,958
Pine	64,065
Wild Pistachio	19,389
Cedar and Fir	597
Others (Almond, Hawthorn, wild pear)	8,631
Euphrates Poplar	2,346
Juniper	1,854
Total	232,840

Figure 5.1. Location of natural forests in Syria (scale 1:300,000).

5.2 Institutional Background

The Forestry Directorate was established in 1943 and there is an office of the Forestry Directorate in every Governorate. Although a range of laws and decrees have been passed concerning forestry in the intervening years, forest protection remains the main objective of Directorate (Forestry law No.7, 20/6/1994).

In addition, the Directorate seeks to maintain natural resources and increase the areas of forest cover through artificial planting. Secondary objectives of the Directorate are to provide employment opportunities through tree planting operations, and to disseminate knowledge about the importance of forests and their economical, environmental and touristic benefits. Forestry policy in Syrian has encouraged technical and economic cooperation with various local, Arab and international bodies to develop forest projects and to introduce new approaches to recognising forests; importance in economic and environmental terms. Main planks of the current forest policy are:

- Set an annual plan for increasing forest areas and thus developing natural forests.
- Develop the tasks of the forest police.
- Develop the plan that protects forest and establishing specialised centres to extinguish forest fires.
- Create task force to take care of forests.
- Increase the number of forest seedlings and nurseries.

The main decrees issued to date include:

- Tree day decree No. 18, date 4/2/1953 that determined the last Thursday of each year as tree day.
- Law of forest police which issued in 30/9/1953 according to legislative decree No. 86. The forest police are a body that has similar characteristic as judicial police, its main task to maintain the Syrian forest regardless of the owner according to law and prevent violation, and vandalism in forestry, and to suppress all type of forest's violation article No. 1 of chapter 1.
- Later set some amendments of forest police issued according to a legislative decree, some of which are:
- Legislative decree No. 86, dated 30/9/1953, No. 870, dated 9/2/1969, No. 1060, dated 20/5/1969, No. 1465, dated 15/7/1965, No. 2324, dated 20/10/1969, No. 2428, dated 26/10/1970.
- Forest law No. 7 of 20/6/1994
- Hunting law that protects wild life.
- Law, No 2163 dated 4/12/1965 consider Balass mountin in Hama and Abou Rimhen in Homs as protected areas.
- Law No. 108 of 20/7/1977 that contains he supreme planting/seedling commission, the role of this commission is to prepare for " tree day" 25 million seedling to be planted in different region in Syria. In addition all needed procedure for protecting this seedling should taken. Thus, this commission has giving a wide range of authority to perform its tasks.

Table 5.2. Main tree species planted in each Governorate in Syria (source: Forestry Directorate)

Species	Damascus	Damascus Rural	Dara'a	Quneitra	Al-Sweida	Homs	Hama	Idleb	Aleppo	AL-Gab	Al-Rakka	Deir-es-Zor	Hassakeh	Lattakia	Tartus
Pinus brutia							*	*	*	*					
Pinus halpensis	*	*					*		*		*			*	*
Pinus pinea		*	*	*	*	*	*	*	*	*	*		*	*	*
Ailanthus glanduloza	*	*			*										
Robinia psedoacacia	*	*									*				
Schinus moll	*														
Pistacia atlantica		*			*	*	*				*	*	*		
Cupressus arizonica				*											
Cupressus		*			*										
Eucalyptus						*		*		*					
E. gomphocephala			*												
Amygdalus orientalis					*	*									
Quercus					*										
Pirus syrica						*									
Castanea sativa						*								*	*
Prunus mahleb								*							
Olea europaea												*			
Cedrus libani														*	*
Abies cilicica														*	*
Lourus nobilis														*	

5.3 Planting of Forest Trees

The Government aim is to plant 24000 Ha of trees a year, and has been so since 1984. In order to meet this aim an annual plan is developed which identifies the land to be planted in that year. Each Governorate produces a plan and these are amalgamated centrally. The Commission for Forestry and Fruit Trees is headed by the Governor and this committee discusses what to plant. Proposals then come to the centre and ultimately decided upon by the Prime Minister. Regional directors select the sites to be planted and the species that will be planted. There is also interaction between Governorates and villages in this process. Sometimes the establishment rate of planted trees is only 50-60% percent (Appendix 5.1). If these trees are replanted then this counts to the second year's target too (this difference is emphasised here by the use of the words 'afforestation' – which means planting on land which did not previously grow trees, and 'reforestation' – which means replanting area where previously planted trees have failed). All plantings occur on state land, and none on private lands. This is in line with the definition of 'State forestry' which is forestry land that owned by the state whether it has beneficiaries rights or not, (According to paragraph T of article 1, chapter 1 of forest law No. 7 of 1994). The strategic forest plan does not apply to strategic crop areas. So in these areas planting is entirely at the discretion of the farmers, and should they request tree planting the Forest Directorate will sell them trees very cheaply, and also will provide help in planting the trees

There is a five year plan for forestry, and the Governorates each have separate targets which together should meet the national target of 24,000 ha, for example in Tartus they try to plant 2000 ha/yr. The Governorates select areas for planting according to different criteria, in Tartus they seek to plant areas which have been degraded in some way, eg through rain erosion, overgrazing or fire and these are selected for planting / replanting. They are planted with local species. When selecting these areas they consider altitude, precipitation, soil, aspect as well as degradation.

Land for planting is getting scarcer, and some Governorates have little land left to plant. Some lands which are currently rangeland could be planted in the future. This would become more possible as cattle can be permitted to graze in mature forests (>10 yrs) and this would create some land for new planting. Grazing cattle have some benefits as forest grazers as they tend to keep weeds down in the forests and also add some fertiliser through their dung and urine. In 2000 the Forestry Directorate tried to reduce the target area for planting, due to land shortage in some areas and the drought in others, but the Ministry refused and made them keep the 24000 ha target. However, the Government is discussing a strategy of having annual increases in planted area of 15,000 hectare.

The forests planted by Government are not for commercial purposes. It is not anticipated they will be cut for commercial logging. Rather they are protection forests with the aims of improving tourism / recreation, CO_2 sequestration, biodiversity, slope stabilisation etc. They seek to plant some varieties of economic benefit relevance and develop protection forests. They seek to improve the natural forests, and try to remove dead / diseased trees and any that are leaning too much. Significant amount of trees have been planted along roadsides as part of developing the greenbelt (Table

5.2), these provide some benefit in terms of protecting the road from moving sand, whilst also providing some shade and a more attractive landscape.

5.4 Tree Husbandry

The planting density of trees varies between 600 / 800 trees / ha in poor areas to 1000 trees/ha in good areas. The density varies with environmental conditions such as slope and rockiness. There are numerous forest workers involved in tree planting, for example in Tartus there is a minimum of 5000 workers doing the planting, and there can be 12,000 at times of peak effort.

In Tartus all of the land is planted between November and February as this is the wettest period of the year, and hence should improve establishment in the absence of irrigation. The land preparation is usually conducted before November, in order to reduce work over the 'planting' months. Planting occurs on terraces when the land is very steep. There is no problem with windthrow in Tartus, but there is in Homs, Latakkia and Slumfe areas.

In 2000 1.5 million seedlings were planted in Tartus alone. Most of the seedlings are produced in the Directorate's nurseries. There are 40 such nurseries across Syria, each under a Governerate's management, and they supply seed and seedlings for planting schemes. For example in Tartus there are 5 permanent nurseries (there is also a temporary nursery for chestnuts which give 40,000 chestnut seedlings\yr). The nurseries specialise in producing certain species, according to their location, eg cedar, fir, and laurels are grown in nurseries in mountainous areas, while pine nurseries can be elsewhere.

Table 5.2. Area of roadsides plantations and shelterbelts (ha) (source: Forestry Directorate).

Province	Area
Damascus	377
Damascus Rural	3205
Quneitra	98
Dar'a	952
Al-Sweida	597
Homs	3426
Hama	516
Al-Gab	-
Idleb	595
Lattakia	20
Tartous	-
Aleppo	1363
Al-Rakka	61
Deir-es-Zor	456
Hassakeh	311
Total	11977

5.4.1 Species Planted

Tree planting is carried out in nearly all governorates of Syria. The species planted vary with Governorate, and ecological situation (Table 5.3 and Appendix 5.2). Trees are largely planted on Government owned land, but should farmers request trees be planted on their land, then the Forest Directorate will sell them trees very cheaply, and also will provide help in planting the trees. It is quite common for farmers to ask for such help. The benefits the farmers perceive from such plantings are windbreaks, fruit production (from chestnut, *Pinus spinia*, Olive, Nuts), soil stabilisation and fuelwood. This sort of activity is supported by an on-going national project entitled 'Silviculture activities which aims to provide fuelwood such as brash and branches in the hope of reducing the pressure on other trees'.

The planting of trees for animal fodder is rare, although some are planted in mixes with other trees, eg a few in a row. There is no planting of leguminous trees for soil fertility, although *Eucalyptus* is planted to encourage bees (even though it has quite high water demand it is still planted). There is no planting specifically for timber and no exploitation of existing trees for industrial wood production. A factory for making paper from straw was established in Deir Ezzor. Unfortunately technical problems dogged the enterprise, and the paper is currently using old and used paper or the wood of poplar trees, which is relatively costly (NCSBD 2000).

Advice on which trees for grow in different places and for different purposes is available to farmers when they visit nursery they gets advice on which species to plant, and how to go about this.

5.4.2 Irrigation

There are various method irrigating forest seedlings, this variety depend on the area and the rainfall. Thus, in areas with good rainfall, such as the coastal area, generally the seedlings don't receive any irrigation, although exceptions do occur. In other areas irrigation is done by using hoses supplied by rivers or wells. The number of irrigations varies from one area to another depending on the distance of the trees from the water source and the species planted. Generally, most seedlings receive irrigation during the first year, and in the less humid areas irrigation may continue for 2 – 3 years after planting.

In some areas irrigation provides a large proportion of the tree's water. For example Al-Rakka area is located close to Assad lake and irrigation is supplied by this lake by irrigation networks and hoses. This also applies to Deir Ezzor forest belt where irrigation is taken from the Euphrates river. Drip irrigation began in 2000 in Deir Ezzor greenbelt, and even then only in limited areas. In other areas irrigation is done from tanks, drip irrigation or flooding.

No conflict concerning tree planting and the use of water were voiced. This could be due to the success of an environmental education programme which seeks to inform people that planting trees is good. Alternatively it could be because the issue has not been considered at all, or has been considered to be of little importance.

5.4.3 Pests

No fertiliser is used when planting the trees, and pesticides are not generally used outside the nursery. In the nursery organic and chemical fertilisers are used. Some pesticides are applied to mature trees if needed. These pesticides can be applied from the air or from the ground depending on the nature of the pest and the state of the forest. The most common pests which are controlled with pesticides are insect defoliators, especially the larvae of Gypsy Moth (*Lymantria dispar*). If the affected area is not too large, then this pest can be controlled manually, however chemical control is needed if large areas are affected. This pest is particularly problematical in areas close to Turkey and tends to be worse in drought years.

Table 5.4. Area of forest effected by fire in each region (ha) 1984-1999. (source : Forestry Directorate)

Year	Damascus	Damascus Rural	Quneitra	Dar'a	Al-Sweida	Homs	Hama	Al-Gab	Idleb	Lattakia	Tartous	Aleppo	Al-Rakka	Deir-ez-Zor	Hassakeh	Total
1984	0	14	0	0	0	11	15	3	62	1352	67	87	0	0	0	1610
1985	0	6	0	0	65.1	25	48	4	80	1919	154	70	0	0	0	2369
1986	0	1	0	0	161	11	102	44	63	68	39	53	0	0	0.5	542
1987	0.6	8	0	2	110	12	128	3	8	318	305	14	0	0	1.5	909
1988	0.05	10	0	0	1.6	33	110	32	109	60	76	145	0	0	0.4	576
1989	0	4	0	0	12.7	3	45	2	81	647	136	2	0	0	2	934
1990	1	0.5	7	0	2.2	11	6	38	26	831	67	11	0	0	0	1001
1991	0	2	0	0.1	0.3	3	2	20	15	775	21	34	0	0	0	872
1992	0.1	4	0	10	0	1	5	7	9	66	50	3	0	0	0.9	155
1993	0.3	2	0	0.5	0	4	13	54	45	507	138	6	0	0	0.2	771
1994	0.3	2	90	0	0.2	49	59	3	46	24	41	160	1	0	60	535
1995	0.7	6	0.3	3	12.9	101	63	19	13	17	42	5	5	19	27.9	333
1996	0.04	29	0	0.1	1.3	9	169	14	29	36	32	11	1	0	9.7	343
1997	0	11	0	0	1.3	13	85	6	13	8	40	19	8	11	72.3	286
1998	2	9	0.2	0.4	1	5	39	31	37	30	27	30	9	6	16.2	242
1999	0	0.5	0	0	0.1	0.2	4	9	8	133	30	1	6	9	0.1	201
Total	6	107	98	16	370	291	892	288	642	6790	1265	652	30	44	192	11681

5.4.4 Fire

There is potentially a problem with wild fires in many forested areas of Syria. There are fire fighting teams ready to fight any fires. Firebreaks are included in planting schedules, and one of the reason for having so much forest road (1400 km in tartus alone) is to aid with firefighting and forest protection. There are observation centres /towers in many forested areas, and their function is to watch for fires and to stop illegal logging / degradation. The Forestry police maintain this service.

Fires are quire common but are generally controlled by the Forestry Directorate (Table 5.4). In 2000 there were 65 fires in Tartus which destroyed 160 donnum (16 Ha) in total, although each fires was only a few hundred metres square. The largest single fire in 2000 destroyed 3 ha. Forested areas are replanted with forest trees after a fire.

5.4.5 Degradation and Protection

In addition to fires forests can be become degraded due to illegal logging, encroachment for cropping / animal production. The forest police seek to prevent such events, but they still continue. In theory the punishment for illegal logging is a fine or even prison. Any land which has been cleared is repossessed from and replanted with trees.

The Forest Directorae have education, training and public awareness programmes, and seek to create cooperation between the local people and the department. Signs are placed on roads in order to inform people where forest areas begin, and also to seek to prevent forest degradation, especially the starting of fires. As part of the cooperation between Forestry Directorates and local people, the Directorates seek to reward local people for helping out with forest activities such as tree planting, removal of dead trees etc. In addition local people are employed as forest guards.

5.5 Citrus Trees

In the 1970s the citrus area of Syria was 2000 Ha, and these trees only occurred in areas of flat land. By 2001 there were are 27,500 ha of citrus in Syria, mainly near the coast, although there are about 1000 ha of citrus in Homs, Daraa and Idleb. This equates to about 10,000,000 trees in the coastal region alone. Assuming that citrus gets around 10,000 cumecs per year from the rainfall, it then needs a further 10 000 cumecs of irrigation water/ha. Given the need to irrigate citrus in nearly every area of Syria, it is imperative that it is planted on flat land, in order to avoid surface run-off of irrigation water. For this reason, it is unlikely that citrus plantations would contribute to erosion in mountainous areas, although other fruit and nut trees which are planted on steep slopes may do so.

Until recently the irrigation water in coastal areas has been drawn from wells. Recently a dam has been developed in Tartus which provides water for use in irrigation. In Latakkia water from dams is used to irrigate 50% of the citrus land. In Tartus, one of the main citrus growing area the water salinity is currently 0.5EC (and a range between 0.5-1.2 is acceptable). However, it is known that in some citrus growing areas of the salinity went from 0.5EC to more than 2.7 EC in one year! So while there is no evidence that irrigation of citrus areas is causing major damage to the soil or aquifers, there remains cause for caution and detailed monitoring.

Citrus needs N,P,K fertiliser and 1 tonne of ammonium nitrate / ha (33% N) is the standard recommendation (Fertiliser needs per tree are 3kg ammoniun nitrate, 1 kg of sulphate potash / tree, 0.5 - 1 kg of superphosphate per tree). This used to be applied once a year, but the current recommendation is to apply it in three events: 25 - 50% in March, 15% beginning of June and 25% in the beginning of August. This change in fertilisation recommendation has arisen due to fears of nitrate pollution of water courses, and the possible environmental and health effects that this may cause in the future.

Since 1993 Syria has followed a policy of biocontrol of citrus pests. Pests of citrus trees are controlled by a combination of natural enemy introduction, augmentation and pheremone trapping. Some of the predators and parasites of citrus pests have been introduced from outside Syria (Table 5.5). The citrus board has a system of multiplying many of the biocontrol agents and distributing them to farmers free This has been very successful and the Citrus board claim that no synthetic pesticides or fungicides are applied to Syrian citrus (although some herbicdes may be used at to control weeds around trees). Indeed so successful has this biocontrol strategy been that the Citrus Board is now investigating the possibility of seeking organic certification for Syrian citrus by a European organic registration company. One of the main institutional problems encountered when developing biological control strategies in Syria relates to the importation of biocontrol agents. Reports suggest that the processing of the living samples at the point of entry (usually an airport) is extremely slow, and that large scale mortality of biocontrol agents occurs between the time they arrive on the aircraft and finally arrive in the Citrus Board (at a time scale which can be up to 3 weeks after arriving in he airport). Not only does the mortality of the biocontrol agents hinder breeding programmes, but it may also delay the timing of biocontrol activities in the field, and thereby reduce the effectiveness.

One reason for their success is that citrus trees grow all year round, hence there is food for populations of predators all year round. Similarly one of the reasons why biocontrol has failed in Syrian glasshouses, when it has been successful elsewhere in the world is related to the punctuated nature of the production cycle, which means that biocontrol agents need to be reintroduced every time.

5.6 Land Reclamation

Land reclamation began in Syria in 1977. The Supreme Commission for Planting were responsible for planting reclaimed areas. Earth moving machines were given to every directorate. There are currently three projects called Region Development (Southern, northern and Coastal & Central) which have been running for 12-15 years and which aim to remove stones from land that is currently unproductive. The Government aims to clear 20,000 Ha annually.

The reclamation of these lands is primarily for fruit trees and ‘green belt’ projects. In the Governerate of Daraa 20,521 ha have been reclaimed since 1977. The green belt projects started in 1983 and 9200 ha have been reclaimed since then. There are 1 million trees on the green belt of Daraa alone, including 6,200 ha of olives. The trees planted on reclaimed land form only part of a large expansion of tree crops, partifculalry olives in the south of the country. For example in Daraa, 22, 297ha of rainfed area is planted with fruit trees, most are olives. This land supports 5 million olive trees, of which 4 million are now fruiting. In 2000 these trees produced 65,000 tonnes of olive fruit, of which 45000 t will be converted to olive oil and 20 000 t for pickling.

There seems to be a combination of top-down and bottom-up approaches used when selecting areas for stone clearing. The Commission generally identify areas where they would like to see some reclamation, then over time they select the villages, and finally the exact spots for clearanace. However, within the general areas identified for reclamation individual land owners can request for their land to be cleared. The requests come from coops and private farmers and the Commission considers all applications and makes a recommendation. A small fee is levied for clearing private land. Public land is cleared and rented to people after is has been reclaimed. Public sector ownership of land is in villages or mountain areas for livestock common grazings.

Table 5.5. Biological control programme of Citrus pests in Syria (source: Citrus Board, MAAR)

Pest	Natural enemies and control	Date of identification	Notes
Red scale	*Aphytis lingnanesis*	1996	Native
	Encarsia gigas	1996	Native
Aonidiella aurantii	*Comperiella bifasciata*	1989	Native
Soft scale	*Encyrtus sp.*	1996	Native
Coccous hesperidum			
Wax scale	*Coccophagus sp.*	1996	Native
	Scutellista cyanea	1996	Native
Ceroplastes sinensis	*Aprostocetus toddalia*	1997	Native
Mealy bugs	*Cryptolaemus montrouzieri*	-	Intro from Turkey and
Pseudococcus adonidum	*Leptomastix dactoloppi*	-	Holland 1994-95
Planococcus citri	*Pachyneuron muscarum*	1995	Native
	Clausenia purpurea	1995	Native
	Anagyrus agraensis	1997	Native
Citrus whitefly	*Encarsia armata*	1995	Native
Dialeurodes citri			
Wooly whitefly	*Cales noackie*	-	Introduced from Italy 1992
Aleurothrixus floccosus			
Waxy whitefly	**Eretmocirus debachi**	-	Native and introduced from Turkey 1994
Parabemisia myricae			
Minio whitefly	*Encarsia hispida*	1996	Native
Paraleyrodes minieo			
Citrus rust	*Phytoseides sp.*	-	Native
Phyllocopturata oleivora			
Redmite	*Phytoseides sp.*	-	Native
	Amplyseius californicus	-	Intro from Holland 1995
Panonychus citri			
Budmite	*Phytoseides sp.*	-	Native
Aceria sheldoni			
Citrus leaf miner	*Ratzeburgiola incompleta*	1994	Native
	Cirrospilus nr. lyncus	1994	Native
Phyllocnistis citrella	*Neochrysocharis sp.*	1994	Native
	Sternomesius sp.	1996	Native
	Ageniapsis citricola	-	Intro from Australia 1995
	Cirrospilus quadristriatus	-	Intro from Australia 1995
	Semilacher petiolatus	-	
	Sympiesis sp.	-	
Lemon flower moth	*Bracon hebetor*	1996	Native
	Elasmus stiffani	1996	
Prays citri	*Traps*		
Mediterranean fruitfly	*Diachasmonerpha tryoni*	-	Introduced from Reunion
	Pheremones		Island 1996
Ceratitis capitata			

There is no official yield (benefit)/ water (cost) calculation used when identifying land for reclamation although land tends only to be reclaimed where average rainfall is good. For example in Daraa rainfall has to be greater than 300mm p.a. in order for the land to be reclaimed, while it is greater than 200 mm p.a. for greenbelt areas. Although these are the official statements on land reclamation, ultimately the farmers decide whether or not the reclamation would be profitable.

The actual reclamation process involves large machines moving extremely large rocks to the edges of ‘fields and to the sides of roads. However, even after the large rocks have been cleared, the soil remains very stony, and for this reason are perhaps better suited to growing tree crops, eg olives, than field crops.

Due to the heavy and deep (up to 3m) soils in many of the reclaimed areas, the reclamation work must cease in winter. So the heavy machinery and labour move from to the green belt projects which tend to be on flatter ground that is easier to work. No problems of erosion have been reported in Daraa during the reclamation, although this remains a risk in certain places. MAAR officials believe that the programme of stone removal is successful in Southern Syria, and is also beneficial in the Central and Coastal Region.

CHAPTER 6. CONSERVATION OF BIODIVERSITY

6.1 Syria's Biodiversity

Biodiversity is a term which describes the range of genes, species and ecosystems which occur in a given area. Data on Syria's biodiversity suggests that a very small proportion of the world's biodiversity is present in Syria (Table 6.1). However, while these data are informative they do not convey the full complexity of biological conservation. This is because the value of biological species and diversity is not simply a numbers game. Thus it does not follow that although a nation or region may not host a large proportion of the globe's species, it has little to conserve. Biological conservation is equally concerned with the relative abundance (rarity) of species, their geographical distribution, degree of endemism (species which are endemic to a country and occur only in that country) and also the rarity / uniqueness of ecosystems. Thus many regions may have proportionately few species, but they may still be of conservation importance because of the nature of the uniqueness and assemblages of the species that live their, or because of the region's geographical situation. This is the case for Syria. In addition it is becoming increasingly evident that species richness is an important part of normal ecosystem functioning, and as species are removed from their natural situation so ecosystems may not function as normal, and thereby providing fewer indirect use benefits to humankind.

Table 6.1. Number and proportion of globally known species which occur in Syria (amended from Biological Diversity National Report 2000) (Number of species in the world seems very low compared with other estimates, no source for these data were given in the original report, cf with data in later Tables, where sources are given).

Taxon	Number of authenticated species in Syria	Number of species in the world	Percentage in Syria
Fungi	641	46,983	1.36
Bacteria	55	26,900	1.47
Algae	754	30,600	2.4
Gymnosperms	10	750	1.33
Angiosperms	3100	220,000	1.4
Insects	14,340	75,100	0.1
Fish	452	19,056	2.3
Amphibians	16	4,184	0.38
Reptiles	127	6,300	2.01
Birds	360	9,040	3.98
Mammals	125	4,000	3.12

There is an unusual diversity of ecosystems occurring over relatively small spatial scales in Syria, ranging from the forested, mountainous coast, to the Baddia and Euphrates valley. This diversity is enhanced by their global importance, much of which derives from Syria's geographical position, on the Mediterranean, whilst also connecting 'Eurasian' Turkey with the more arid areas in Jordan and Iraq. This 'geographic' situation is particularly important for many birds which migrate between

Europe and Africa or Asia. Birds prefer not to fly over large expanses of ocean, hence the two most important routes for these migratory birds is across the Straits of Gibraltar at the western end of the Mediterranean, and across Turkey, Syria, Palestine and Jordan at the eastern end. For this reason some of Syria's habitats, particularly its wetlands, are of real international importance.

Data on the degree of endemism in Syria is similar to that of Jordan and Lebanon, while the data on species recognised internationally threatened is greater in Syria than its neighbours ofr plants, amphibians and reptiles (Tables 6.2 – 6.5). The numbers of threatened mammals and birds are similar in all three countries. All these comparisons suffer from under-recording and incomplete species lists. It is worth noting that declines have been reported for numerous species over the last 50 years, ie within living memory. Species particularly affected by these declines include many mammals which once inhabited Syria, and which are now extinct or rare (eg gazelles, onagers, wolves, wild buffalo). The cause for many of these declines is believed to be over hunting and habitat degradation.

Table 6.2 Numbers of plant species in Syria and selected neighbouring countries . * includes flowering plants, conifers, cycads and fern allies. [a] From K.S.Water and H.J.Gillet (eds.) (1998). [b] A subset of the 31,195 species listed as threatened in the IUCN (1997) Red list of threatened plants. This subset refers to full species that occur in a single country (taxa at the intraspecific level are not listed).

Region	**Plants**				
	Number of species				
	Higher plants *	Flowering plants	Ferns	Endemic	Threatened
World	270.000 [a]	x	x	x	25.971 [b]
Syria	3134	3100	22	100	7
Jordan	2,220	2,220	X	x	4
Lebanon	3,000	2,863	35	x	3

Table 6.3. Numbers of amphibians and freshwater fish species in Syria and selected neighbouring countries. [a] Values standardised using a species area curve. [b] World total includes marine and freshwater fish, where freshwater fish constitute about 40-45% of the estimate.

Region	**Amphibians**			**Freshwater Fish**	
	Number of Species			Number of Species	
	All	Endemic	Threatened	All	Threatened
World	4.522 [a]	x	124	25.000 [b]	734
Syria	16	0	3	157	0
Jordan	x	0	0	26	0
Lebanon	8	0	0	60	0

Table 6.4. Numbers of a reptile species in Syria and selected neighbouring countries. [a] World total estimated by World Conservation Monitoring Center.

	Reptiles		
Region	Number of Species		
	All	**Endemic**	**Threatened**
World	6.900 [a]	x	253
Syria	127	2	34
Jordan	73	0	1
Lebanon	42	1	2

Table 6.5. Numbers of a bird and mammal species in Syria and selected neighbouring countries. [a] Includes cetaceans. World total comes from D.E.Wilson and D.M.Reeder (eds),(1993). [b] World total comes from C.G.Sibley and B.L. Monroe, (1993)

Region	**Mammals**			**Birds**		
	Number of Species			Number of Species		
	All	Endemic	Threatened	Breeding	All	Threatened
World	4,629 [a]	x	1,096	9,672 [b]	x	1,107
Syria	125	2	4	204	0	7
Jordan	71	0	7	141	0	4
Lebanon	57	0	5	154	0	5

6.2 Agricultural Biodiversity

6.2.1 Trees and Crops

Syria has been cultivated for about 10,000 years, and along with other neighbouring countries, was the origin of many important agricultural species. These include at least three species of wild wheat (*Triticum monococcum*, *T. urarta* and *T dicoccum*) and a range of local varieties of domesticated wheat which have been developed over the centuries. Barley is similarly well represented in the Syrian flora, which includes the wild species *Hordeum spontaneum*, *H. bulbosum*,, *H. glaucum* and *H vulgare* and numerous varieties of domesticated barley.

Western Asia is also considered to be the origin of lentils and chickpeas, and Syria has 5 species 5 wild lentil (*Lens ervoides*, *L. nigricans*, *L. orientalis*, L. *montbretti* and *L. odemensis*) and 4 of chickpea (*Cicer arietinum*, *C bijugum*, *C jordanicum* and *C pinnatifidum*). Whilst few of the vegetables currently grown in Syria are of particular note, numerous varieties of legume are grown for human consumption (eg *Vicia faba*) and fodder (*Lathyrus* spp., *Pisum arvense*, *Medicago* spp.).

Although there are numerous local varieties of apple, wild pear and plums, none of these species originated in Syria. However, the commercial Pistachio (*Pistacia vera*) did originate in Syria, and wild Pistachios (*Pistacia atlantica*, *P palaestina*, *P khinjuk*, *P terbenthus*, *P lentiscus*) still grow in certain regions, as do wild almonds (*Amygdalus orientalis*). Although not normally associated with Syria, grapes have been grown there for 6,000 years and at least 10 local varieties have been recognised. The Olive tree (*Olea europaea*), though is associated with Syria, and it is claimed that the tree was first cultivated in Syria and then exported to neighbouring countries. There are at least 25 strains of olive remaining in Syria, as well as numerous 'wild olives' (*Olea oleaster*). The genetics of figs (*Ficus*) and pomegranate (*Punica*) are equally rich with numerous varieties of the domesticate species growing in Syria.

6.2.2 Livestock

Syria has some distinct species of livestock, some of which have declined rapidly in numbers as more productive breeds have been imported, while others are losing their genetic integrity as a result of breeding programmes with other breeds. Some of these livestock typesare described below.

6.2.2.1 Shami cattle

The Shami Cattle are related to *Bos taurus indicus and* were originally raised in Ghouta from where distributed to other Syrian regions and some Arab countries. The number of these cows has substantially decreased in recent years after the import by Syria of Fresian cows which have a higher milk production. There were 8,000 Shami Cattle in Syria in 1993 and they are at risk of becoming rarer unless are protected.

6.2.2.2 Akshi Cattle

Akshi Cattle, also related to *Bos taurus indicus,* are characterized by small size, various colors and their ability to increase weight quickly. The species was cross bred with Shami and Friesian cattle with the aim of obtaining a hybrid which produces large quantities of milk and meat. The breeding programmes failed to meet this aim and now numbers of this species are decreasing rapidly.

6.2.2.3 The Buffalo

There are two species of buffaloes in Syria, the Mediterranean buffalo which lives in al Ghab plain and the Iraqi buffalo which lives in Quamishli. The number of buffaloes has decreased to 1,000 as a result of the decline in the suitable environment of this animal after the drying of Al- Ghab Swamps and the interest of the farmers in raising imported cattle which have a high production.

6.2.2.4 The Arabian Camel

The Arabian camel is related to *Camelus dromidarius*, of which there are two types in Syria: AI Kwar camels and Shami camels. The latter being distributed widely across Syria. The number of Arabian camel has decreased rapidly in the last quarter of the 20^{th} century and was recorded as being only 6,449 in 1994.

6.2.2.5 Syrian Awass Sheep

Syrian Awass sheep are related to *Oviss aries* and were raised in the area between the Tigris River and the Euphrates River in Syria and Iraq. It is the only species of sheep which is raised in Syria but is also raised in neighboring Arab countries. Awass sheep are well adapted to survive in the Baddia, and are considered an important livestock resources.

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6.2.2.6 Shami or Damascus Goat:

The Shami or Damascus Goat is related to domesticated species *Carpa hircus and is a* milk producing species. The number of Shami goats has decIeased rapidly from 177,000 in 1987 to 40,000 in 1994 as a result of illegal export.

6.2.2.7 The Syrian Mountain Goat:

The Syrian Mountain Goat is related to *Capra hiras* and is classified among multi-purpose goats. Due to the difference of their shapes, it is believed that these goats are a mixture of groups of different genetic species. The number of Syrian Mountain Goats has decreased after the issuance of legislation in 1958 which prohibited the raising of these goats in the forested areas, but then increased as farmers in the Baddia began to breed them. The Mountain Goat is indiscriminately by hybridized with the Shami Goat by the farmers to increase their production of milk. This hybridization to many lead to the extinction of these species unless suitable measures are taken to protect it and improve it in different ways.

6.2.2.8 Arabian horses

Syria is considered the refuge for the original Arabian horses (*Equus cabalus) and their numbers have* decreased from 46,000 in 1984 to 27,000 in 1993.

6.2.2.9 Asses

There are two species of ass (*Equus asinus)* in Syria .The local, small ass is believed to be of African origin. While the larger, Cyprus ass, is believed to originate from the European domesticated ass. Indiscriminate hybridization is being carried out between the two species in order to obtain a fixed and stable species.

6.2.2.10 Poultry

There are large numbers of species of local domesticated poultry , and it is believed that these are of wild origin i.e. *Gallus gallus* which are distributed in India and South East Asia. Generally they have low production of eggs and meat because they have not undergone any genetic improvement. Although groups of local poultry have undergone indiscriminate hybridization with foreign species in attempts to improve their production. A small number of local poultry still maintain their original genetic status. These varieties are at the risk of becoming extinct unless suitable measures are taken to protect them.

6.2.2.11 Honey bees

There are two types of the Syrian Honeybee *(Mellifera syrica),* the moon bee and the sword bee. Bee keeping has increased in recent years and the Syrian species of bees have proved their superiority and adaptation to the environment in comparison with the imported Italian, Crenoli and Caucus bees. The introduction of foreign species has led to some indiscriminate hybridization which may threaten the Syrian species in losing their genetic integrity which are well adapted to the environment.

6.2.2.12 Silk Worm

The Syrian Silk worm is related to the species of *Bombyx mori* which looks like Baghdad Silk worms raised in the Sham Countries. The breeding of this worm has declined and it is exposed to extinction as a result of the decrease in its production and the growing interest of farmers in buying the eggs of imported species which have high rates of production.

Table 6.6. Biodiversity of agricultural crops and trees in Syria (source BDNR 2000).

Crop type	Species	Area (Ha)	No. reported varieties
Field crops	Wheat	1,350,000	v. high
	Barley	15,000,000	v. high
	Maize	70,000	Few
	Lentils	132,000	Few
	Chickpeas	49,000	Few
	Faba beans	8,000	Few
	Sesame	4,000	
	Carthamus		
	Sunflower	9,000	Few
	Peanuts	2,000	Few
	Apples	30,000	8
	Pears	13,000	8
Fruit trees	Apricots	2,500	11
	Cherries	8,900	Numerous
	Almonds	21,400	4
	Pistachios	56,000	6
	Walnuts	4,300	Few
	Grapes	67,000	100
	Quince	900	4
	Citrus	24,700	9
	Olivs	402,000	13
	Figs	10,700	33
	Pomegranate	6,600	20
Industrial crops	Cotton	20,500	6
	Cannabis	Decreasing	
	Lin		
	Tobacco	17,800	8
Forage crops	Lathyrus	22,200	27
	Vetch	12,200	
	Peas	200	
	Berseem	300	
	Alfalfa	3,400	23

6.3 Causes of Biodiversity Loss

Many of the causes of biodiversity loss in Syria are discussed throughout this document, however it is worth summarising some of the main issues here for completeness. However, it is also worth noting that an absence of good monitoring data restrict analysis of recent trends in biodiversity.

Perhaps the largest impact on biodiversity in the last 50 years has arisen through the management of the Syrian steppe, the Baddia. This area which comprises 55% of the country's area has been subjected to a range of impacts. These have included massive increases in the population of sheep grazing the Baddia, leading to vegetation change.

Over a similar time period the human population of the Baddia has also increased, leading to increased activities such as uprooting trees and shrubs for firewood, driving large vehicles over the Baddia thereby disturbing the surface soil and through cropping large areas of the Baddia, and thereby removing natural vegetation and increasing susceptibility to erosion. Hunting of large mammals and birds has also probably severely reduced their numbers. Not only have these pressures seen a loss of biodiversity but they have contributed to wider environmental issues such as erosion and desertification. For example, wind erosion has degraded 1620 thousand hectares and water erosion 1058 thousand hectares. Desertification has encroached on 480,000 hectares.

There has also been a loss of forest land in Syria, although attempts are being made to reverse these losses. For example, the forests of *Pistacia atlantica* which had occupied 3,000 ha in the internal mountains now only cover hundreds of hectares. The forests of *Populus euphratica* which had until recently covered thousands of hectares in Raqa, Deir Ezzor and Hasaka now covers no more than a few hundreds of hectares. They are still present on some river islands of Euphrates and Al Khabour. The forests of *Quercus calliprinis* had covered the hills overlooking Aleppo city from the west and north until the 1960s. These forests are now extinct due to overgrazing and random felling for firewood and urban expansion (NCSBD 2000). Further degradation continues and between 1984 and 1999 forest fires affected 11,681 hectares.

Flooding covered an area of 85,000 hectares in the provinces of Ghab, Rouge, Kneitra, Tartous and Lattakia. Agricultural practices are responsible for salinisation of 12,5000 hectares irrigated land, mainly in the Euphrates basin. Well drilling has changed the moisture status and the contribution of underground aquifers to ecosystem stability.

Other issues primarily related to industrial development have contributed to biodiversity loss. These include the loss of habitat due to urbanization and expanding cities and the extraction of minerals such as sand and stone. Chemical wastes originating from industry, municipal water and agro-chemicals can all have negative impacts on aquatic and terrestrial habitats.

These issues can be particularly apparent in freshwater systems, where impacts can include human health as well as biodiversity loss. Marine biodiversity is difficult to monitor, and may not be of tremendous importance in Syria. However, despite the relatively small size of this ecosystem it is important to note that the Syrian coastal water faces uncontrolled fishing, although catches have remained stable over the past 25 years (Table 6.7). Seawater is subjected to oil pollutants from the discharge of ballast water from oil tankers near the coast. Untreated sewage from coastal cities is dumped directly into the sea. Removal of sand from the shore causes loss of natural marine habitats.

Table 6.7 Size of catches (tonnes) of marine fin fish and crustaceans in Syria 1976 – 1990. (source: NCSBD National Country Study of Biological Diversity in the Syrian Arab Republic 2000).

Category of fish	Year		
	1976	1980	1990
Marine finfish	1,257 t	964 t	1,574 t
Crustaceans	14	12	17

6.4 Protected Areas

Currently there are 13 recognised protected areas in Syria covering 0.6% of the land area (Appendix 6.1). This is one of the lowest percentages of total land area in protected areas of any Mediterranean country. These protected areas have been recognised by law over the last 30 years. There are also 33 grazing protectorates in Al Baddia (discussed in detail in Chapter 3) (Appendix 6.2) and 31 additional areas that have been suggested for legal recognition as protected areas (Appendix 6.3). Despite the national legislation none of these protected areas are recognised by international standards (Table 6.8). There are no marine protected areas in Syria (Table 6.9).

This situation, though relatively poor by international standards is not untypical of neighbouring Arab countries. Jordan has one small Biosphere Reserve, while Syria, Lebanon, and Saudi Arabia have none (Table 6.10). None of these countries have any World Heritage Sites, which given the cultural heritage present within them really is remarkable. Syria has one Wetland of International Importance, as do Lebanon and Jordan. However, while Syria has no protected areas which is recognised by IUCN standards, the neighbouring countries of Lebanon, Jordan and Saudi Arabia have 5, 11 and 71 respectively (Table 6.8). However, neither Egypt nor Syria has any form of marine (away from the coast) or littoral (including the coastline) protected areas, despite many aspects of Mediterranean ecology being recognised as important and threatened (Table 6.9).

Table 6.8. Details on protected areas IUCN categories 1-5 in Syria and selected other Arab countries (source World Resources 2000-2001: People and Ecosystems The Fraying Web of Life, Washington DC

Country	Descriptor of protected areas				
	Number	**Area (000 Ha)**	**Land area (000 Ha)**	**No > 100,000 Ha in size**	**No > 1 M Ha in size**
Syria	0	0	0	0	0
Lebanon	3	5	0.5	0	0
Saudi Arabia	71	4,973	2.3	8	2
Jordan	11	298	3.3	0	0

Table 6.9 Numbers of marine protected areas (IUCN categories 1-6) and other forms of coastal marine protected areas (MPAs) along the coast of five Arab countries. One

project in Syria is being considered at Om'Attouyour. Source: Batisse Michel and Alain Jeudy de Grissac 2000. A Global representative System of Marine Protected Areas – Volume 1. Marine Region 3, Mediterranean. URL: http://www.environment.gov.au/marine/marine-protected/nrsmpa/mpa/03medit.html

Country	Coastal Length (km)	Total	Littoral	Marine protected area (MPA)
Syria	183	0	0	0
Lebanon	255	1	1	0
Egypt	950	0	0	0
Saudi Arabia	-	7	3	4
Jordan	-	1	0	1

Table 6.10. Number and area (ha) of protected areas that are part of global agreements (Area is 000 Ha)

Country	Type					
	Biosphere reserves		World Heritage Sites		Wetlands of International Importance	
	Number	Area	Number	Area	Number	Area
Syria	0	0	0	0	1	10
Lebanon	0	0	0	0	3	1
Saudi Arabia	0	0	0	0	N/A	N/A
Jordan	1	31	0	0	1	7

All of Syria's existing protected areas are on State land, as will be all new ones (barring any marine ones) and as such are the responsibility of MAAR. However MSE have a strong interest in these areas, and are also the lead body concerning international biodiversity conservation. MSE are responsible for planning any management of the protected areas, but this management is carried out by MAAR. There are no protected areas on private lands, nor is there any discussion of such developments.

The active management of protected areas is a relatively new issue in Syria. The existing protected area network is largely historic in nature and there has not been any recent gazetting of new reserves. However, a current UNDP / MSE project will seek to develop the existing protected areas and suggest new ones (probably 3 in the first instance).

There are few restrictions on people entering the protected areas, and generally the forest reserves are degraded, largely through illegal grazing, harvesting, burning etc. This is despite several of the protected areas having guards, who in truth are rarely well motivated or rewarded. The development of the protected areas will attempt to work with local people in order to prevent further degradation, but as public awareness of biodiversity is poor, this will be a challenging task. It also noteworthy that currently there is no data on the economic value of biodiversity in Syria, despite this being a recommendation of the National Report on Biological Diversity.

6.5 Species Conservation

Some data is available on the species which currently exist in Syria (Table 6.1). However, the accuracy of the national species list is debatable, and data on the distribution of species appears to be absent. There has been substantial loss of vertebrate species over the last 50 years, largely due to hunting, but some work on reintroducing the Arabian Oryx to Syria is on-going in the Talila project, Palmyra. There are no public zoos or public botanical gardens in Syria. This is probably one reason why public appreciation of biodiversity remains low. The development of such resources for educational reasons would seem justified.

6.5.1 The Talila Project

This project was established in 1991 by MAAR with the main objective of protecting wild animals. Secondary objectives were to protected the plant cover and grazing resources. Since 1996 under Project 003 the project has aimed to rehabilitate the plants and also to concentrate on extension to the Bedouin. This Bedouin extension is a subset of the wider rural extension undertaken by MAAR. Around the project area are 107,000 Ha which is managed by the three local Associations. Theses associations communicate with the project about planting, guards etc.

WITHIN THE 22,000 HA. OF THE TALILA RESERVE IS ONE OF THE RAREST SPECIES OF MAMMAL IN THE WORLD: THE ARABIAN ORYX. THE ORYX BECAME EXTINCT IN THE WILD IN THE RELATIVELY RECENT PAST. LUCKILY THE SPECIES BREEDS QUITE WELL IN CAPTIVITY AND IT WAS KEPT EXTANT IN BREEDING PROGRAMS IN THE USA AND OMAN. INDEED THE NUMBERS IN CAPTIVITY HAD GOT SO BIG THAT THE ORYX WAS RELEASED BACK INTO THE WILD IN OMAN A FEW YEARS AGO. DESPITE GOOD EARLY GROWTH OF THIS POPULATION, IN THE LAST TWO YEARS THE HUNTING HAS RESUMED AND THE POPULATION WAS SEVERELY DEPLETED. THE HUNTING PRESSURE WAS SO GREAT THAT THE SURVIVING ANIMALS WERE ROUNDED UP AND BROUGHT BACK INTO CAPTIVITY FOR THEIR OWN SAFETY.

The Syrian Oryx came from Jordan in 1996. Eight animals were originally introduced (4 males, 4 females), now there are 20. Accompanying the Oryx is the ‘Arim’ a species of gazelle which has gone extinct in Syria through hunting and pasture degrdation. The gazelles in Talila were reintroduced from Saudi Arabia. Given that the Oryx is now only breeding in captivity in Oman, Saudi Arabia, Jordan and Syria the importance of this reserve cannot be overstated.

6.5.2 Trade in Endangered Species

There are limited data on the level of trade in endangered species which occurs in Syria, and its neighbours (Tables 6.11 and 6.12). It appears as if Syria was a net importer of live parrots and tortoises in 1997, but no other data are available. If Lebanon could be taken as a suitable comparison for Syria, then we can imagine that there is significant trade in lizard and snake skins within Syria, that is currently unreported, but could well contravene CITES. This is pure speculation in the absence of hard data, but must constitute a real risk to the country's biodiversity.

Table 6.11. Trade in wildlife products Reported by CITES (WR1 2000- 2001) International Legal Net Trade Reported by CITES,1997(b) [a] World total reflect the total number of animals traded. x Under reporting requirement met indicates that a country ratified CITES after 1997. Balance of imports, exports are shown as a negative balance (in parentheses).

Region	Animal commodity									
	Live primates	Live parrots	Live Tortoises	Live Lizards	Live Snakes	Wild Orchids	Cat Skins	Crocodile Skins	Lizard Skins	Snake Skins
World [a]	25,733	235,336	76,079	948,497	258,715	343,801	21,864	850,198	1,637,973	145767
Syria	12	(2)	(2)	X	X	X	X	X	X	X
Jordan	2	37	X	X	X	X	X	X	X	X
Lebanon	X	194	46	5	2	X	X	483	3,540	4

Table 6.12. CITES reporting record for selected Arab countries. [a] The number of annual reports sent to CITES as a percentage of the number expected since becoming a party to the convention.

Region	Year CITES entered into force (year)	CITES Reporting Requirement met as of 1997 [a] (percent)
Syria	N/A	N/A
Jordan	1979	32
Lebanon	N/A	N/A

6.6 Institutional Background

There is no single ministry or Directorate which deals with biodiversity, rather the responsibilities are shared between ministries, and many councils and committees contribute to decision making at all levels. Some of these are described below (data from Biological Diversity National Report 2000).

5.4.3 Supreme Council on Environmental Safety

The Supreme Council on Environmental Safety is the highest national authority concerned with environment and biodiversity. The Council is headed by the Prime Minister and its membership comprises 12 ministers. It does not have regular meetings, but rather convenes meetings as necessary.

5.4.4 General Commission for Environmental Affairs (GCEA)

GCEA is governed by the Minister of Environmental Affairs and is responsible for the coordination among different ministries in all matters concerning the environment. GCEA has the authority to prepare draft laws, decrees and regulations to be passed by the Supreme Council on Environmental Safety.

The functions of GCEA are:
1. Study environmental problems and propose the suitable solutions.
2. Preparations of plans and legislation for environmental safety.
3. Upgrading public awareness, evaluation of standards for the use of natural resources and the development of standards and criteria for environmental protection.
4. Management of environmental problems in soil, water and air, and the control of industrial institutions dealing with products which may affect public safety.
5. Study international conventions and agreements concerning the environment and submitting the necessary advise to the Government.

5.4.5 Ministry of State for Environmental Affairs (MSE)

This is the lead Ministry on all matters related to the environment. It is in charge of policy formulation, inter-sector coordination, regulatory and research functions. The Minister has the power to prepare laws, orders and regulations relevant to addressing the country's environmental problems. This is achieved through the Supreme Council for Environmental Safety (described above). The Ministry of Environment, under the direction of the Minister of State for Environmental Affairs has the direction and authority to transcend across all the operating ministries in order to fulfil its mandate, which covers the following:

1. Define environmental problems and prepare their solutions.
2. To prepare draft plans and legislation for the protection of the environment.
3. To raise public awareness, evaluate the risks of exploiting natural resources and establish standards for the protection of the environment.
4. To monitor environmental problems of soil, water and air, as well as dangerous industrial establishments, which may affect the safety of the national environment.
5. To study international agreements on environmental affairs and provide recommendations to the Government.

The Ministry includes the following departments:
1. Department of Biodiversity and Protected Areas.
2. Department of Air Safety.
3. Department of Soil and Agriculture Safety.
4. Department of Information and Public Awareness.

5. Department of Ozone Layer.
6. Department of Chemical Safety.

The Consultative Technical Committee (CTC) is the MSE's primary mechanism for inter-ministerial and public consultation on environmental policies. The CTC is made of members from different stakeholders of biodiversity (34). In addition to the CTC, there are nine other Environment Committees, which are working as inter-sectoral bodies, charged with resolving specific environmental issues.

The National Biodiversity Unit (NBU), situated in the MSE, was established in 1996, and has an important role to play in conserving and developing Syrias's biodiversity. The Consultative Technical Committee (CTC) is the MSE's primary mechanism for inter-ministerial and public consultation on environmental policies. The CTC is comprised of members from different stakeholders of biodiversity. In addition to the CTC, there are nine other Environment Committees, which work as inter-sectoral bodies, charged with resolving specific environmental issues.

5.4.5.1 National Biodiversity Unit (NBU)

The National Biodiversity Unit was initiated in January 1995 and the Unit was established at the GCEA. Soon after the Government nominated a special Scientific Steering advisory Committee on Biodiversity, which includes representatives from all stakeholders of Biodiversity in the country: The universities (4), Research Centres (3) and concerned ministries (4) (The Ministry of Environmental Affairs, Higher Education, Agriculture and Agrarian Reform and the Ministry of Planning).

In 1996 The National Biodiversity Unit assumed responsibility for the preparation of the Biodiversity Country Study, which was financed by UNEP. A preliminary data bank on biodiversity was established and awaits upgrading. It was also the national executive body of NBSAP. This Unit is expected to play an important role in the development of a comprehensive system of protected areas in Syria.

5.4.3 The Ministry of Agriculture

Despite the mandate of the Ministry of State for Environmental affairs (MSE) it is The Ministry of Agriculture and Agrarian Reform (MAAR) which is perhaps the Ministry which has the greatest potential impact on biodiversity in Syria. MAAR has the highest number of employees working on Biodiversity of any Ministry and it is also the home for several important Directorates including Forestry and Afforestation , Baddia Directorate and the Soil Directorate. The Forestry and Afforestation Directorate has three different protected areas which preserve natural forest remnants (total area > 6000 hectares). The Baddia Directorate also has an important role in biodiversity conservation, not least because of its responsibility for rangeland protected areas.

In addition to these policy interests, MAAR also carries out several important tasks:

1. Maintaining a plant gene bank comprising 8750 accessions, mainly of wheat, barley, lentils, vegetables and different food and feed legumes.
2. Maintaining 15 live collections of fruit tree clones, distributed across the country. These include improved commercial varieties.

3. Maintaining an herbarium of about 3000 specimens in the Agricultural Research Directorate.
4. Funding and developing The Directorate of Agricultural Research's breeding program for field crops.
5. Propagating and distributing seed of main crops: wheat, barley, lentils, chickpeas, potatoes, sugar beets and cotton (under the Auspices of The General Organization of Seed Multiplication (GOSM))
6. Collecting and propagating range shrubs seed for the production of plants for rehabilitation of degraded areas (under the auspices of The Directorate of the Steppe)
7. Managing tree nurseries and executing plans for forestry and afforestation (under the auspices of The Directorate of Forestry and Afforestation).
8. Maintaining The Directorate of Animal Breeding's live collection of Shami goats and camels for the aim of breeding and distribution. .
9. Establishing a seed bank for forest trees within The Directorate of Forestry and Afforestation.

5.4.3 The Ministry of Higher Education

The Ministry of Higher Education potentially has an important role to play in biodiversity conservation due to its relationship with Universities and research centres. In many countries these institutions have been the catalysts for, and drivers of, biodiversity conservation. This is partly because of the research they carry on natural ecosystems and species, plants and animals, but also because of their role in educating students. It is important to note in this respect, that simply having specialist environmental or conservation degrees may not be sufficient to achieve sustainable development. Rather, many courses, such as business and engineering, should also contain elements pertaining to environmental sustainability and biodiversity.

6.7 Recent Developments in Biodiversity Conservation in Syria

Two recent reports have been concerned with biodiversity in Syria:

National Country Study of Biological Diversity in Syrian Arab Republic (funded by GEF / UNEP) (2000) available from MSE
Biological Diversity National Report. Biodiversity strategy and Action Plan (2000) available from MSE.

There is also an on-going project between UNDP and ICARDA considering agrobiodiversity within Syria

As a result of this activity a strategy for biodiversity has been put forward in the Biodiversity National Report. Some of the issues raised by this strategy are of relevance to this study and a summary of the strategy is given in Appendix 6.4 for information. As a result of this recent work, and discussions carried out as part of this project it is suggested that the priorities for biodiversity conservation in Syria are, in declining order:

- Develop and enhance existing protected areas

- Improve legislation and enforce current legislation
- Gain increased knowledge about the species that exist in Syria and their geographical distributions list.
- Develop new protected areas
- Increase research on agrobiodiversity, the economic benefits of biodiversity and the general ecology of Syria's native fauna and flora.

CHAPTER 7.

IMPACTS OF POLICY ON THE ENVIRONMENT AND SOME POLICY RECOMENDATIONS

7.1 Rationale of Environmental Policy

There are four main reasons why any Government should be concerned about its country's environment:

- The environment provides a resource base which can be utilised to generate wealth and thereby help meet wider social needs (eg extraction of minerals, provision of timber and fish, provision of a fertile soil for agricultural production).

- The environment provides a range of 'services' which provide benefit to humans, (eg nutrient cycling, filtering of pollution, aesthetic beauty)

- A badly managed environment can cause real economic and socials costs, eg wind erosion damaging roads and buildings, pollution of water bodies impacting human health, salinisation of soils leading to lost yields.

- An ethical concern for other species and ecosystems.

So while Governments should be concerned about environmental issues, ultimately their resources, both financial and organisational are limited, hence in practice decisions about priorities have to be made. Further, it is often the case that seeking to meet a national environmental objective may conflict with one or more Government sectoral objectives of increasing output or wealth. Similarly, the reality of meeting environmental objectives may also conflict with the individual objectives of citizens. Hence there are a range of barriers to the introduction of, and adherence to, policies concerned with protecting and enhancing the environment which are common to nearly all Governments. These barriers are often so real that many Governments acknowledge the importance of environmental issues, but frequently place them down the policy agenda when faced with apparently more pressing, short term issues such as wealth generation and national security. This is a very understandable response, but in many cases it is ultimately flawed, and the consequences of Governments' ignoring environmental issues in the short term are that in the long term these issues multiply and their effects can potentially become enormous. So while dealing with environmental issues in the short term can be a painful experience for Government and citizens, the effect in the long term of not doing so could be far, far worse.

If Governments are to act in the short term, then it is important that they act on the correct issues. One of the criteria for identifying the issues to be tackled in the short term is reversibility. Reversibility describes whether or not an environmental problem could be reversed at some future time should the right corrective action be undertaken. So for example, the impact of a minor pollution spill in a river could be reversed over time, and the river should recover, assuming no other pollution events occur. However, should a certain species of wild animal go extinct, it can never return. Some issues are reversible but over a very long time scale, for example, soil erosion leads to the loss of soils from certain areas. New soil is produced from rocks, and can regain some nutritive value, but only over very, very long time scales. So while not absolutely irreversible, soil erosion is effectively irreversible when considered against the average human lifespan.

A second criterion for identifying environmental issues of importance concerns their associated economic costs and benefits. For example, a certain resource, may in theory be able to provide long term economic benefits if managed correctly, but if mismanaged these benefits may be reduced, or even disappear. Alternatively a certain environmental problem may bring economic costs and rectifying the problem will reduce these costs. An example of the former would be the cultivatable soils of Syria, eg in the Euphrates valley, while an example of the second would be damage to infrastructure from soil erosion.

From these two criteria, reversibility and economic costs/benefits, it is possible to prioritise environmental issues into those that require immediate action and those that do not. This effectively identifying those issues which would bring large long term costs (or benefits foregone) if not addressed immediately. (Note: A formal cost/benefit analysis (CBA) could aid such a decision, however there is much debate about the relevance of CBA to environmental problems which could have costs or benefits over a very long time scale, ie hundreds of years. For this reason, and a lack of data, only a qualitative assessment of issues is undertaken here, but a more complete assessment would be possible given more time and data).

The environmental issues of concern identified during this study, and an estimate of their reversibility and economic importance are shown in Table 7.1. From this table it is possible to argue that the most important issues for immediate action are those with high economic impacts over the whole of Syria, and which are only reversible over the long term. Thus the physical loss of soils appears to be the most urgent issue to be resolved, followed by depletion of groundwater, salinisation of soils and the loss of Steppe grazing. The analysis presented in Table 7.1, is effectively a qualitative multi-criteria analysis (MCA), and as for cost-benefit analysis a more formal MCA is possible given good data. Within a classical MCA framework it is possible to introduce weightings to different issues in order to represent their relative importance to decision-makers. A simple scale may be of the type 1-10, where 1 is low and 10 is high. Decision-makers could then place appropriate weightings against the issues to be considered, and in this way affect the outcome of analysis. For example, a decision-maker concerned with food security could give a weighting of say 10 to loss of soils and 1 to loss of species. Alternatively a decision-maker concerned with species conservation, may give a high rating of say 10 to loss of species and only 7 to loss of soil. Although individuals may differ in their weightings, ultimately it is the role of Government to agree, and apply, these weightings.

Regardless of analytical method, the issues of importance for Syria are clear: soil conservation, protection of ground waters, salinisation of soils and the grazing resource of the Baddia. Policy options for each of these, and some of the other sectors are given in the following sectors. However, before considering these options it is worth noting that success in achieving environmental objectives is not necessarily related to any political system. Both laissez-faire capitalist systems, such as in the USA brings environmental problems, as did the centralised systems of the

Table 7.1. Qualitative ranking, based on the results of this report, of the reversibility and economic importance of several environmental issues in Syria. 'Reversibility' assumes that appropriate management is taken to enable the recovery process.

Environmental issue	Reversibility	Known economic impact of loss per unit area	Known economic loss over whole of Syria
Extinction of species	Never	Low	Low
Physical loss of soil (wind erosion)	Very long term (>100 years)	Very high	Very high
Chemical degradation of soil with heavy metals	Very long term (>100 years)	Very high	Medium
Pollution of groundwaters with heavy metals	Very long term (>100 years)	Very high	Low
Loss of natural ecosystems	Long term (10-100 yrs)	Low	Medium
Depletion of groundwaters	Long term (10-100 yrs)	High	Very High
Pollution of water bodies with nutrients	Medium term (4-10 yrs)	Low	Low
Pollution of water bodies with disease organsisms	Medium term (4-10 yrs)	Medium	Medium
Salinisation of soils	Medium term (4-10 yrs)	Very high	Very high
Loss of Steppe grazing lands	Medium term (4-10 yrs)	High	Very high

former USSR and other countries. Indeed it is worth noting that in several developing countries the process of economic adjustment and the withdrawal of Government from central planning role has seen a worsening in their environmental problems. Several analysts now agree that there may be more of a role for Government in managing the environment then some free-market economists had previously thought. It may not simply be enough to offer economic incentives on their own, although they may be important as part of a package, rather a combination of market economics, Government control and Government incentives may be needed to achieve good environmental management. However, one vital part of this package is that Government removes any signals or incentives, which may be contained within sectoral policies, for citizens to degrade the environment. The removal of such incentives is as important as developing new policies to tackle the identified problems.

The next section considers the specific impacts of current policy on the environment, it then assumes some policy objectives which may be relevant to the Syrian Government and some policy options which could enhance the impact of policy on the environment. These are only options, and policy makers may pick and mix these as appropriate, however a prioritised list of policy recommendations is given in Section 7.9.

7.2 Water for Irrigation

7.2.1 Impacts of Policy on Water Use

This section highlights the interactions between the current policy and water use.

i) Economics suggest that price is a signal of scarcity, and absence of unit price for water, sends the signal to farmers that the water has no 'value' and is not scarce. For these reasons there is no incentive to use water sparingly and/or efficiently, and hence over use of water occurs, leading to depletion of groundwaters and in some areas to salinisation of soils.

ii) As water is scarce it is important that the maximum value of output is gained per unit of input. There is no point in 'wasting' water producing something which has low value, if a higher value product could have been produced instead. Here 'value' is a combination of benefits (ie market return to the farmer) and costs, ie environmental costs that may impact the farmer and/or other citizens. Thus a high 'value' crop would be one that gave a high market return while causing no environmental damage.

iii) The imposition of a centralised cropping plan does not necessarily lead to any one individual farmer growing the crops that would make best use of the soil / water conditions on his land. Thus the cropping plan does not necessarily encourage farmers to grow the highest value crop on any one parcel of land. However, neither would a free market, if farmers were totally free to grow any crop they wished it is perfectly plausible that environmental damage may ensue. A centralised planning system could, in theory, be a very efficient way of allocating a scarce resource like water, but it would require perfect knowledge of the biophysical condition of each field on each farm, and the socio-economic characteristics of each farmer. This is unlikely ever to be achieved.

iv) The functioning of the irrigation systems themselves may be inefficient in terms of the time and amount of delivery of water. This does not necessarily lead to efficient water use. The nature of many of the irrigation delivery mechanisms leads to undue losses of water in transport. The issue of irrigation *per se* is not dealt with in this report, but is dealt with explicitly in the work of (Varela-Ortega & Sagarday 2001).

v) Technical advice available to farmers on irrigation management may be limited.

vi) The lack of meters on water delivery systems severely restricts management options.

vii) The drainage systems over much of the irrigated lands are ineffective. This is particularly important in the Euphrates basin and other areas where salinisation is likely. The development of adequate sub soil drainage is the best way to prevent salinisation.

7.2.2 Assumed Policy Objectives

The assumed policy objectives are:

- Improve the efficiency of on-farm water use so that the actual water used on any one crop is similar to the theoretical amount needed, ie there is little, or no, overuse of water.
- Maintain the overall use of water within the sustainable capacity of the basin
- Prevent salinisation of soils and ground water

7.2.3 Policy Options

a) Metering
No water management can be undertaken until there is adequate metering of irrigation water. This needs to be in place for all sources of water: Government projects, wells and surface waters. It is therefore imperative that the Government continue to support the on-going project to put meters on all irrigation water sources. Once meters are in place several options are available.

b) Education in irrigation and water management
<u>Action:</u> Undertake an extensive education programme which would inform extension officers, and through them farmers, about irrigation management and the water requirements of each crop. The farmers would then be able to monitor their own use of water against the theoretical estimates for their area.

<u>Evaluation:</u> A worthwhile exercise, but education alone is unlikely to significantly reduce water use across all farmers.

c) Establish a price per unit cost of water
<u>Action:</u> Set a price per unit of water that each farmer uses, and charge them at the end of the year for their use. Charging could be direct, or through the Government Marketing Boards withholding the correct amount of money from the sale of the crops. The price of water could vary regionally to reflect regional scarcity, and/or with season in order to discourage summer crops. Alternatively water charges could vary with uses, such that water being supplied to irrigate certain crops, say wheat, could be supplied at a lower cost than water for irrigating other crops.

<u>Evaluation</u>: Potentially very effective at reducing water use. A major problem would surround the pricing of water, and whether or not it should vary regionally, or with crop. The more complex the pricing system the more difficult it would be to administer. Such a pricing system may be politically unacceptable.

d) Establish a Quota and Fine system
<u>Action:</u> Allocate a given farmer a certain amount of water according to some criteria (see below for further discussion), and continue to charge for operation and maintenance of the system, but also introduce a penalty for overuse of water. This system is most definitely not a water pricing system, it is simply a penalty system for misuse of water, which is a common resource.

To improve effectiveness this penalty could increase non-linearly with the degree of exceedance of the agreed amount. For example, consider the situation were a farmer is allocated 1,000 cumecs per ha/yr. Should he consume less than this amount over the year, then he only pays the operation and maintenance charge. However, should he exceed this allocation by anything up to 50 cumecs then he would pay a penalty, say SP1000. However should he exceed the allocation by between 50 and 100 cumecs then the penalty would be SP4000, and for exceedances of 100 - 150 cumecs the penalty would be SP10,000 and so on.

If such a penalty system were to be adopted then it would be essential that the original allocation should be fair. This would require knowledge of the biophysical situation on the farms (eg soils and rainfall) and excellent knowledge of the crop water demands. Some data on crop water demands are available (eg from ICARDA), but more work would be needed to develop comprehensive recommendations for all situations.

However, even if crop water demands are known it remains an open question as to how water allocations should be set. It would be possible to simply give each farmer in each agroecological zone the same allocation of water / ha, and then let him decide how to use the allocation. Alternatively it could be possible to provide sufficient water for a given crop (or set of crops), say wheat / cotton. Such a crop specific allocation would be one way of encouraging farmers to grow certain crops. For example, if it was deemed important to grow more cotton in one year, then the allocations could be increased in certain agroecological zones to permit a given proportion of land to be put under cotton. Alternatively, if in another year, it was more important to grow wheat, then the allocations could be reduced below that needed to grow cotton everywhere, and simply give sufficient water for wheat, and so on. In this way the combination of water allocation and the penalty system could become a 'guiding hand' in the cropping decisions of Syria's farmers.

This mechanism is quite flexible as allocations and fines could vary between basins. In order to meet the second assumed policy objective it would be important to ensure that total water allocations across a basin did not exceed the basin's sustainable capacity. Also allocations could be made to villages, rather than individuals, and the village would then be responsible for keeping its water use within the allocation, or collectively paying the fine.

Evaluation. This system is probably politically more acceptable than developing a system of water charging. Its functionality depends upon setting the initial allocations correctly and ensuring that the level of fines are sufficient to discourage over use. It requires administrative input in making allocations and checking actual water use. It is unlikely to work on its own, but would benefit from being put alongside a widespread education and extension strategy to ensure that farmers understand the policy and how they should manage the irrigation of their crops. If the sustainable supply of water from each water basin were known, then the national planning system could be used to ensure that the overall water use in each basin did not exceed sustainable limits.

e) Tradeable water quotas
Action: Provide allocations of water per hectare as described above, but enable farmers to trade any unused water in the next time period. Thus if a farmer is allocated 1000 cumecs /ha/yr but only uses 800 cumecs over the season, then in the

next season he again receives 1000 cumecs/ha/yr but can also sell his rights to his unused allocation in the previous year, ie 200 cumecs in the example used here. The person(s) who bought the rights to this extra water could then use his own baseline water allocation plus the extra purchased allocation. The price at which the unused allocation is sold could be fixed by Government, or simply be set by the market. This basic framework could also be applied at village level, and villages could seek to sell their 'rights' to unused water to other villages.

Evaluation: Economically this is a very efficient way of allocating water. It does require administrative input to check water allocations and actual use. It could be combined with the 'Quota and fine' system described above. It only makes environmental sense if trades are only allowed within a basin.

f) Establish adequate drainage
Action: Very saline land in the Euphrates valley has been reclaimed through the introduction of deep drains. The programme of introducing adequate drains into areas which are, or may become, salinised should be undertaken as soon as possible. No future Government irrigation projects should go ahead without the inclusion of adequate drains.

Evaluation: The introduction of drainage does not bring any immediate economic benefit, but it does prevent a developing environmental cost: salinisation. Given the growing population of Syria, and its relative land shortage per head, it is essential that currently productive land is not lost over future years. Drainage is the only way to reclaim currently salty lands and prevent future losses.

g) Research reclamation methods
Action: Trials should be undertaken on reclamation methods for saline soils, and best practice should be disseminated widely.

Evaluation: This is a necessary step in combating salinisation and should be undertaken as soon as possible. The returns on the money invested in this research will be very high over the long term.

h) Research and develop water efficient rotations and crop intensification in line with the agricultural planning system.
Action: Research should be undertaken to develop crop rotations which cause minimal environmental damage. This will include minimal water use and perhaps minimal soil erosion. If water efficient rotations could be developed then the current planning system would be a good way of ensuring they were adopted.

In addition methods should be considered which try to maximise output of food per unit of input of the most limiting resource, which is probably water. This intensification of cropping could be based on traditional agronomic methods such as new varieties, improved application of fertilisers, better pest management, altered husbandry practices and/or on crops modified through biotechnological means.

Evaluation: This is a necessary step and must be an area of high priority for research and development. Only through getting more food from each unit of land and water can Syria hope to meet if food policy.

i) Consider the development of a 'management plan' approach for developing sustainable cropping systems
Action: Jointly with the above action (h) consider the development of a 'management plan' approach to developing and rewarding sustainable cropping systems. Here farmers would develop a plan for their land which incorporated good drainage, good management of inputs and erosion control measures like non-crop strips and wind breaks. In return they would receive some annual reward for adhering to the plan, and thereby reducing the social costs of poor management. Such a plan could have different aims and rewards in different areas in order to reflect local environmental issues.

Evaluation: One of the few approaches suitable for reducing on-farm erosion and developing on-farm biodiversity. It may not be necessary in all regions, and would require the loss of some currently cropped land and also incur extra short term costs to Government. However, it should ensure the long term productivity of the cropping environment which is under enormous threat. It may only be feasible if the results from h) above enable greater production per unit area from the remaining cropped area.

7.3 Sewage Treatment and Use of Waste Water

7.3.1 Impacts of Policy on Treated and Untreated Sewage Water Use

i) There is very little policy concerning the use of sewage water. Sewage water is not supposed to be applied to leafy vegetables, however many farmers may have no alternative but to use treated or untreated sewage waste water for irrigation purposes.

ii) Not only does the use of sewage water lead to potential health impacts, through eating contaminated foods, but it also has the potential to introduce heavy metals and other chemical contaminants into soil and ground water. Such pollution is very hard to clear from these systems, and may continue to impact human health and ecosystem functioning for many years.

iii) The lack of sewage treatment plants in many of Syria's main cities is a serious problem and allows contaminated water to enter natural waterways, where it is used by local people for irrigation and other uses. This also has serious health and environmental impacts.

iv) Disposal of the solid component of sewage may lead to contamination of soil and water with heavy metals and other chemical pollutants.

7.3.2 Policy objectives

- To dispose of domestic waste and urban run-off in an environmentally benign manner.
- To enable use of waste water and solids where appropriate.

- To protect soil and water systems, especially ground water, from contamination with persistent and harmful chemicals.

7.3.3 Policy Options

a) Develop sewage treatment plants as planned

Action: Continue to develop sewage treatment plants as planned for major towns and cities

Evaluation: An essential action, which should have no unplanned budgetary cost.

b) Enhance the treatment of ensure it meets international standards of cleanliness

Action: Seek to improve the treatment process so that treated water could be used for irrigation without causing harm to humans or the environment.

Evaluation: This may be difficult, but there is clearly room for improvement in the Adra plant in certain areas. Continued use of polluted treated water in the Ghouta will harm groundwater, soils and humans.

c) Seek to separate industrial pollution from domestic waste.

Action: Seek methods of separating run-off from industrial areas from domestic sewage. Alternatively seek methods of pre-treating industrial pollution prior to its entry into the sewerage system. This would help reduce the amount of heavy metals and other chemical pollutants in the sewage.

Evaluation: Mixing of domestic and industrial sewage is a difficult problem which is common to many countries. However , it is particularly important in arid countries such as Syria, where the treated water may be used for irrigation. This may be expensive, but it would prevent pollution problems developing in areas which utilise treated sewage water for irrigation. It may be easier to include this in the design of treatment plants, rather than after they are operational.

d) Transport treated waste-water down closed pipes, not open channels.

Action: In future developments try to transport the treated water down closed pipes, not open channels as in the Ghouta.

Evaluation: This is a more expensive option than the channels, but it should prevent casual use of the sewage water and thereby bring health benefits.

e) Seek to provide drinking water for Ghouta from non-contaminated sources.

Action: Seek to supply clean drinking water to the citizens of the Ghouta, either by piping it in from another sources, or by improving the cleanliness of existing sources.

Evaluation: This may be expensive and no real economic return may be perceived. However, ERM (1998a) of days lost due to water borne illness suggest this is a real cause of economic loss.

f) Ensure use of sewage sludge is non-polluting

Action: Consider only using solid sewage sludge in areas where contamination of groundwaters is unlikely.
Evaluation: A relatively easy action, but it is important to get it right.

g) Apply solid sewage sludge to forestry and greenbelts

Action: See section 7.6d for further discussion of this issue
Evaluation: See section 7.6d for further discussion of this issue

h) Research and monitoring of treated water

Action: Support continued monitoring of chemical and biological water quality before and after sewage treatment, and also in wells in areas which utilise the treated sewage water.
Evaluation: This should simply be a continuing cost in Ghouta, but new monitoring schemes may need to be developed in other towns as their sewage plants become operational.

7.4 Al Baddia

7.4.1 Impacts of Rangeland Policy on the Environment

i) The lack of property rights over the land in Al Baddia provides no incentive for long term management and leads to a classic 'tragedy of the commons'. It is clear from work across the world that misuse of open access resources is an almost universal phenomenon. It is also clear from many examples across the world that the best way to bring about improved management of open access resources is to allocate some kind of property rights to the users of the resource.

ii) The provision of increased numbers of wells enables sheep to remain on the Baddia longer into the summer, and to return earlier, than was historically the case. Studies of the biology of plant-animal interactions in the Baddia suggest that the impacts of early summer grazing are extremely detrimental on the perennial shrubs in the area. It is also clear that these shrubs play an important role in maintaining the grazing resource. The provision of increased water to herders encourages them to keep grazing their sheep longer into the summer than is biologically sustainable. There is currently no policy signal to the herders encouraging them to leave the Baddia earlier in the year.

iii) The provision of subsidised feed enables the maintenance of stocking densities above that which could be supported by the natural environment alone. Studies clearly demonstrate that the provision of concentrate feed enable herders to keep more sheep than would be the case in the absence of concentrate feed. The current policy signal to herders is that keeping many sheep must be a good thing else why would the

Government provide ‘subsidised’ feed. However, in terms of a world market this feed is not ‘subsidised’, in fact it is probably more expensive than world prices.

iv) The prohibition on slaughtering female lambs / young sheep leads to artificially high stocking rates. Scientific estimates suggest that current stocking densities in the Baddia may be three times higher than is biologically sustainable. If the grazing resource is to be maintained then grazing densities need to be reduced. The current policy of only permitting official slaughter of female sheep over 7 years old is contributing to the increased stocking density. This is a very unusual policy, and shepherds the world over are capable of managing their sheep numbers, this is normally done by keeping about 33% of a years’ stock of female lambs. It is also desirable to be able to slaughter weak and ill sheep under 7 years, as they take food without contributing much to production.

v) The closed export market serves to keep the flock of Awassi sheep high. As stated above it is desirable to reduce stocking rates. By preventing export of what is an internationally tradeable product, the stocking densities are kept higher than would be the case if export were possible.

vi) Establishing the grazing protectorates was an excellent idea and sent a clear policy signal that the Government felt there had been degradation of the Baddia. However, opening these protectorates to grazing a few years after their establishment sends the signal that these protectorates were probably not that important after all, and the Government can’t have been that concerned about rangeland degradation. This signal was reinforced by the low level of fines for entering the protectorates when they were functioning, and the simultaneous weak enforcement of even these low levels of fine.

vii) Revegetating large areas of the Baddia with native shrubs is an excellent policy and sends the signal that there had been degradation, and that the Government wanted to reverse this degradation.

viii) Banning the cultivation of the Baddia was a good decision, and again sends the signal that this was an environmentally damaging activity. This ban should continue indefinitely.

7.4.2 Assumed Policy Objectives

- Maintain the grazing resource in a good condition so it can support grazing sustainably over a long time period
- Maintain the ecological characteristics of the Baddia as they are important components of Syria’s biodiversity.
- Reduce wind erosion on the Baddia, both in order to improve the grazing resource and in order to reduce damage to infrastructure and economic activities caused by shifting sand.
- Maintain a certain standard of living for the herders.

7.4.3 Policy Options for Protecting the Environment of Al Baddia

a) Redesignate property rights

<u>Action:</u> Certain groups should be given responsibility to manage given pieces of land for the good of their group. This will encourage good grazing management and by necessity good management of the steppe. The areas managed by a group should be small enough to maintain some identity within the group, but large enough to allow realistic management of sheep within the land available. Natural resources in the Baddia are patchy in space and change over time, so management areas have to be large enough to enable effective use of these patchy resources. It may not be best practice for these groups to be based on current coops, rather some amalgamation of the current coops should be possible, perhaps reducing the number of grazing groups to less than 100. Penalties for utilising land outside a herders' specified 'area' without agreement should be strongly enforced. Membership of such groups should be as inclusive as possible, but also recognise the real users of any given parcel of land. As such member ship could be restricted to individuals who own sheep and can prove that they are regular users of the parcel of land in question.

It could be useful for each group of herders to have one or more 'guards' who would help police the grazing system. These guards should be appointed by the herders and also paid by the herders, perhaps on an incentive scheme. Money for paying the guard could be raised by charging a grazing fee on all sheep in a given area, or alternatively on each sheep over a certain number, say 100. So each herder could graze 100 sheep for free, and then pay for each additional head of sheep kept.

<u>Evaluation</u>: Establishing groups that will be cohesive and will function to manage their land will be a difficult and time consuming process. However, it is by far the easiest way of achieving sustainable use of rangelands. A clean break from the established cooperative system would be useful as it would give the signal that this is a 'new era' and that new responsibilities are to be assumed by the groups. Again this may be a difficult task at the organisational level, but at the field level there is very little evidence that the herders have any real allegiance to the current cooperatives as units of identity. For this reason they are unlikely to be useful units of management.

It would be expected that social pressures would prevent a herder from using land outside his given area, however it would be highly desirable for Government to set a level of fine which would provide a real disincentive to such transgressions, and it would also be useful if all those involved in upholding the law, took such transgressions seriously. If the first transgression is dealt with according to the law, then the message will soon spread amongst the herders that the Government is serious about the policy.

If this scheme were adopted there would be far fewer coops than at present, but these coops could continue to function largely as at present. Thus they could continue to provide storage for feed and credit / access to feed. They could also provide veterinary support for the herders, and ensure that all sheep were dipped prior to returning to the Baddia in the autumn. They could also be responsible for maintenance of wells, water harvesting and vegetation rehabilitation programmes.

b) Provide incentives for good environmental management (the management plan)

Action

Whilst simple provision of property rights should bring about an improvement in the condition of the Baddia it is possible to provide further incentives to the herders and to 'compensate' them for their reduced grazing levels. One way to do this would be to invite each grazing group to agree a 'Management plan' with a suitable authority which would outline the number of sheep to be kept in the area, the agreed times of migration, the distribution of sheep between owners, likely migration patterns etc. The management plan need not be a strictly defined set of actions, rather it could be up to an elected grazing committee to ensure adherence to the spirit of the plan. So for example, migration out of the steppe would depend on range quality (as assessed by the grazing committee), not on a predetermined calendar date. The grazing committee should be small enough to be useful, but large enough to represent all groups of herder.

The plan could also include recommendations concerning the use of shrubs for fuelwood and medicinal purposes, and should designate certain routes as being suitable for use by motor vehicles. It should also be possible to agree which land could be available for rangeland rehabilitation, ie planting of seeds.

Should the grazing group adhere to their management plan then after a suitable time, say 2 years, a fixed payment could be made to the group as a 'reward' for maintaining the environment. Such payments could be on an area basis, so much per Ha, or on some other basis, but should not be related to number of sheep or any other production related factor, so as to avoid any incentive to increase sheep numbers. The grazing group could decide how to distribute / utilise this money. Potential uses could include paying a guard, compensation to those herders who reduced their flock or for range rehabilitation etc.

The overall stocking levels that could be supported by any particular parcel of land could be estimated by the herders and/ or by range management specialists. Once agreed, it may be necessary for all herders within the group to agree how they would reach this target e.g. for all to make an equal proportional reduction in head, or for the bigger herds to make larger reductions than smaller ones. This is potentially a very difficult decision to make, and the need to reduce stock may be a disincentive to some of the herders to participate in the scheme. For this reason it may be better to let the herders decide how to meet their targets in their own way, and to stress that the financial support would be available as 'compensation' for those making stock reductions.

Payment as a reward for meeting the plan's objectives need not be an 'all or nothing' affair. A range of targets could be agreed and a certain payment made for achieving different parts of the plan. Care would be needed in developing such a plan so as to avoid strategic behaviour by the herders to only undertake the parts of the plan which were easiest to meet.

This type of behaviour can be avoided through setting a baseline set of objectives which must be met if any payment is to be made. These objectives should be those that are fundamental to environmental protection, such as timing of migration. The payment for meeting these objectives should constitute a large part of the total payment available. In addition there could be other objectives for which additional payments would be made. These may include payments for performance exceeding those specified in the baseline objectives or alternatively for meeting entirely different objectives, eg rangeland rehabilitation. In this way an essential minimum of environmental protection is obtained through the baseline objectives, while additional ones are rewarded should they be achieved.

Technical support could also be provided to the grazing group perhaps by a dedicated project officer, and independent monitoring of the vegetation within the group's area could be undertaken in order to track progress, and to inform future management decisions.

Evaluation: Such a plan clearly brings financial costs to the Government which may not be welcome in the short term. However, these costs are likely to be far lower over the long term than will be the costs of continued rangeland degradation. This would provide the signal to the herders that the Government is serious about sustainable rangeland management. This type of policy has been used in certain countries for over 10 years now, and has brought about significant environmental benefits. The administrative costs of the plan are relatively small compared with other policies, the main costs being in the establishment phase and in the continued monitoring of the achievement of objectives. Generally farmers have been favourable to this sort of policy as it gives them relative freedom to make their own agronomic decisions, whilst ensuring some financial support from Government.

Area based payments for environmental protection are deemed to be production neutral by the EU and WTO, and are therefore entirely acceptable within current international regulations.

c) Restrict further provision of water for stock

Action: Further provision of water resources for stock should be stopped immediately. The provision of extra water to stock is clearly an important factor in the unsustainable growth of the sheep flock. Further provision of water for stock will only exacerbate the situation and send the signal to the herders that keeping the same amount, or more, sheep is a desirable aim. If the policy of the management plan were agreed, then the provision of water resources could be included as part of the plan.

Evaluation: This is a relatively simple policy to enact. It may be unpopular with several groups of actors, but is an essential plank in any policy aimed at managing sheep numbers in the Baddia.

An alternative but perhaps, less drastic solution would be to prevent stock from using water holes after a certain date, say mid-April. This may encourage the stock to leave the Baddia before the damaging summer grazing would occur. In practice this would be a difficult policy to enact and police, and is much less preferred than some other options presented here. Indeed a similar policy has been tried previously with the effect that the poorer herders left the Steppe as water became limiting, but richer ones simply transported water from the Euphrates in their lorries.

d) Remove slaughtering restrictions

Action: Permit the slaughter of all female sheep in official slaughterhouses. The Syrian herders are capable of deciding their own replacement policy, just like other shepherds all over the world. This would contribute to a reduced stocking level in the Baddia

Evaluation: A simple policy to enact, and it is unclear that any negative impacts would occur.

e) Relax import/export restrictions

Action: Relax restrictions on the export and import markets. The '2 for 1' policy which has been in place for several years was relaxed in 2000. This is a good thing from an environmental perspective and further relaxation of export restrictions should also help to reduce stocking densities on the Baddia.

Evaluation: Reform of the '2 for 1' happened relatively recently and the exact details of the new policy were unclear at the time of writing. From an environmental perspective further relaxation of export restrictions would seem a good idea. The wider trade issues need to be investigated. One positive aspect of this would be an increase in the income to herders from their exports.

f) Alter provision of feed

Action: Remove the subsidy on feed, and consider fixing the amount of feed given to any one herder so as to not permit expansion of his flock beyond the current size. Clearly periods of drought may necessitate that more feed is provided in some years. But the general rule should be that each herder only gets a fixed amount of feed according to his flock size at some given date even if his flock should increase after that date.

If the management plan policy were enacted than as stocking rates would be restricted by the grazing groups managing the resource the provision of feed could be maintained at any level if it was felt to be desirable.

The current system of delivering feed may be inefficient, with considerable losses incurred in transit and in store. Perhaps a more efficient system would require herders to state in May, after the barley harvest, how many sheep they have. This would allow relative allocation of feed to be made immediately, and the grain could be shipped immediately to the herder. This would make the herder responsible for the grain over the summer and during the winter, and would shift the balance of responsibility for storage from he Government to the herder.

Evaluation: Potentially a politically difficult policy to enact. But continued increases in feed provision clearly encourage increased flock sizes. This should be discouraged.

g) Cropping ban

Action: Maintain current restrictions on cropping. Cultivation of the Baddia clearly caused environmental problems in the past. These should not be allowed to happen in the future.

Evaluation: Maintenance of existing policy should not be problematical.

h) Research and monitoring

Action: Establish several long term monitoring programmes across the Baddia and make the results widely available. This monitoring could learn from monitoring undertaken as part of the Talila project, and may even wish to replicate its experimental design. As a minimum monitoring should include estimates of vegetation cover and species presence along permanent transects at least twice a year. In addition, experimental grazing exclusion areas could be established if funds permit. These could include areas from which grazing is totally excluded, as in the Talila project, and areas where grazing is partially excluded, say from April to October. In this way the impacts of different grazing regimes could be monitored.

If the management plan policy were adopted, then this kind of monitoring would become an essential and continuing part of their planning process.

Evaluation: A relatively easy project to establish. It may require that certain staff are trained in relevant ecological techniques, but the capacity for this type of training and monitoring is already present in Syria.

i) Education of extension officers and herders in range management

Action: Undertake an extensive education programme which would inform extension officers, and herders, about good rangeland management. This should be an essential prerequisite to either the redesignation of property rights and/or the management plan policy.

Evaluation: A worthwhile exercise, but education alone is unlikely to significantly improve rangeland management, it needs to be backed up by other policies.

j) Rehabilitation of vegetation

Action: Continue to undertake rehabilitation of the Baddia, but consider the areas where such rehabilitation may be most useful. For example, Bichri mountain is a known source of mobile sand, and has also been the site of a successful rehabilitation project and rehabilitation should continue here. Similarly rehabilitation could be undertaken parallel to roads, in bands of varying distance, and also around towns and villages.

The areas to be rehabilitated are vast, so careful thought needs to be given as to the quickest and most cost effective method of rehabilitation. It is debatable whether or not current Baddia Directive policy of rehabilitating 16,000 ha with seedlings is being successful. It may be more cost effective to direct drill with seed in bands several hundred metres apart as practiced in the Palmyra project and Jordan.

Should the management plan policy be adopted, then rehabilitation activities could be undertaken by herders as part of their plan.

Evaluation: It is absolutely essential that erosion be prevented, the technology for achieving this is available and relatively cheap, the major issue to achieving this is the sheer logistical effort required to sow the seeds over very large areas.

7.5 Biodiversity

7.5.1 Impacts of policy on biodiversity

Policy in this area is complex as it is concerned both with management of protected areas, which are under direct control of the Government, and also with the individual actions of citizens, who should be discouraged from killing species and damaging ecosystems. It is further complicated as the relevant issues cross many other sectoral policies and are relevant to several Ministries.

i) The fact that protected areas are not particularly well managed, sends the signal that biodiversity is not an issue of major concern to the Government. This signal is reinforced by the lack of protection given to certain forests and grazing protectorates. If the Government believes these areas are worthy of protection, then they should be protected and trespassers should be prosecuted according to the law.

ii) Current agricultural policy does not incorporate any incentives to conserve biodiversity. This is despite the excellent example set by the biocontrol strategy in the Citrus sector.

iii) The relative paucity of environmental education in schools, colleges and Universities leads to the population of Syria having a relatively poor level of environmental awareness. This in is a real hinderance to furthering environmental objectives in the country. Environmental education is not helped by the absence of any public zoos and botanic gardens in Syria.

iv) Recent development of the Biodiversity Unit within MSE is a positive step, and its ‘National Report on Biological Diversity’ is a useful starting point for further work.

7.5.2 Assumed policy objectives

- Maintain and enhance existing protected areas
- Ensure survival of species in Syria
- Integrate biodiversity conservation into other policy areas.

7.5.3 Policy options

Many policies for biodiversity have been presented in the National Report on Biological Diversity (Appendix 6), some similar ideas also appear here, and this signifies support for that general policy area.

a) Review administrative structures

Action: Review administrative procedures and consider whether the balance of responsibilities and authority for actions within the Government are appropriate. For example, the current arrangement whereby all land currently designated as a protected area is owned and run by MAAR while MSE has responsibility for achieving international biodiversity objectives. This situation of shared responsibility may cause difficulties in the future, and experience in other countries has shown that such institutional difficulties can be detrimental to biodiversity conservation.

The review may reveal that current structures are appropriate and all objectives are being met easily and efficiently. However, should this not be the case then one alternative may be to establish an independent Government agency which is charged with meeting biodiversity objectives. Such an agency should work closely with MAAR and MSE, but would be independent from them. It should also be responsible to a senior committee composed of individuals from MAAR, MSE and elsewhere in Government.

Evaluation: Such a review may be politically difficult, but given both the cross cutting nature of biodiversity conservation, and their international importance, it is important to be sure that the Government decision-making is carried out efficiently and fairly.

b) Develop and enhance existing protected areas

Action: Several actions are necessary under this heading:

- Ensure that no further degradation of protected areas occurs. This may be achieved by upholding existing laws, and ensuring that they are enforced on the ground, and also by working with local communities and all those interested in protected areas to ensure that the integrity of existing protected areas is maintained.
- Coordinate the planting of forest trees so that they can act as a buffer around protected natural forests (see Forestry section of this Chapter).
- Develop other ‘buffer zones’ of sustainable land uses around other protected areas.
- Prevent development of infrastructure and buildings in or near protected areas.
- Prevent dumping of waste and other potential pollutants in and around protected areas.
- Develop a plan for rehabilitating degraded protected areas

Evaluation:
Some of these suggestions simply require upholding existing legislation, others though, like working with local people to develop systems of sustainable use of the protected areas, may require substantial investment of time, and some resources (NB this may be about to start in a limited way with GEF funding in the near future).

c) Promote species conservation

Action: Several actions are necessary under this heading:

- Support species action plans which may have been developed for species which occur in Syria but are currently threatened and/or endemic. If none have been developed, then seek to develop these in the near future.
- Enforce laws which prohibit the illegal shooting and trapping of wildlife.
- Undertake an education programme on the importance of not shooting or trapping wildlife.
- Seek to prevent illegal trade in endangered wildlife products.

Evaluation: These actions are hard to achieve unless the citizens have some sympathy for species conservation. Hence public education is a cornerstone of these policies.

d) Identify and develop new protected areas

Action: Seek to identify areas which would warrant legal protection because of their natural ecosystems and/or species. Explore the constraints to develop these areas in the near future and begin to work with local people in order to develop buffer zones and plans for sustainable use of these areas. Particular attention could be given to sites of importance to migrating birds as this will attract international support.
Evaluation: A relatively easy task, which is necessary in order to ensure sufficient protection of Syria's natural heritage.

e) *Ex situ* conservation

Action: Develop *ex situ* conservation mechanisms for Syria's biodiversity. This may include:

- Developing a seed bank for local species and varieties of wild and domesticated plants.
- Developing one or more botanical gardens which could serve both as a reserve of plants and their genes, and also as an educational and recreational facility.
- Developing a gene bank to store sperm and ova from local varieties of domesticated animal.
- Breeding local animal varieties on State farms so as to ensure their continued genetic integrity.
- Developing a zoological garden, or encouraging a private enterprise to do so which could breed threatened species and also act as a recreational and educational facility.

Evaluation: These actions will cost money to set up, but should be good long term investments, if only in terms of educational value. The support of ICARDA may be useful in achieving the first three of these actions.

f) Encourage biodiversity on-farms in order to reduce soil erosion and pest populations

Action: Undertake a study to consider costs and benefits of encouraging the use of trees as living windbreaks and uncropped strips in fields and along water courses as means of reducing soil erosion. Research in Tunisia has shown that strips of 5m can be effective in reducing erosion, but strips of 10-20m are even more effective. Such biological elements are widely accepted elements of sustainable agricultural systems and the areas of natural vegetation will have several benefits. They act as a reservoir of natural enemies which will serve to keep pest populations under control, they reduce erosion, they act as a habitat for natural plant species and as a grazing resource for livestock. However, they may also compete with crops for water, and also remove land from production.

It is debatable how farmers should be encouraged to implement windbreaks and strips. It could be made compulsory for all farmers in certain regions to have to incorporate so many strips per ha, alternatively some kind of incentive system based on adhering to a management plan could be developed (*cf* the management plan for Baddia).

Evaluation: The study itself would incur some cost, but should provide information of importance in developing sustainable cropping systems.

g) Protect Al Baddia

Action: The Baddia is an ecosystem of national and international importance for conservation. Every effort should be made to prevent further degradation, and to seek rehabilitation of its flora and fauna. See section 7.4 for further discussion of the Baddia.
Evalaution: see section 7.4.

h) Support the Talila project

Action: Provide continued support for the Talila project. The breeding of the Arabian Oryx and gazelle in the Talilia project, Palmyra is of extreme international importance, especially with the recent collapse of the Omani Oryx population. This project should be well supported, not only for the biodiversity benefits, but also as it could bring significant ecotourism benefits in the future.
Evaluation: A relatively simple task, which should attract international support.

i) Research

Action: Initiate research into the distribution and abundance of species in Syria. Current species lists are inaccurate, and data on population densities and distribution are absent. Without these data it is impossible to comment on the status of species in Syria, and impossible to understand the impact of policies on many aspects of biodiversity. It is important that such surveys are repeated at regular intervals in order to detect any changes.
Evaluation: This research would entail some costs, but surveys could be done relatively cheaply if University students were used as surveyors. This type of baseline data is essential in biodiversity planning.

j) Enhance education on biodiversity issues

Action: Initiate education into biodiversity at all educational levels from primary school level to college and University level, and to the general population through the wider media.
Evaluation: Education and awareness are necessary elements of achieving wider biodiversity and sustainability objectives.

7.6 Forestry, Fruit Trees and Reclaimed Lands

7.6.1 Impacts of Forestry Policy on the Environment

i) Rigid adherence to the planting plan may be inefficient as so many trees fail to establish. The inclusion of the reforestation areas in the plan also dilutes the impact of target. The requirement of each Governorate to meet set targets tends to force them to plant on land which may not bring the highest return nationally.

ii) Many species of tree are planted including species not native to the country or region. The introduction of exotic trees can become a future environmental problem, s evidenced in many Mediterranean countries where they have a negative impact on biodiversity and now money is being spent in trying to remove them from the landscape.

iii) Many of the protected areas are forested, but they are not well managed. More forestry effort could go into managing these areas.

iv) Most tree planting is on State land. There may be environmental benefits in planting more trees on private lands, especially of agroforestry and/or multipurpose trees.

v) Forest fire is not a major problem, but better forest management may reduce losses.

vi) Poorly motivated forest guards do no protect the forests very well.

vii) The policy of land clearing and planting trees has been successful, but from an environmental point of view such land clearing is not a priority. The resources could be better spent on preventing erosion.

viii) Policy in the citrus sector seems to have been successful, and the sector seems responsive to environmental concerns, but it is hindered in its biocontrol by the bureaucracy and processes surrounding the import constraints of biocontrol agents.

7.6.2 Assumed Policy Objectives

- Increase the area under trees in order to provide environmental benefits such as erosion control and enhancement of biodiversity.
- Increase the benefit to local people from forests in terms of non-timber forest products.
- Enhance the landscape of Syria.

7.6.3 Policy Options

a) Change rationale of planting plans

<u>Action</u>: Move from a system of area based planting targets to one based on survivorship targets. Large proportions of trees that are planted in order to meet area-based planting targets subsequently fail to establish and die. It is well known that good treatment in nurseries, careful planting and good after-care can significantly

improve the survivorship of tree seedlings. Some of these issues can become secondary to meeting an area-based planting target, with the result that many trees subsequently die, and resources are wasted. A policy where the target was to achieve a certain survival rate, say 85% survival of transplanted trees, may be more resource efficient. This assumes that there is no overuse of irrigation in order to meet this target.
Evaluation: This should be a resource saving policy, that would stress the importance of tree care and husbandry rather than arbitrary target areas. This will be especially useful in those Governorates where land for future planting is becoming scarce.

b) Target planting areas to those giving most environmental benefit to the whole nation

Action: Develop a scheme whereby Forest Directorate resources are targeted at the areas of national priority, not Governorate priority. Of particular national concern is the need to combat desertification, which is not a common problem across all Governorates.
Evaluation: Such a policy may not be popular with those Governorates who would lose resources in the short term. However, from a national perspective it is important to recognise that the environmental benefits of forestry are not the same across all locations, hence planting plans should reflect this.

c) Consider the species planted

Action: Consider the long term costs and benefits of planting exotic species. Exotic species are a major threat to biodiversity and ecosystem functioning in many countries, particularly around the Mediterranean Sea. Planting exotic species now, may bring problems in the future, so it is better to try plant indigenous trees, unless a special case can be made for planting exotics. Such a special case may be that native trees would grow too slowly to stop erosion in certain places. In this case planting exotics may bring environmental benefits, but a long term plan should made to replace them with native species as soon as is possible.
Evaluation: This should be a relatively easy policy to invoke, and while there will be no short term benefits, long term costs will be avoided.

d) Consider the use of sewage sludge in forestry

Action: Consider the use of sewage sludge as a fertiliser in greenbelts and forests. Disposing of sewage sludge will become a problem to Syria in the next few years. Current technologies enable this sludge to be pelletted and used as a fertiliser. Any potential health risk which may arise from using the sludge on vegetables and crops could be avoided by using the sludge in forest areas. This would improve establishment and growth. If applied to green belts it would also serve to minimise transport costs.
Evaluation: A simple task that may require some trial sites, but may prove to be a useful means of achieving two different aims.

e) Planting around protected areas

Action: Develop plans to plant buffer zones around natural forests and protected areas as part of the development of these protected areas (see Section 7.5, on Biodiversity). These areas should be developed in consultation with local people in order to reduce the threat to the protected areas.
Evaluation: This is a relatively easy policy to achieve, and simply requires cooperation between MAAR and MSE to develop suitable plans.

f) Increase planting on private lands

Action: Further encourage the planting of trees on private lands, as part of a combined biodiversity / soil conservation strategy (see Section 7.5 on Biodiversity). These trees could be agroforestry trees that provide some benefit to the farmer, perhaps as a fodder tree, or as providing a non-timber product. In addition the formation of these trees as wind breaks will reduce soil erosion. The means for encouraging such plantations could be as part of a management plant approach with farmers / villages or by providing more incentives / support directly to farmers to plant trees.
Evaluation: Farmers tend not to like planting trees as they are perceived as taking land and water that could be used for crops. However, experience suggests that the establishment of trees is the hardest part of any such policy, and once farmers become accustomed to having trees on their land, they learn to appreciate their benefits.

g) Improve management of forested areas

Action: Improve the motivation of forest guards and some forestry practices that may lead to forest fires and forest degradation.
Evaluation: A relatively simple policy that requires education of guards and adherence to existing laws.

h) Consider the benefits of land clearing

Action: Consider whether or not the resources that go into clearing land that subsequently goes to tree crops are being used for the greatest environmental gain in the short term. The land currently being cleared is not causing environmental problems in its natural state, prevention of erosion, combating desertification and salinisation are greater environmental priorities.
Evaluation:
It may be that land clearing has other purposes other than environmental improvement, if this so, then this suggestion may not be relevant. However, if environmental improvement is a major objective of the land clearing programme, then the money that supports it could be better spent on other environmental issues. Such a movement of resources may not be popular with some actors, but it may be in the national interest.

i) Develop mechanisms for encouraging biocontrol in citrus and other sectors

Action: Streamline the import processes of biocontrol agents for citrus and explore the possibility of expanding this very successful programme to other tree crops and protected crops.
Evaluation: A relatively small task which would significantly aid the citrus biocontrol programme. Some plans are in existence to expand biocontrol into apple and grapes in the very near future, this should be supported.

7.7 Soil

7.7.1 Impacts of Policy on Soil Management and Conservation

There is no specific policy for the soils of Syria. Soil degradation is occurring because of the impact of policies related to water use on cultivated areas and resource management of the Baddia. Many of the soil related issues have been dealt with as part of the recommendations relating to these topics. It is clear that soil conservation is an important long term issue for Syria, and needs to be dealt with effectively. This basically means transferring existing knowledge from projects in Syria, and elsewhere, and making these happen over the majority of Syria's cultivated land.

7.7.2 Assumed Policy Objectives

- Maintain the productive capacity of the soil
- Prevent soil erosion

7.7.3 Policy Options

a) Develop cropping patterns that minimise soil erosion

Action: Consider the use of non-cropped strips and windbreaks in cultivated areas to reduce soil erosion. See section 7.5f for discussion of this option.
Evaluation: See section 7.5f for discussion of this option.

b) Redirect resources from forestry and land clearing to combating desetification

Action: Consider utilising resources that currently go into forestry and land reclamation to specifically combat desertification. See section 7.6h for discussion of this option.
Evaluation: This could be a difficult aim to achieve, but soil erosion is a major problem that needs urgent attention. See section 7.6h for discussion of this option.

c) Improve drainage in irrigated regions

Action: Improve the drainage in existing irrigated regions and ensure that all new irrigated areas have adequate, sub soil drainage systems. See section 7.2f for discussion of this option.
Evaluation: See section 7.2 f for discussion of this option.

d) Improve trials on best methods of rehabilitating salinised land

Action: Enhance research capacity in rehabilitating already salinised lands. See section 7.2g.
Evaluation: See section 7.2g .

e) Monitoring of soil degradation.

Action: Establish a network of monitoring sites for soil quality and erosion across all agricultural systems in Syria. Some good data are available for certain areas of Syria, but these tend to be undertaken as part of fixed time-scale projects and/or by external agents such as ICARDA and ACSAD. Consistent long term data are needed to guide management
Evaluation: There will be a cost in establishing and running these monitoring sites, but the data collected will be extremely useful in measuring the success of soil conservation policies.

7.8 General Issues

Three general issues, which do not fall neatly into the disciplinary sections are worthy of comment: training of extension service, use of environmental impact assessment and development of indicators of environmental sustainability:

a) Training of extension officers
Extension officers have a major role to play in communicating best practice to farmers. Before they can do this it is essential that they are aware of best environmental practice. Some training is undertaken presently, but further training may be needed certain areas, particularly irrigation management and soil conservation. This training should not be a one-off affair, rather continuous training is needed to maintain and develop the skills of the extension workers.

b) Develop environmental impact assessment procedures for all policies
It is far easier to avoid environmental damage, than to rectify it after it has occurred. Environmental Impact Assessment (EIA) has been applied to projects in some countries for over 30 years, and is increasingly being applied to individual policies. There are many examples of poor EIAs from around the world, however if conducted well and conscientiously EIA can bring many benefits. It would be extremely useful for the Government to develop procedures for conducting EIA on all polices relating to agriculture and environment in order to try and foresee potential environmental problems, which can then be mitigated before they occur. It is also important for EIA to be taken seriously by decision-makers, else the assessments themselves can become meaningless.

c) Development of indicators of environmental sustainability
Many governments have found it useful to develop indicators of environmental sustainability. These are simple indicators that allow Government and others to monitor the success in achieving environmental sustainability. This provides a useful feedback to all involved in agriculture and environmental management. Such indicators use data that is easy to collect and they should be easy to understand. Topics of indicators may include:

- change in the level of aquifers (as measured in certain wells that are regularly monitored),
- change in the level of soil (as measured in certain sites that are regularly monitored), pollution of waterways (or other water quality indicators)
- change in forest area,
- change in the amount of land that has salinised soils above a certain threshold

7.9 Policy Options by Priority for Action

Policy recommendations are given in Table 7.2. The recommendations are presented in three groups in terms of when they should be initiated. From an environmental point of view all the recommendations should begin as soon as possible. However, resources are constrained and this is clearly impossible. For this reason the recommendations are grouped. The groupings are made according to a combination of criteria which include, ease of initiating the policy, logical groupings of recommendations within a subject area, their relevance to on-going plans and their importance.

Within each grouping certain policies are of higher priority than others, and this is indicated on a three point scale, where 1 is the highest priority. The priority of a policy indicates its importance, and suggests that it should be addressed as soon as possible, and perhaps be worthy of more resources than other lower policy recommendations.

Table 7.2. Time scale and priority for initiating policy recommendation. Some of these recommendations are to continue with certain policies, clearly these do not need to initiated. Priority is designated on a three point scale, where 1 is the highest priority. C denotes a continuing policy. Not all the policy options discussed previously are presented as recommendations.

a) First group, for immediate attention

Subject area	Recommendation	Priority
Water and crops	7.2 a) Metering of water use	C
	7.2 f) Establish adequate drainage	1
	7.2 g) Research reclamation methods	2
	7.2 h) Research water efficient rotations and crop intensification	1
Sewage	7.3 a) Develop sewage treatment plants as planned	C
	7.3 c) Seek to separate industrial pollution from domestic waste.	2
	7.3 d) Transport treated waste water down closed pipes, not open channels.	3
	7.3 f) Ensure use of sewage sludge is non-polluting	2
	7.3 h) Research and monitoring of treated water	2
Al Baddia	**7.4 c) Restrict further provision of water for stock**	1

	7.4d) Remove slaughtering restrictions	2
	7.4 e) Relax import/export restrictions	3
	7.4 f) Provision of feed	1
	7.4 g) Maintain cropping ban	C
	7.4 h) Research and monitoring rangeland condition	2
	7.4 j) Rehabilitation of Baddia	C
Biodiversity	7.5 h) Support the Talila project	3
Forest	7.6 d) Consider the use of sewage sludge in forestry	2
Soil	7.7 a) Develop cropping patterns that minimise soil erosion	1
	7.7 b) Redirect resources from forestry and land clearing to combating desetification	1
	7.7 e) Monitoring of soil degradation	2
General	7.8 b) Develop environmental impact assessment procedures for all policies	2

b) Second group

Subject area	Recommendation	Priority
Water and crops	**7.2b) Education in irrigation and water management**	2
	7.2d) Establish a Quota and Fine system	1
	7.2i) Research management plans for cropping areas	1
Al Baddia	7.4a) Redesignate property rights.	1
	7.4b) Provide incentives for good environmental management	1
	7.4i) Education of extension officers and herders about rangeland management	2
Biodiversity	**7.5a) Review administrative structures**	2
	7.5b) Develop and enhance existing protected areas	2
	7.5 j) Education on biodiversity issues	3
Forest	**7.6a) Change rationale of planting plans**	2
	7.6b) Target planting areas to those giving most environmental benefit	1
	7.6 c) Consider the species planted.	2
	7.6 g) Improve management of forested areas	2
	7.6 h) Consider the benefits of land clearing	3
	7.6 i) Develop mechanisms for encouraging biocontrol in citrus and other sectors	2
General	7.8 a) Training of extension officers	2

c) Third group (to be initiated after other actions have been initiated)

Subject area	Policy recommendation	Priority
Sewage	7.3 b) Enhance the treatment of ensure it meets international standards of cleanliness. 7.3 e) Seek to provide drinking water for Ghouta from non-contaminated sources.	1 3
Biodiversity	7.5 c) Promote species conservation 7.5 d) Identify and develop new protected areas. 7.5 e) *Ex situ* conservation **7.5 f) Encourage biodiversity on-farms** 7.5 i) Research on species abundance and distribution in Syria	3 2 2 3 3
Forestry	**7.6 e) Planting around protected areas** 7.6 f) Increase planting on private lands	2 1
General	7.8c) Development of indicators of environmental sustainability	2

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APPENDIX 2.1

Appendix 2.1 Annual average rainfall and water supply according to ecological zones in Syria between 1995 –2000 (source MAAR)

Years	Weighted Annual average rainfall (mm)						Annual water supply from rainfall (mm^3)					
	Ecological zones						Ecological Zones					
	1st	2nd	3rd	4th	5th	**Total**	1st	2nd	3rd	4th	5th	**Total**
Basic year Average (1960-1985)	617.9	306.1	261.0	223.2	141.4	**294.4**	16689.77	7560.32	3408.88	4083.21	14440.5	**46182.68**
1995 – 1996	623.4 100.9	324.7 106.1	263.4 100.9	282.9 126.7	135.7 96.0	**255.6 102.5**	16840.05 100.9	8019.55 106.1	3440.13 100.9	5173.67 126.7	13856.5 96	**47329.94 102.5**
1996-1997	598.0 96.8	309.7 101.2	269.1 103.1	246.3 110.3	174.9 123.6	**268.3 107.6**	16153.79 96.8	7648.96 101.2	3515.53 103.1	40505.7 110.3	17853.9 123.6	**49677.88 107.6**
1997-1998	664.5 107.5	319.1 104.2	268.9 103.0	221.2 99.1	201.0 142.1	**291.2 116.7**	17949.84 107.5	7880.82 104.2	3512.78 103	4045.14 99.1	20525.9 142.1	**53914.46 116.7**
1998 – 1999	464.6 75.2	182.1 59.5	139.5 53.5	110.2 49.3	56.2 39.8	**143.8 57.7**	12549.42 75.2	4498.51 59.5	1822.35 53.5	2014.66 49.3	5740.21 39.8	**26625.15 57.7**
1999-2000	513.5 83.1	192.6 62.9	166.2 63.7	131.5 58.9	67.2 47.5	**162.4 65.1**	13869.72 83.1	4757.75 62.9	2171.49 63.7	2405.51 58.9	6861.49 47.5	**30065.96 65.1**

APPENDIX 2.2

Data on water, soil and plant quality in Al Ghouta, the peri-urban area surrounding Al Ghouta. (These data were collected from several sources including MOE/ACSAD/Damascus University 1995/1996 Biological and toxic monitoring of pollution caused by using Barada river and ground water for irrigation. Damascus Ghouta (Toxic and Bacterial pollution) on water, soil and plants.

a). The Content of Pesticide, Microbiological, Biological, Chemical, and Heavy Metal in water of Barada River (Surface Water) and Wells (Underground Water) in Damascus Ghouta 1&2

	Surface Water				**Underground Water**			
	Yelda*1 Village	**Kharabou Village**	**Zebdine Village**	**Acceptable Level**	**Yelda*1 Village**	**Kharabou Village**	**Zebdine Village**	**Acceptable Level**
1. Chemical	Chemical (mg/l)							
1.1 NO3	-	-	0.1625	10 to 13	-	5.04	10.74	
1.2 SO4	-	-	61.87	250	-	61.97	59.57	
1.3 PO4	-	-	17.88	40	-	0.11	0.098	
1.4 NH4	-	-	32.88	1.2	-	0.43	0.74	
1.5 BOD & COD	- -	- -	280 46.57	4 to 6 10	- -	45.71 0.8	49.28 1.71	
2. Heavy Metal	Heavy Metal (mg/l)							
2.1 Cd	-	-	0.00073	0.01	-	0.000035	0.000047	
2.2 Pb	-	-	0.002	5	-	0.00146	0.00158	
2.3 Cr	-	-	0.014	0.1	-	0.00036	0.0003	
2.4 Hg	-	-	0.001	0.001	-	0.00073	0.00081	
3. Microbiological	Microbiological (cell/ml)							
3.1 Viable Count	-	-	3517.75		-	192	271	
3.2 Total Coliforms	-	-	379.63		-	10.4	577.71	
3.3 Salmonella – Shigella	-	-	80.375		-	0	0	
3.4 Fecal Streptococcus	-	-	15.125		-	0	0	
4. Biological	Biological /l							
4.1 Entamoeba coli	-	-	-		-	-	-	
4.2 Entamoeba histolytica	-	-	5300		-	-	-	
4.3 Giardia lambila	-	-	-		-	-	-	
4.4 Ascaris lumbricoides	-	-	600		-	-	-	
4.5 Strongyloidies stercoralis	-	-	30		-	-	-	
5. Pesticide	Pesticide (microgram/l)							
Insecticide	Insecticide (microgram/l)							
5.1 Deltamethrin	0	-	-		0	0	-	
5.2 Aldrin	5 (July)	-	-		3 (Aug)	0	-	
Fungicide	Fungicide (microgram/l)							
5.3 Fenarimol	45 (July)	-	-		32 (July)	0	-	
5.4 Triadimefon	0	-	-		0	0	-	
Herbicide	Herbicide (microgram/l)							
5.5 Trifluralin	5 (Aug)	-	-		7 (July)	0	-	

b) The Content of Heavy Metals (Cd, Pb, Cr, Hg) in water of Barada River and Wells in Damascus Ghouta (Zebdine) 1995, by (mg/l)

Element	Cd	Pb	Cr	Hg
Average 'Well'	0.0376	0.098	1.166	1.4744
Average 'River'	0.301	0.304	6.454	1.529
Acceptable Level	0.01	5	0.1	0.001

c) The Ideal Concentration for the Content of Metals in Soil (mg/kg) *4

Element	Range	Ideal
Cd	0.01-2	0.35
Cr	10-150	40
Pb	2-200	20
Hg	0.02-0.15	0.07

d) The Content of Microbiological *2 in Agricultural Soil which is irrigated by the water of Barada River (Surface Water) and Wells (Underground Water) in Damascus Ghouta

	Surface Water			**Underground Water**		
	Kharabou Village	**Zebdine Village**	**Acceptable Level*3**	**Kharabou Village**	**Zebdine Village**	**Acceptable Level*3**
2. Microbiological	Microbiological (cell/ ml)					
2.1 Viable Count	-	1810.5		4575	3275	
2.2 Total Coliforms		774.85		2718.5	23200	
2.3 Salmonella – Shigella		-		-	-	
2.4 Fecal Streptococcus		-		-	-	

e) The Content of Heavy Metals (Cd, Pb, Cr, Hg) in Plants Irrigated by Water of Barada River – irrigation channels in Damascus Ghouta (Zebdine), 1995, by (ppm)

Element of Cd					
Plant	Z	M	R	P	L
Natural Level	0.05-0.2	0.05-0.2	0.05-0.2	0.05 – 0.2	0.05-0.2
Poison Level	5 to 30	5 to 30	5 to 30	5 – 30	5 – 30
Average	0.0325	0.1235	0.1692	0.0737	0.066
Element of Pb					
	Z	M	R	P	L
Natural Level	5 to 10	5 to 10	5 to 10	5 to 10	5 to 10
Poison Level	30 to 300	30 to 300	30 to 300	30 to 300	30 to 300
Average	1.723	0.086	0.0.5727	0.5727	0.259
Element of Cr					
	Z	M	R	P	L
Natural Level	0.5-0.1	0.5-0.1	0.5 – 0.1	0.5-0.1	0.5-1
Poison Level	5 to 30	5 to 30	5 – 30	5 – 30	5-30
Average	0.97	7.4	14.527	3.09	4.613
Element of Hg					
	Z	M	R	P	L
Natural Level	-	-	-	-	-
Poison Level	1 to 3	1 to 3	1 –3	1 –3	1 –3
Average	0.465	0.409	0.33	0.329	1.368

f) Ideal concentration for the content of metals in plant tissues (mg/kg)*4

Element	Range	Ideal
Cd	0.05-1.2	0.0005 – 0.012
Cr	1 –5	0.01 – 0.05
Pb	0.1 –30	0.001 – 0.3
Hg	0.1 – 300	0.01 – 3

g) The content nutrients, BOD and COD in water of Barada river and wells in Damascuc Ghouta from 1995-1996. Notes: acceptable level of $NH4^+$ is 1.2 mg/l, N-$NO3^-$ = 10-13 mg/l. Study period was Sept 1995 – Feb 1996 BOD = Biological Oxygen Demand. COD = Chemical Oxygen Demand, units = (mg/l)

Zebdine river

Sample	NH4+	N-NO3-	SO4-	PO4--	COD	BOD
1	28	0.16	58	18.39	56.5	170
2	44	0.1	61	7.45	39.4	350
3	40	0.12	61	18.4	48.4	235
4	40	0.12	96	38.3	62.2	235
5	35	0.25	60	26.8	38.4	350
6	24	0.35	60	12.26	44	350
7	28	0.1	54	12.26	46.3	350
8	24	0.1	45	9.2	37.4	200
Average	32.875	0.1625	61.875	17.8825	46.575	280

Zebdine well

Sample	NH4+	N-NO3-	SO4-	PO4--	COD	BOD
1	1.1	10.8	90	0.04	0	50
2	0.9	10.5	54	0.03	2	45
3	1.2	7.4	52	0.06	1.6	65
4	0.6	10	57	0.2	2.4	65
5	0.3	14	56	0.18	4.8	35
6						
7	0.8	13	45	0.06	1.2	40
8	0.3	9.5	63	0.12	0	45
Average	0.74	10.74	59.57	0.09	1.71	49.29

Kharabou well (mg/l)

Sample	NH4+	N-NO3-	SO4-	PO4--	COD	BOD
1	0.8	5.4	72	0.06	0.4	60
2	0.5	5.1	45.7	0.02	0.2	40
3	0.4	5	43	0.09	1	35
4	0.4	4.2	150	0.18	1.6	45
5	0.2	4	43.6	0	0.2	45
6	0.5	5.6	44.5	0.38	1.4	60
7	0.2	6	35	0.06	0.8	35
Average	0.429	5.04	61.97	0.11	0.8	45.71

h) Heavy metal concentrations in surface water in Ghouda, Damascus, 1998 (source: JICA Study Team)

Station	Location	Element				
		Fe (ppm)	Cd (ppm)	As (ppm)	Cr (ppm)	Pb (ppm)
SW1	Barada	0.175	ULD	ULD	0.026	0.329
SW2	Al-Hamme	0.269	ULD	ULD	0.048	0.326
SW3	Keewan	0.16	0.025	ULD	0.072	0.288
SW4	Kabass	2.727	0.034	ULD	0.777	0.516
SW5	Zebdeen	0.218	0.022	ULD	0.609	0.411
SW6	Effl. channel:Adra	0.240	0.027	ULD	0.445	0.361
SW7	Effluent channel	0.226	0.024	ULD	0.538	0.452
SW8	Beit Tema	0.224	ULD	ULD	0.025	0.642
FAO irrigation water standard		5.00	0.01	0.1	0.1	5.0
Syrian sewer discharge standard		-	0.5	0.1	5.0	5.0

i) Heavy metal concentrations in soil in Ghouda, Damascus, 1998. (source: JICA Study Team)

Station	Location	Element					
		Fe (mg/l)	Cd (mg/l)	As (mg/l)	Cr (mg/l)	Pb (mg/l)	Pesticides (ug/l)
SW3	Keewan	19.39	0.072	0.01	0.962	1.52	25
SW4	Kabass	4.16	0.064	0.01	1.23	0.998	61
SW4a	Dyanni river	14.164	0.073	0.01	0.833	0.786	0
	Zebdeen	5.175	0.051	0.01	0.938	0.789	61
WHOdrinking water standard		0.03	0.003	0.01	0.05	0.01	
Syrian drinking water standard		0.03	0.003	0.01	0.05	0.01	0.2-10

j). Heavy metal concentrations in groundwater in Ghouda, Damascus, 1998. (source: JICA Study Team)

Station	Location	Element				
		Fe (mg/l)	Cd (mg/l)	As (mg/l)	Cr (mg/l)	Pb (mg/l)
GW1	Barada spring well field	0.06	ULD	ULD	0.020	0.103
GW2	Vasraya Well field	0.07	0.027	ULD	0.021	0.173
GW3	Jaramana (village)	0.11	0.034	ULD	0.047	0.238
GW4	Zebdeen (village)	0.07	0.031	ULD	0.095	0.196
GW5	al Adawi Well field	0.10	0.023	ULD	0.021	0.151
GW6	Tannery district	0.07	0.050	ULD	0.447	0.272
WHO drinking water standard		0.3 ??	0.003	0.01	0.05	0.01
Syrian drinking standard		0.3 ??	0.005	0.01	0.05	0.01

k) Pesticide concentrations in groundwater in Ghouda, Damascus 1998. (source: JICA Study Team)

Station	Location	Pesticide					
		Aldrin	Dieldrin	OP DDT	PP DDT	Hepta chlor	Fenithro thion
GW1	Barada spring well field	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
GW2	Vasraya Well field	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
GW3	Jaramana (village)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
GW4	Zebdeen (village)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
GW5	al Adawi Well field	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
GW6	Tannery district	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
WHO drinking water standard		0.03	0.032	2	2	0.03	-

l) Microbiological content of surface water in Ghouda, Damascus, 1998. (source: JICA Study Team)

Station	Location	Faecal colliform (# / 1000 ml)	Intestinal nematodes (#/1000 ml)
SW1	Barada	4,080	0
SW2	Al-Hamme	3,740	500
SW3	Keewan	4,760	5,000
SW4	Kabass	150	20,000
SW5	Zebdeen	0	12,000
SW6	Effl. Channel:Adra	4,590	0
SW7	Effluent channel	3,910	0
SW8	Beit Tema	4,590	0
FAO irrigation water standard		10,000	0

m) Microbiological content of groundwater in Ghouda, Damascus, 1998. (source: JICA Study Team)

Station	Location	Faecal colliform (# / 1000 ml)	Intestinal nematode s (#/1000 ml)
GW1	Barada spring well field	0	0
GW2	Vasraya Well field	0	0
GW3	Jaramana (village)	110	0
GW4	Zebdeen (village)	66	0
GW5	al Adawi Well field	14	0
GW6	Tannery district	2890	0
Syrian drinking standard		0	0

n) Heavy metal content (CD, Pb, Cr, Hg) in water of Barada river and wells in Damascus Ghouta 1995-1996

Barada river, irrigation channels in Zebdine

Sample	Element			
	Cd (ppm)	Pb (ppm)	Cr (ppm)	Hg (ppm)
1	0.00504	0.01	0.0577	0.0025
2	0.000018	0	0.01038	0.000091
3	0.00014	0.00009	0.00408	0.00256
4	0.00001	0.00034	0.0129	0.00069
5	0.00001	0.0037	0.0074	0.00076
6	0	0.00079	0.012	0.000021
7	0	0.00054	0.00457	0.00066
8	0.00006	0.00097	0.00345	0.0009
Average	0.00073	0.0021	0.01406	0.0010

Zebdine well

Sample	Element			
	Cd (ppm)	Pb (ppm)	Cr (ppm)	Hg (ppm)
1	0.00005	0.01	0.00015	0.00129
2	0.000019	0	0.00001	0.000083
3	0.00004	0.0002	0.00028	0.00201
4	0.00005	0.0003	0.0004	0.00067
5	0.00012	0.00018	0.0004	0.00073
6				
7	0	0.00023	0.00076	0.00011
8	0.00005	0.00015	0.00002	0.0008
Average	0.000047	0.00158	0.0003	0.00081

Kharabou well

Sample	Element			
	Cd (ppm)	Pb (ppm)	Cr (ppm)	Hg (ppm)
1	0.00003	0.01	0.00066	0.00123
2	0.00002	0	0.000061	0.000095
3	0.00005	0.00029	0.0002	0.00197
4	0.00017	0.00066	0.0007	0.0008
5	0.00001	0.00017	0.00022	0.0007
6	0	0.00016	0.00009	0.000021
7	0	0.0002	0.00036	0.00022
8	0	0.000235	0.000605	0.000575
Average	0.000035	0.001464	0.000362	0.000725

o) The content of biological V.C, T.C, SS. F.S) in water of Barada river and wells in Damascus Ghouta 1995/96. Number of biological entities in 1 ml of water. VC = viable count, TC = Total colliforms, SS = Salmonella, Shigella, FS Fecal Streptococcus.

Irrigation channels in Zebdine

Sample	**Variable**			
	VC	**TC**	**SS**	**FS**
1	186	1654	0	0
2	14234	474	0	6
3	3693	193	463	0
4	400	197	175	0
5	197	140	0	0
6	9305	143	5	105
7	122	61	0	0
8	5	175	0	10
Average	3517	380	80	15

p) The heavy metal content (Cd, Pb,Cr, Hg) in plants irrigated with water for Barada river and associated irrigation channels in Damascus Ghouta 1995/96

Cd (mg/kg) in Barada river irrigation channels in Zebdine

Sample	**Plant**			
	Raphanus	**Allium**	**Lactuca**	**Mentha**
1				
2	0.128	0.038		
3	0.055	0.146	0.0113	
4	0.108	0.037	0.213	
5	0.103	0.028	0.01	0.046
6	0.033	0.018	0.049	
7	0.22	0.032	0.082	
8	0.122	0.046	0.228	
Average	0.10843	0.049	0.11583	0.046

Pb (mg/kg) in Barada river irrigation channels in Zebdine

Sample	**Plant**			
	Raphanus	**Allium**	**Lactuca**	**Mentha**
1				
2	0.524	0.338		
3	0.258	1.271	1.062	
4	0.898	0.211	0.413	
5	0.683	0.309	0.09	1.669
6	0.868	0.279	0.161	
7	1.034	0.205	0.3	
8	1.546	0.758	2.496	
Average	0.83014	0.48157	0.75367	1.669

Cr (mg/kg) in Barada river irrigation channels in Zebdine

Sample	Plant			
	Raphanus	Allium	Lactuca	Mentha
1				
2	5.35	1.27		
3	0.339	6.69	3.71	
4	6.88	1.4	7.28	
5	1.56	0.328	0.31	1.366
6	2.11	0.235	2.3	
7	2.61	0.268	0.03	
8	0.125	0.046	0.86	
Average	2.71057	1.46243	2.415	1.366

Hg (mg/kg) in Barada river irrigation channels in Zebdine

Sample	Plant			
	Raphanus	Allium	Lactuca	Mentha
1				
2	0.059	0.072		
3	0.478	0.18	0.241	
4	0.143	0.086	0.12	
5	0.073	0.069	0.077	0.076
6	0.211	0.013	0.366	
7	0.026	0.034	0.67	
8	0.05	0.06	0.08	
Average	0.14857	0.07343	0.259	0.076

q) Content of biological entities in agricultural soil irrigated by water of the Barada river and irrigation channels in Zebdine 1995/96. (cells/cm^2 of leaf)

Barada river and irrigation channels in Zebdine

Sample		Variable
	VC	TC
1		
2	4000	2367
3	1650	278
4		1284
5	740	264
6	3161	121
7	10	10
8	1300	1100
Average	1810.5	774.9

Well water in Zebdine

Sample	VC	Variable TC
1		
2	12750	120000
3	2250	1000
4		
5	645	18000
6	3275	0
7	5	0
8	725	200
Average	3275	23200

r) The content of biological entities in agricultural soil irrigated by well water in Kharabou 1995/96. (cells/cm^2 of leaf)

Sample	VC	Variable TC
1		
2	7575	2987
3	1475	2450
Average	4525	2718

s) The Content of Heavy Metals (Cd, Pb, Cr, Hg) in plants irrigated by water of Barada River – irrigation channels in Damascus Ghouta "Zebdine" 1995, by (ppm). L + Lactuca sativa, P = Pteroselinum sativum, R = Rumex acetosa, M = Mentha viridis and Z = Zea mays.

Cadmium (Cd)

			PLANT		
Date	**L**	**P**	**R**	**M**	**Z**
FEB	0.07	-	0.138	-	-
	0.079	0.132	0.96	0.082	
MAR	0.095	0.064	0.074	0.086	-
	0.035	0.08	0.136	0.082	-
APR	0.051	0.049	0.115	0.187	-
	-	0.052	0.103	0.054	-
MAY	-	0.027	0.103	0.086	-
	-	0.031	0.044	0.051	-
JUN	-	-	0.121	0.36	-
	-	0.037	0.07	-	-
JUL	-	0.12	0.099	-	-
	-	0.104	0.15	-	0.038
AUG	-	-	-	-	-
	-	0.115	0.087	-	0.027

Average	**0.066**	**0.0737**	**0.1692**	**0.1235**	**0.0325**
Natural level	0.05 – 0.2	0.05 – 0.2	0.05 –0.2	0.05 – 0.2	0.05 –0.2
Poison level	5 – 30	5 – 30	5 – 30	5 – 30	5 - 30

Lead (Pb)

			PLANT		
Date	**L**	**P**	**R**	**M**	**Z**
FEB	0.013	-	0.013	-	-
	0.59	0.22	0.051	0.158	-
MAR	0.359	0.058	0.059	0.239	-
	0.299	0.009	0.002	0.025	-
APR	0.034	0.149	0.482	0.051	-
	-	0.073	0.069	0.021	-
MAY	-	0.101	0.218	0.088	-
	-	0.504	0.393	0.05	-
JUN	-	-	0.476	0.058	-
	-	1.295	1.498	-	-
JUL	-	2.575	2.969	-	-
	-	0.189	2.425	-	1.371
AUG	-	1.127	1.85	-	2.076
	-	-	-	-	-
Average	**0.259**	**0.57273**	**0.80808**	**0.08625**	**1.7235**
Natural level	5 – 10	5 – 10	5 – 10	5 – 10	5 – 10
Poison level	30 – 300	30 – 300	30 – 300	30 – 300	30 –300

Chromium (Cr)

			PLANT		
Plant	**L**	**P**	**R**	**M**	**Z**
FEB	2.97	-	2.97	-	-
	2.4	3.75	14.05	13.05	-
MAR	2.79	4.39	9.51	2.86	-
	8.745	4.745	2.635	8.715	-
APR	6.16	4.08	13.762	7.495	-
	-	4.38	14.71	5.41	-
MAY	-	3.01	5.39	3.01	-
	-	4.45	9.59	8.88	-
JUN	-	-	42.46	9.78	-
	-	1.295	13.6	-	-
JUL	-	2.575	20.09	-	-
	-	0.189	24.178	-	1.818
AUG	-	1.127	15.907	1	0.12
	-	-	-	-	-
Average	**4.613**	**3.09009**	**14.527**	**7.4**	**0.97**
Natural level	0.5 – 0.1	0.5 – 0.1	0.5 – 0.1	0.5 – 0.1	0.5 – 0.1
Poison level	5 – 30	5 – 30	5 – 30	5 – 30	5 - 30

Mercury (Hg)

			PLANT		
Date	**L**	**P**	**R**	**M**	**Z**
FEB	3.045	-	0.25	-	-
	2.03	0.5	0.64	0.56	-
MAR	0.58	0.52	0.29	0.83	-
	0.39	0.27	0.8	0.41	-
APR	0.77	0.307	0.58	0.63	-
	-	1.21	0.49	0.55	-
MAY	-	0.11	0.49	0.03	-
	-	0.09	0.09	0.05	-
JUN	-	-	0.081	0.214	-
	-	0.0315	0.0115	-	-
JUL	-	0.0109	0.088	-	-
	-	0.2	0.2	-	0.43
AUG	-	0.38	0.31	-	0.5
	-	-	-	-	-
Average	**1.363**	**0.32995**	**0.332346**	**0.40925**	**0.465**
Natural level	-	**-**	**-**	**-**	**-**
Poison level	1 – 3	1 –3	1 –3	1 –3	1-3

t) The Content of Heavy Metals (Cd,Pb,Cr,Hg) in water of Barada River and Wells in Damascus Ghouta "Zebdine" 1995, by (mg/l)

Well Water:

		ELEMENT		
Date	**Cd**	**Pb**	**Cr**	**Hg**
JUN	0.04	0.22	0.84	0.129
JUL	0.01	0.15	1.5	1.114
AUG	0	0	1.29	2.9
AUG	0.08	0	1.36	3.1
Average	**0.0376**	**0.098**	**1.166**	**1.4744**
Acceptable level	0.01	5	0.1	0.001

Surface Water

		ELEMENT		
DATE	**Cd**	**Pb**	**Cr**	**Hg**
JUN	0.215	0.3	4.02	1.18
JUL	0.205	0.92	4.21	0.086
JUL	0.215	0.3	6.31	0.079
AUG	0.04	0	6.76	3
AUG	0.83	0	10.97	3.3
Average	**0.301**	**0.304**	**6.454**	**1.529**
Acceptable level	0.01	5	0.1	0.001

Notes: Acceptable level is for irrigation water which is used for all types of soil.

u) Physical-Chemical Characteristics

Station	Location	COD (mg/l)	SS (mg/l)	Conduc (ms/cm)	Tot N (mg/l)	Tot P (mg/l)	Na (mg/l)	B (mg/l)	CI (mg/l)	TA (mg/lCaCO3)	Ca (mg/l)	Mg (mg/l)
GW1	Barada	O	O	379	0	0.02	6.8	0.8	6.6	15.3	0.0	14.5
GW2	Vasraya	0	0	580	0	0.02	22.0	0.2	12.0	16.0	0.0	35.0
GW3	Jaramana	0	0	894	0	0.04	32.0	1.0	34.0	18.0	11.0	35.0
GW4	Zebdeen	0	0	996	0	0.02	36.0	1.0	26.0	31.0	0.0	31.0
GW5	Al-Adawi	0	0	773	0	0.2	26.0	2.1	36.0	16.0	9.0	47.0
GW6	Tannery	0	0	735	0	0.12	32.0	2.1	18.0	26.0	0.0	25.0
SW1	Barada	144	8.5	357.5	0.25	0.14	7.8	2.8	10.0	14.0	67.2	8.07
SW2	Al-Hamme	42	10.4	502.5	0.9	0.49	17.3	2.5	24.8	19.0	86.4	11.35
SW3	Keewan	50	11.3	718.5	0.8	0.68	32.2	1.9	50.0	13.2	96.0	27.7
SW4	Kabass	596	2349	1155	8.3	3.45	54.3	10.0	99.4	30.0	68.0	32.8
SW5	Zebdeen	350	2370	1108.5	6.3	3.6	53.4	7.0	106.5	35.0	76.0	32.0
SW6	Effluent	46.2	14.48	853.4	3.47	3.4	48.7	3.6	72.4	12.0	66.1	29.4
SW7	Effluent	50.75	336.02	800.4	2.51	3.7	47.0	5.5	77.3	21.1	66.0	28.7
SW8	Beit Tima (Awaj R.)	38	16.65	443.5	1.0	0.8	26.0	0.3	56.8	2.0	66.0	12.9

Source: JICA Study Team

Notes: Boron concentrations less than 0.7mg/l have no restrictions on use in agriculture, concentrations between 0.7 and 3.0 can cause light to moderate restrictions and concentrations over 3.0 mg/l can cause severe restrictions.

APPENDIX 4.1

Detailed description of the soils of Syria
(taken from an untitled document in the Directorate of Soils, MAAR)

SOIL CLASSIFICATION IN SYRIA.

The system of soil classification used in this study was adopted from the comprehensive soil classification system which was developed by the Soil Survey Staff of the United States Department of Agriculture. In this study, soils are classified at the subgroup level. The main soil types found in Syria are described below.

ARIDISOLS

Aridisols are soils that do not have water available to mesophytic plants for long periods. During most of the time, when the soil is warm enough for plants to grow, water is held at a tension >15 bars or it is salty, or both. There is no period of 3 months or more when moisture is continuously available and the soil warm. Aridisols are developed in regions where the potential evapotranspiration greatly exceeds the precipitation during most of the year and no water percolates through the soil. Because of the limited amount of water available in the soil profile, the soil forming processes are less intense than in the humid regions. As a result, the soils inherit much of their morphological characteristics from the parent material. The lack of teaching has left the profiles with high base status. Therefore, many of the pedogenic horizons may be the result of translocation and accumulation of salts, carbonates, sulfates or silicate clays or of cementation by carbonates or by silica. There may also be only an alternation of the parent materials without any significant accumulation. Common salt features in Aridisols are salic horizons (salt accumulations) and nitric horizons (sodium affected). Their formation is favoured by periodic accumulation of water as in or near broad seasonal lakes, like the lake Jaboul, or in areas of seepage. Many of the salt and sodium concentrations are caused by man through his application of irrigation water.

Most Aridisols have an ochric epipedon. This epipedon is characterized by its light colour low organic matter and soft consistency when dry. They are not both hard and massive when dry although, if the texture is fine, the individuals peds may be hard. The subsurface horizons are mostly calcic or gypsic. The petrocalcic or petrogypsic horizons could also be presnt. The cambic and salic horizons occur in the depressions.

Most aridisols are gravely on the surface as a result of the removal of fine soil particles by wind (deflation) or by repeated wetting and drying. These actions form the very characteristic gravely and stony landscape, known as desert pavement. Upper surfaces of stones and gravels are commonly coated with black manganese and iron-oxides, which is often called desert varnish.

The temperature regimes of Aridisols range from cyric to isohyperthermic. Thus, it is possible to classify soils in Polar Regions as “Aridisols”, because these areas are frozen for 9 or 10 months of the year. While frozen, the soils are inactive, mineral decomposition is retarded and water is not available. The moisture regimes of

Aridisols are dominantly aridic. A few of these soils are salty and have ground water at a shallow depth. A few others may have ustic or xeric moisture regime that is marginal to aridic and they also are salty.

Aridisols occupy very extensive areas in Syria. They cover almost all of the southern and eastern part of the country, extending from the Jordanian border in the south to Haseki in the north, and from the Iraqi border in the east to the Jaboul lake and Antiliban mountains in the west.

INCEPTISOLS

These are soils that have not developed features diagnostics for other orders but have some features in addition to the ochric epipedon and other diagnostic horizons which are permitted in the Entisol order. Although they are better developed than Entisols they are still immature soils having profile features more weakly developed than the other orders and resemble very closely the parent material. These are generally soils of humid regions that have altered horizons which have lost bases or iron and aluminium but still retain some weatherable minerals. In many cases the soil forming processes are still active and one can predict that certain inceptisols will become Alfisols or some other soil order.

By definition, Inceptisols are very complex and may range from poorly drained to well drained. They may have any kind of epipedon, but the mollic epipedon is rare and restricted to some certain intertropical regions. Incepttisols generally have a cambic horizon, but it is not required if there is a calcic or petrogypsic horizon, or fragipan or duripan. The texture should be finer than coarse sand throughout the profile.

The Inceptisols are found in humid and subhumid regions. They do not occur in a Torric moisture regime. In Syria they are confined chiefly to the areas with Mediterranean climate. They cover almost the entire 1st and 2nd settlement zone. They occupy approximately 40,100 km^2 of land or 21.7% of the country. Two suborders are recognized in Syria Andepts and Ochrepts.

MOLLISOLS

These are mainly very dark coloured, base-rich soils of Steppes. Nearly all of them have mollic epipedon. Many also have an argillic or a nitric horizon or a calcic horizon. Some also have duripan or petrocalcic horizon. They are developed under any of the defined moisture or temperature regimes but enough moisture to support perennial grasses is essential. In Syria, Mollisols are not very extensive and are almost entirely confined to the Ghab depression in the west, to the basaltic areas west of Hom, and to the part of the marine aggradation plains and terraces in the west coast near the town of Jable. Only one suborder (Xerolls) is found in Syria, which comprises Mollisols of the Mediterranean regions. They are dry in Summer but receive a considerable amount of moisture during the winter. Almost all have mollic epipedon. All Xerolls in Syria belong to the Haploxeroll Great Group.

Haploxerolls are Xerolls that have a cambic horizon or a layer of only slightly altered parent materials below the mollic epipedon. Most of them have horizons in which carbonates have accumulated. Many have a calcic horizon, but in them at least parts of the surface horizons are free of carbonates. Only 3 sub groups are recognized. Typic Haploxerolls are freely drained, brownish soils that have Xeric moisture regime. They have a cambic epipedon, and do not have accumulation of carbonates at a shallow depth. They are dominant in the Ghab region. Lithic Haploxerolls are shallow Haploxerolls that have bedrock within 50 cm of the surface. They are confined chiefly to the relict volcanic mountains, hills and basaltic plateaus at the west of Homs. Entic Haploxerolls usually have a calcareous epipedon and weakly developed horizons. They have a high amount of rock fragments in the subsoil. They are not extensive and are found mostly as associated with other soils on the Ansariyeh mountain system along the coastal rgion. In total Mollisols cover approximately 2,150km^2 of lands or 1.2 % of the country.

VERTISOLS

These are fine textured soils that have wide and deep cracks. They have wide variations in soil colours, base saturation, amount of carbonates and depth to bedrock. They may have different temperature regimes, but most Vertisols have a regime that is thermic or warmer.

Vertisols are massive and very hard when dry and very sticky when wet, therefore it is very difficult to prepare seedbeds for cultivation. However, most of the Vertisols are cultivated in regions where the rainfall or the supply or irrigation practises present some special problems because the hydraulic conductivity of Vertisols is very low.

The most important characteristic of Vertisols is the formation of deep and wide cracks which may be 1cm or many cms wide at a depth of 50cm and may extend to a depth of 1m or more. There is also considerable movement of soils within the profile due to the swelling characteristics of clays. Because of this movement, houses, roads, telephone and power poles and pipelines could be tilted or even broken. This movement also causes a very characteristic shiny and smooth ped faces, called "slickensides", which are very common in Vertisols.

In Syria, Vertisols have developed primarily under a xeric moisture regime. They are quite extensive in the Haourane plateau in the south western part, associated mostly with Vertic Xerochrepts. The one single big unit is found east of El Malkiyeh, near the Tigers River, in the most northeastern tip of the country. Almost all Vertisols in Syria belong to the Xerert sub order, which consists of Vertisols of the Mediterranean region. Although some Vertisols of the aridic regions (Torrerts) are also found, they cover very small areas and are confined mostly to the lowlands and depressions of the regions with torric moisture regimes. Xererts are separated into two Great Groups according to the colour of their top soil. Chromoxererts are characterized by higher chroma, i.e. lighter colour whereas Pelloxererts are dominantly grey or black Vertisols. In Syria, Chromoxererts are by far the most common Vertisols. Two subgroups are recognized in Syria. Typic Chromoxererts are like Typic but their surface horizons are darker. Pelloxererts are not common. They are seen in a very limited area in the Akkar plain near Tartous and in the Jable plain south of Lattakia in the coastal regions. In total, Vertisols cover approx. 2,200 km2 of land or 1.2 % of the national territory.

APPENDIX 4.2

Institutional response to combating desertification

Ministry of Agriculture and Agrarian Reform

MAAR is responsible for numerous projects aimed at controlling desertification, including:

Planting fruit trees
It aims to reclaim and plant hilly and rocky lands which are uncultivable in areas where raining level exceeds 300 mm annually. The activities of this project include the breaking of rocky layers in the soil, the gathering of stones in rocky areas and the provision of machines for terracing in high slopping areas which are difficult to plant.

Greenbelt project
It aims at establish a greenbelt of forest and fruit trees between Badia and its cities in order to reduce desert crawl towards these urban areas. The project is located in the region between 205-300 mm rain level. The project provides machines remove stones in areas targeted for the planting of seedlings. The state usually offers seedlings free of charge. The universal food schedule has provided participating people with foodstuffs.

Developing agriculture in the southern area
This project began in 1984 and aims to reclaim 101,000 ha in Daraa and Swida governorates. This land is divided into three categories::
- 77,000 ha for fruit tree planting after reclamation and removing stones.
- 21,000 ha for removing stones in favour of field crops.
- 72,000 ha for developing field crops.

Project of the martyr Dr. Ali- Al-Ali to develop fruit tree planting
This project began in 1986 and aims to develop and plant 19,000 ha of hilly and rocky lands located out of agricultural investment scope in six governorates:
- Damascus (Rankus- Isal Alward).
- Homs (Dahr Al- Kser).
- Aleppo (tarik al –bab)
- Latakia (Kirdaha)
- Hama (Daher Al)
- Tartus (Alinazi)

These lands are developed through the breaking up of soil and the removal of stones. Terraces have been established in certain areas and planted with suitable fruit trees.

Forest tree planting – forest development
This project aims to plant forest trees in areas which are not eligible for agricultural investment and which are uncultivable economically with crops and fruitful trees. Large areas were planted, represented in mountainous regions, city entrances, road sides and greenbelts around cities.

Project for developing the Syrian Badia (Further details are given in Appendix 4.X)
It aims at extending plant recovery and contribute to limiting sand crawl. It also aims to produce quantities of meat, wool and milk to provide a part of the needs of the local market. It aims to do this by:

- Establishing 13 grazing nurseries producing 9 million grazing seedlings annually to be distributed for grazing protectorates, breeding sheep cooperatives. In addition to, improving pastures free of charge to get back the extinct grazing shrubs.
- Establishing 28 grazing protectorates in an area not less than 20 thousand Hectare for each protectorate to be planted with seedlings and give the opportunity for natural grazing plants to grow and represent the different environments of the Syrian Badia .
- Establishing 7 centres for multiplication of grazing seed producing 60 Ton annually perennial shrubs to be sowed in different environments of Badia to recover plant and limiting desertification.
- Establishing 10 green oasis along Damascus, Palmyra, Der-Ezzor road to help limit desertification.
- Establishing 10 centres for breeding sheep and pasture improvement by preventing sheep, which do not belong to the centre, and specifying the overgrazing.

Fixation of dunes
The project aims to treat dunes in Abuther Al–Gephari in Deir-Ezzzor, Al-Kasra and Jwif in order to limit sand movement.

Establishing centres to produce palm trees
Two centres were established in Palmyra and Maslaka (Albu–Kamal) to produce palm seedlings and help in planting palm in suitable areas .

Planting trees in Qunaetra governorate
It aims to plant about 35,000 ha in Qunaetra through stone removal, land reclamation and tree planting.

High seedling committee
This committee was formed by the Republican Decision No.108 in 1977 to increase planting and production of fruit and forest seedlings and to put a comprehensive plan for planting all cultivable areas with fruit trees in the country. This committee has taken a number of procedures and decisions, which are put into execution:

1- Planting main roads between cities.
2- Establishing public sector companies near dams, lakes and summer regions in order to afforest them.
3- Identifying an area for each cooperative association in each governorate to plant forests on tree day supervised by the subsidiary committees in the governorate.
4- Planting a belt of trees around Deir- Azzor to prevent Badia crawl.
5- Seedling the area surrounding Al Assad lake with forestry and fruit trees.
6- Planting area surround dams and lakes in the country.
7- Commencement of expanding in palm agriculture.
8- Immediate replanting of burnt areas and forests.

9- Expanding in planting forestry trees for timber.
10- Strict protection of forest and using supervising planes and immediate informing of fires.
11- Preventing those who cut, burn, cultivate or graze forests.
12- Expanding the agricultural areas specialized for fruitful trees planting by adding new areas in agricultural investment in hilly and rocky areas.
13- Recommending of planting two fruit trees in the garden of each house.
14- Putting agricultural centres of forestry and fruit tree seedlings production under the supervision of the high seedling committee to gain good seedlings at a reasonable price.

Ministry of Information

Information plays an important role in clarifying the importance of controlling desertification through the use visual and audio programs, bulletin advertisements which show the necessity of protecting natural resources, reducing pollution and not removing natural tree or shrubs.

Ministry of local administration

This is concerned with main aspects, particularly with regard to cities:

- Seeking to ensure laws relevant to environment protection are effective by finding alternative energy sources other than wood and increasing awareness of the importance of trees.
- Establishing greenbelts around cities and villages.
- Preventing pollution of water sources.

Ministry of housing

It participates planning and undertaking social, economic and technical studies which include:

1- Population projections for a number in water basins.
2- Predicting industrial and economic developments in certain areas.
3- Analyzing the expected prices of buildings and their running costs.
4- Choosing unfertile area when planning housing projects.
5- Studying future water needs for residence, industry and agriculture.

Ministry of State for Environmental Affairs

The Ministry of State for Environmental Affairs shoulders the responsibility of unifying decisions and putting polices, studies, execution, investment and maintenance a well as preventing problems and overlap in issuing decisions to avoid waste of time and effort. In particular it is concerned with:

1- Coordination and integration among competent authorities in controlling desertification.
2- Developing policy to control desertification.
3- Developing legislation to protect natural resources and preventing cutting trees and cultivating fertile lands in pastures.
4- Developing legislation which protect water sources and protect them from pollution.
5- Issuing bulletins and information, including documentary films.

APPENDIX 4.3

Official details of the Badia Project:

'Improving pastures and breeding sheep and controlling desertification in the Syrian Badia'

The Ministry of Agriculture and Agrarian reform in Syria (directorate of Al-Badia and pastures) have developed a program, which depends on ancient grazing polices to improve pasture and provide fodder. The items of this program were specified as follows:

Dividing Syrian Badia to cooperative associations of raising sheep and pasture improvement:

MAAR and the Peasants Union have specified the area of each cooperative association and signed maps, which specify the area of each cooperative.

The aims of these cooperatives are:

- Protecting the lands of these cooperatives from wrongful grazing i.e. each cooperative protects its land and limits desertification in it.
- Applying polices concerning good grazing desertification control by putting suitable overgrazing in pastures in a way that eliminates wrongful grazing.
- Cooperative associations contribution in planting deteriorated lands with high drought controlling grazing shrubs. The number of these cooperatives reached 414 in the end of 1992. They include more than 70% of sheep existed in Al-Badia.
- Studying the needs of each cooperative association for water and working to provide additional sources.
- Offering helps and loans for these cooperatives by ministries and establishments of the state.
- Trying to limit instability phenomena to provide natural reserve fodder to be used in concentrated fodder by special loans.

<u>Fattening sheep cooperatives</u>
A program of fattening sheep has been developed to control desertification, limit overgrazing in Al-Badia pastures and to stabilise sheep numbers and breeder income. This program seeks to prevent the increase of cattle in pastures and cover the country's needs for sheep meat which form 71,7% of the general country consumption of meat. Eighty-two cooperatives specialized in fattening sheep have been established in order to obtain better production.

<u>Centres for raising sheep and improving pastures</u>

Centres for raising sheep haven been established in Al- Badia. The aim of establishing these centres is:

1. Produce quantities of meat, wool and milk, which provide a part of local market needs.
2. Undertake research into pastures, sheep and fodder.
3. Instructing the members of these cooperatives of the importance of protection as well as the importance of applying correct grazing polices in preserving natural pastures as sources of fodder.
4. Protecting areas specified for the centre and applying suitable grazing polices to protect cover plant and prevent desertification.
5. Prevent desertification processes through planting a part of the deteriorated lands with high drought resistance grazing shrubs.
6. Producing improved rams and distribute them to breeders.
7. Provide education and instruction for Bedouin.
8. Providing work opportunities for number of Bedouin.

<u>Limiting desertification through planting some lands of Badia with grazing shrubs</u>

The program aims at producing grazing seedlings in nurseries of the Al-Badia directorate and distributing them to cooperatives. Thirteen nurseries have been established capable of producing 15 million seedlings annually and distributing these annually to cooperatives of raising sheep, improving pastures and grazing protectorates

<u>Desertification controlling through improving plant cover by grazing planting within protectorates</u>

Establish 28 grazing protectorates in order to controlling desertification and provide grazing seed, which have high resistance and compatibility, in addition to nurseries. Thus the amount of grazing seed collected was 60 ton in 1993.

<u>Desertification controlling through improving plant cover by sowing in pastures</u>

This is a very effective method in controlling desertification and the area covered by sowing area increased from 70 ha 1985 to 2800 ha in 1993. The result was 20 –70 plant per m^2 in Marga spot in Aleppo and Palmyra.

<u>Within agricultural polices, there should be animal breeding and planting green fodder in the agricultural rotation in order to control desertification</u>

Announcement of planting green fodder in the agricultural rotation to substitute the barren land in order to serve as a pasture for the increasing number of cattle and to provide a substitutable fodder provision instead of Al-Badia, these procedures will help in decreasing desertification.

<u>Fodder policy in Syrian Badia (concentrated fodder)plays an important role in decreasing harmful effects of desertification</u>

Natural pastures in fertile years can provide sheep with all their needs during the end of spring and winter. But there is still a need to submit concentrated fodder in pregnancy and birth periods and before fertilizing season. Public establishment of fodder has been established to provide sheep with concentrated fodder and fodder warehouses have been started to be established.

Fodder currency fund:

It is established to provide sheep with fodder in time, preserve them and to decrease drought results. This fund offers loans annually with simple interests.

Maintaining grazing sources, preventing tillage, issuing legislations necessary for limiting desert crawl and decreasing desertification results.

Several decrees, laws and decisions which organize investing Al-Badia for grazing only have been issued such as 140 decree amended by law No. 13 for year 1973 and 96/T decision and 591/OL which specifies population assemblages in Al-Badia. All these decisions contributed in stopping desertification crawl.

Water wealth:

Syrian Badia depends on the following sources to provide water:

1- Old water reservoirs: their number is about 3000 which provide a part of sheep wealth needs.
2- Ancient Arab and Roman canals.
3- Manual digging of surface wells, numbering 2500 .
4- Underground wells and surface dams.

Fixing dunes and desertification controlling

2,131 ha has been treated by intense forestry seedling in Abi thar Al Gaphari in Deir Azzor governorate tin order o limit sand crawl. Eleven mechanical dams have been established in a total size 43,000 m^3. 542,000 forest and grazing seedlings have been planted in 300 hectare to stop sand crawl on the railway linking between Der Alzor and Aleppo. Dunes have been covered with mud soil 73 dunes. Mechanical dams have been established. This project is one of the most successful projects in desertification controlling field.

Establishing green oasis in the middle ofAl- Badia

Establishing centres for palm trees seedlings and distributing offsets to civilians

APPENDIX 5.1

Total area of forest planted in Governorates in Syria for 1992 – 2000. Afforestation if new planting. Reforestation is planting on land where previous forestry plantings had failed for some reason (source: Forestry Directorate)

i) 1993

Province	Base year 1992	1993		
		Reforestation	Afforestation	Total
Damascus	380	20	95	115
Damascus Rural	14063	940	1479	2419
Quneitra	1621	31	80	111
Dar'aa	6316	411	32	443
Al- Sweida	2331	207	70	277
Homs	13011	1383	969	2352
Hama	16523	497	2260	2757
Al-Gab	4249	125	35	160
Idleb	27410	619	2367	2987
Lattakia	7744	1435	-	1435
Tartous	12736	441	452	893
Aleppo	20318	1000	1180	2180
Al-Rakka	4449	490	500	990
Deir-es-Zor	2950	87	300	387
Hassakeh	10587	1650	950	2600
Total	144688	9337	10770	20107

b) 1994

Province	**1994**		
	Reforestation	**Afforestation**	**Total**
Damascus	5	72	77
Damascus Rural	678	1491	2169
Quneitra	230	120	350
Dar'aa	337	147	484
Al- Sweida	210	125	335
Homs	1890	1597	3487
Hama	2498	330	2828
Al- Gab	425	240	665
Idleb	2726	400	3126
Lattakia	1975	-	1975
Tartous	938	897	1835
Aleppo	777	1397	2174
Al-Rakka	500	950	1450
Deir-es-Zor	47	294	341
Hassakeh	1930	950	2880
Total	15166	9010	24176

c) 1995

Province	1995		
	Reforestation	Afforestation	Total
Damascus	10	78	88
Damascus Rural	684	1171	1855
Quneitra	71	31	102
Dar'aa	209	209	418
Al- Sweida	135	413	548
Homs	1298	1695	2993
Hama	1716	397	2113
Al- Gab	661	-	661
Idleb	1793	1399	3193
Lattakia	1641	-	1641
Tartous	1980	-	1980
Aleppo	1119	1176	2295
Al-Rakka	540	860	1400
Deir-es-Zor	164	125	289
Hassakeh	1000	2000	3000
Total	13021	9555	22576

d) 1996

Province	1996		
	Reforestation	**Afforestation**	**Total**
Damascus	59	76	135
Damascus Rural	41	1890	1931
Quneitra	0	100	100
Dar'aa	154	284	437
Al- Sweida	81	400	481
Homs	833	2842	3676
Hama	1676	323	1999
Al- Gab	428.5	291	720
Idleb	967	3009	3976
Lattakia	2382	-	2382
Tartous	2149	-	2149
Aleppo	689	3041	3730
Al-Rakka	386	1400	1786
Deir-es-Zor	-	220	220
Hassakeh	105	3200	3305
Total	9950	17076	27027

e) 1997

Province	1997		
	Reforestation	Afforestation	Total
Damascus			
DamascusRural	240	240	-
Quneitra	1997	2208	211
Dara'a	50	65	15
Aa- Sweida	300	400	100
Homs	425	435	10
Hama	2782	3525	743
Al- Gab	190	1761	1571
Idleb	192	733	540
Lattakia	2367	3156	789
Tartous	0	2016.7	2017
Aleppo	-	2128	2128
Al-Rakka	2303	2364	60.9
Deir-es-Zor	2050	2050	-
Hassakeh	300	400	100
Total	3000	3389	6389

f) 1998

Province	1998		
	Reforestation	Afforestation	Total
Damascus	92	306	398
Damascus Rural	161	2163	2324
Quneitra	18	50	68
Dar'aa	69	238	307
Al- Sweida	-	500	500
Homs	853	2897	3750
Hama	1751	244	1995
Al- Gab	546	135	681
Idleb	2080	1000	3080
Lattakia	2048	-	2048
Tartous	2315	-	2315
Aleppo	1672	1279	2951
Al-Rakka	300	2000	2300
Deir-es-Zor	-	260	260
Hassakeh	820	2200	3020
Total	12726	13272	25998

g) 1999

Province	1999		
	Reforestation	Afforestation	Total
Damascus	20	200	220
DamascusRural	143	734	877
Quneitra	9	51	60
Dar'aa	32	170	202
Al- Sweida	80	500	580
Homs	1396	1392	2787
Hama	548	1037	1586
Al- Gab	774	30	804
Idleb	2236	1100	3336
Lattakia	2032	50	2082
Tartous	2207	-	2207
Aleppo	1322	1441	2763
Al-Rakka	892	327	1219
Deir-es-Zor	250	280	530
Hassakeh	1040	2035	3075
Total	12981	9347	22328

h) 2000

Province	2000		
	Reforestation	**Afforestation**	**Total**
Damascus	31	203	233
Damascus Rural	424	373	798
Queneitra	52	50	102.8
Dar'aa	50	406	456
Al- Sweida	328	172	500
Homs	1365	1759	3123
Hama	1447	402	1849
Al- Gab	674	130	804
Idleb	1564	2000	3564
Lattakia	2197	-	2197
Tartous	2097	-	2098
Aleppo	1175	1486	2661
Al-Rakka	508	756	1264
Deir-es-Zor	50	50	100
Hassakeh	1045	2000	3045
Total	13010	9788	22798

APPENDIX 5.2 Area and number of fruit and forest tree ('000) 1993 – 2000
(source: Forestry Directorate).

a) 1993 - 1996

Species	1993		1994		1995		1996	
	Area	No trees	Area	No trees	Area	No trees	Area	No trees
Pinus pinea	12000	10066	12700	10889	13100	11502	13800	13485
Castanea sativa	790	823	890	853	940	870	990	886
Prunus mahleb	1804	564	2055	664	2326	795	3223	955
Rhus coriaria	55	53	55	53	91	70	91	70
Laurus naobilis	243	243	346	346	400	400	468	468
Pirus syrica	178	107	272	197	272	197	441	265
Ceratonia siliqua	17	17	30	30	113	113	168	168
Total	**15087**	**11873**	**16348**	**13032**	**17242**	**13947**	**19181**	**16297**

b) 1997 – 2000

Species	1997		1998		1999		2000	
	Area	No trees	Area	No trees	Area	No trees	Area	No trees
Pinus pinea	18718	16415	24317	19683	30506	23219	35452	25864
Castanea sativa	1114	980	1200	1024	1261	1062	1291	1087
Prunus mahleb	3272	986	3272	986	3300	992	3300	992
Rhus coriaria	91	70	101	75	132	92	174	115
Laurus naobilis	638	610	776	730	853	810	948	878
Pirus syrica	573	328	651	359	793	411	797	413
Ceratonia siliqua	168	168	206	204	212	212	283	263
Total	**24574**	**19557**	**30523**	**23061**	**37057**	**26798**	**42245**	**29612**

APPENDIX 6.1

Description of natural reserves and legally protected areas in Syria
(source:. MSE / UNEP.1998. *National Country Study of Biological Diversity In Syrian Arab Republic* . Damascus , Syria).

Name of reserve	Location	Size (Ha)	Date established	Ecosystem type	Species /communities of note
Cedar-Fir Protected Area	Northern part of the Syrian coastal mountain range,and over looked by the summit of the prophet"Matte"near the city of Slenfeh. Longitude: 36.10, Latitude: 30.25 Lattakia Governorate	1350 ha ,distributed over several hill sides between 1100-1562 m above sea level and extendable.	22 / 6 /1996, Decree No. 19 Ministry of Agriculture	Mediterrnean forest,Cedar & Fir forests (Humid Mediterranean Bioclimate,cold winter) The ecosystem in the area is fragile in spite of the abundance of large vivid trees the forest is characterized by its harmonious coexistence with its ambient environment in terms of the large quantity of rain water, adequate humidity, mist and clouds year.	1.The *Anthrisco-Abietum cilicicae* community 2.The*Aieto-Rhamnetum catharticae* community 3.The *cytiso-cedretum libani* community 4.The *Abieto-carpinetum orientalis* community several species of *Orchids,* rare threatened species of *Pteridophytes,fungi,Pirus Syriaca, Malus trilobata,Prunus,mahlab, Crataegus monogyna,Prunus ursina,etc. Ostrya carpinus orientalis.*
Al fronloque Reserve	Governorate of Lattakia,in Al Bayer Region. 47 Km north of the city of Lattakia	1500 ha	18/ 5 /1999, Decree No. 17 Ministry of Agriculture	It is considered the most ideal eco-system of forests in Syria Represents a coned forest which is close to a stabilized state with the surrounding conditions	Oak -Pine forest .It is rich in a large number of rare and threatened species *Quercus Pseudocerris* (deciduous forest) *Al fronloque Iris* endangered
Um El Toyour Reserve	Governorate of Lattakia,30 Km north of the city of Lattakia	1000 ha	13/ 5 /1999, Decree No. 15 Ministry of Agriculture	Mediterranean deteriorated forests (thermal Mediterranean Bioclimate) Pine forest + Marine life	*Ceratonia siliqua,Piscacia lentiscus, Olea europaea var. oleaster* In general thick shrubbery and semi-shrubbery cover the hills close to the shore
Ras- al Bassit Reserve	Governorate of Lattakia	3000ha	Unknown	*Brutia Pine* forest	*Brutia Pine* forest
Abou Kobeis Reserve	Governorate of Hama	11000ha	Unknown	Evergreen Med. Forest	Evergreen Med. Forest

Abdul Aziz mountain Reserve	Governorate of Deir-ez-zour Abdul Aziz mountain	84050ha	29/ 6 /1993, Decree No. 20 Ministry of Agriculture	Mediterranean deteriorated forests (arid & semi- arid Mediterranean Bioclimate) *Pistacia atlantica* stand	*Pistacia atlantica,P.khinjuk,P.mutica,Amygdalus orientalis,Prunus,Rhamus palaestina,Figs ,Artemisia herba alba Noaea mucronata, Salsola vermiculata,Achillea sp.,Thymus sp.*
Al Thawra island Reserve	Governorate of Al Raqa , in the south eastern part of Al Assad Lake.	590 ha	27/ 2 /1994, Decree No. 7 Ministry of Agriculture	(Arid Mediterranean Bioclimate) Lake on Euphrates	*Pistacia atlantica, Pinus brutia ,Quercus calliprinus*
Al Basel Forest Reserve	Governorate of Idleb	2000 ha	12/ 9 /1998, Decree No. 20 Ministry of Agriculture	(semi-arid Mediterranean Bioclimate)	Unknown
The eastern Al sha'ra Reserve	Governorate of Tartous	1000 ha	29/ 8 /1998, Decree No. 19 Ministry of Agriculture	Mediterranean deteriorated forests. (Upper Mediterranean Bioclimate) Evergreen Med. Forest	*Quercus sp*
Al Beshri mountain Reserve	Al Beshri mountain	7500 ha	Unknown	Deteriorated forests (Arid Mediterranean Bioclimate)	*Pistacia atlantica,Amygdalus sp., Atriplex Salsola sp., Artemisia*
Al bal'as Reserve	Governorate of Hama, Albal'as mountain, 120Km east of the city of Hama	12000 ha	Unknown	Mediterranean deteriorated forests (Oro- Mediterranean Bioclimate) / semi arid *Pistacia atlantica* stand	*Pistacia atlantica, Rhamnus palaestina, Prunus sp.,Amygdalus orienytalis Pyrus syriaca*
Sabkhat Jabboul Reserve	Governorate of Aleppo	10000 ha	Unknown	Wetland life	Unknown
Tlailet Reserve	Governorate of Homs	22000 ha	Unknown	Desert wild life	Unknown

Note : * refer to reference 4 , others from reference 1 & 2. Date established (2*), Species (1*)

APPENDIX 6.2

Rangeland Protected Areas in Syria
(Source: Department of Environment, Directorate of Soil, Ministry Of Agriculture and Agrarian Reform. 2001. *Protected Areas in Syria*.(various leaflets), * MOP/ GEF/ UNDP.2000. *Biological Diversity . National Report*. Biodiversity Strategy and Action Plan and Report to the Conference of Parties. NBSAP Project SY/97/G31)

Name of reserve	Location	**Size (Ha)**	**Date established**	Ecosystem type	**Species /communities of note**
1) *Udami Reserve	Governorate of Alepo	1250 ha	1981	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
2) Al maraqa Reserve	Governorate of Alepo	8000 ha	1986-1985	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
3) *Ain El Zarka Reserve	Governorate of Alepo	1250 ha	1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
4) Obesat Reserve	Governorate of Alepo	7500 ha	1995	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
5) Dlboh Reserve	Governorate of Alepo	5000 ha	1997	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
6)* Abou-Elnitle Reserve	Governorate of Hama	3017 ha	1991-1990	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
7) *Abou El-fayad Reserve	Governorate of Hama	2900 ha	1986-1985	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
8)* Wadi El-Azib Reserve	Governorate of Hama	1140 ha	1964	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
9) * Rasm El Ahmon Reserve	Governorate of Hama	940 ha	Unknown	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
10) Al 'amalah Reserve	Governorate of Al raqa	12000 ha	1990	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
11)* Hayel El Romman Reserve	Governorate of Al raqa	3574 ha	1989	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
12)*Rajm El shih Reserve	Governorate of Al raqa	3080 ha	1992	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
13) Mksar Alfrs Reserve	Governorate of Al raqa	5000 ha	1997	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
14) Al zrab Reserve	Governorate of Der -Alzour	5000 ha	1985-1984	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
15)*Jlieb ElHoukouma Reserve	Governorate of Der -Alzour	3934 ha	1995-1990	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
16) Al hajef Reserve	Governorate of Der -Alzour	7000 ha	1998-1997	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
17) *Al shoula Reserve	Governorate of Der -Alzour	900 ha	1992-1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses
18) Adman Reserve	Governorate of Der -Alzour	5000 ha	1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,* and other grasses

19)* Al Mankoura Reserve	Governorate of Rural Damascus	80 ha	1992-1990	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
20)* Al Shadada Reserve	Governorate of Alhasaka	2365 ha	1984	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
21)*Zahmimieh Reserve	Governorate of Alhasaka	685 ha	1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
22)*Toual El Iba Reserve	Governorate of Al raqa	1000 ha	1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
23) Ksban Alrmleh Reserve	Governorate of Der –Alzour	655 ha	1986	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
24) Afra &Alpojari Reserve	Governorate of Alhasaka	3000 ha	1990	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
25) *Um-Madfah, Reuoch Reserve	Governorate of Alhasaka	600 ha	1991	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
26) Athman Reserve	Governorate of Der -Alzour	5000 ha	1991-1992	Deteriorated rangelands ecosystem	*Salsola .sp., Artemisi.sp., Atriplex.sp.,*
27) *Jib El Murr Reserve	Governorate of Homs	5000 ha	Unknown	Unknown	Unknown
28) *Kasr El Hir Gharbi Reserve	Governorate of Homs	1760 ha	Unknown	Unknown	Unknown
29) *Subhieh Reserve	Governorate of Damascus –Rif	1000 ha	Unknown	Unknown	Unknown
30)*Research Center Asfar Reserve	Governorate of Sweida	100 ha	Unknown	Unknown	Unknown
31) *Merajha Reserve	Governorate of Alepo	2007 ha	Unknown	Unknown	Unknown
32) *Umableh Reserve	Governorate of Al raqa	3627 ha	Unknown	Unknown	Unknown
33)* Chaurat Bejara Reserve	Governorate of Alhasaka	4275 ha	Unknown	Unknown	Unknown
34) *El- Sukri Reserve	Governorate of Homs	1125 ha	Unknown	Unknown	Unknown
35)* Kaser El-Hallabat Reserve	Governorate of Homs	2300 ha	Unknown	Unknown	Unknown
36)*Serj Msallam Reserve	Governorate of Sweida	688 ha	Unknown	Unknown	Unknown
37)* Ard El Aoura Reserve	Governorate of Sweida	380 ha	Unknown	Unknown	Unknown
39)* Zrad Reserve	Governorate of Der - Alzour	35258 ha	Unknown	Unknown	Unknown
40)* Uzma Reserve	Governorate of Der - Alzour	700 ha	Unknown	Unknown	Unknown

APPENDIX 6.3

Suggested Areas for Protection in Syria.
(Source:_Biological Diversity. National Report. Biodiversity Strategy and Action Plan and Report to the Conference of Parties. NBSAP Project SY/97/G31).(2000)

Name of reserve	Location	Size (Ha)	Ecosystem type	Species /communities of note (1*)
1. Jabal Abou Rajman Reserve	Governorate of Homs About 45Km north of the city of Palmyra.	60,000	Pisticia desert Mountain Mediterranean deteriorated forests (arid Mediterranean Bioclimate)	Pistacia atlantica,Ramnus palestina, Amygdalus orientalis,Pyrus syriaca,Prunus sp., Artemisia Herba-alba,Noaea mucronata, Salsola vermiculata Thymus sp.poa sp .Helianthemum sp. Erodium
2. Jabal Al Arab Reserve	Governorate of Sweida Al arab mountain, in the southern part of Syria.	38500	Evergreen Oak forest Mediterranean deteriorated forests (semi-arid Mediterranean Bioclimate) Pistacia atlantica Stand	Quercus calliprinus,Q.infectoria,Q.cerris subsp pseudoceris,Quercus libani,Quercus brantii, Acer monspessulanum,Iris auranitica, Crataegus sinaica, C.azarolus, Pyrus syriaca, Pistacia, Prunus tortuosa, Prunus ursina.
3. Kalmoun Mountains Reserve (Juniperus excelsa)	Governorate of Damascus –Rif. At the peaks of East Lebanese.Mou. Ranges	3500	Juniper Stands Mediterranean deteriorated forests (Oro- Mediterranean Bioclimate)	Juniperus excelsa,Pyrus syriaca, Crataegus azarolus, Acer monsppessulanum, Rhus coriaria,Rosa sp.,Ulmus sp., Rhamnus,sp.
4. Euphrats basin Reserve (Populus euphratica)	Governorate of Rakka	Not –deter-mined	Fresh water life, Riparian ecosystem (Arid climate)	Populus euphratica,Salix persica, Aeluropus ittoralis, Imperata cylindrica,Solanum dulcamara, Lippia nodiflora,Eryngium campestre, Tamarix Tigrensis, Galega assyriaca, Typha latifolia , Solanum sodamaeum, Xanthium echinatum.
5. Sabkhat Maouh Reserve	Governorate of Homs	20000	Salt water life	Unknown
6. Zallouh and Ribas Reserve	Governorate of Damascus -Rif	20000	Medicinal plants	Unknown

7. Qurah Doran Reserve	Governorate of Lattakia West of the Kasab city close theSyrian-Turkish border on the southern slopes of Al Aqraa Mou.	1250	Deciduous oak forest	Quercus caliprinus , Quercus cerris subs. Pseudocerris, Cupressus sempervirens, Pinus brutia , Laurus nobilis, Ceratonia Siliqua
8. October 16 Reserve	Governorate of Lattakia	National Park	Pine forest art.Lake	Unknown
9 . Jabal wastani Reserve	Governorate of Idleb, in the west of the city of Idleb.	Not – deter-mined	Deciduous oak forest (semi -arid Mediterranean Bioclimate)	Quercus calliprinus, Q.infectoria, Q.aegilops, Quercus.castaneaefolia subsp. Wastaniana
10 . Akoum Reserve	Governorate of Homs	Mountain with Lebanon	Deciduous oak forest	Unknown
11 . Mastoura Reserve	Governorate of Homs	Mountain with Lebanon	Evergreen Oak forest	Unknown
12.Wadi Al Karn, Rakhleh Reserve	Governorate of of Damascus -Rif	Mountain with Lebanon	Deciduous oak forest	Unknown
13 . Khatounieh Reserve	Governorate of Hasakeh	Unknown	Wetland life	Unknown

14 . Wadi Hzairin Reserve	Governorate of Lattakia 15Km north east of the city of Slenfeh.	Unknown	Coastal forest Mediterranean deteriorated forests (EU- Mediterranean Bioclimate)	Pteris longifolia , Phyllitis scolopendrium.
15 . Assad Lake Reserve	Governorate of Rakka	64000	Fresh water lake	Unknown
16 . Katinah Reserve	Governorate of Homs	Wet-land	Fresh water lake	Unknown
17 . Mount Hermon Reserve	Governorate of Damascus Kneitra	Unknown	Evergreen Oak forest	Unknown
18 .Mount Sinjar Reserve	Governorate of Hasakeh	Badia with Iraq	Desert Mountain	Unknown
19.Mount El Bashri Reserve	Governorate of Deir-El Zour	30000	Desert Mountain	Unknown
20 .Mzeiribe Lake Reserve	Governorate of Deraa	Unknown	Wetland life	Unknown
21 .Rastan Dam Reserve	Governorate of Homs	Unknown	Watershed area	Unknown

22.Btaise (Barshine) Reserve	Governorate of Homs-Tartous	100	Evergreen Oak forest	Unknown
23 .Barbaris Reserve	Governorate of Damascus- Lebanon bordu	30000	Berberis antilife	Unknown
24.Hasanli Mountain Reserve	Governorate of Aleppo	Unknown	Deciduous oak forest	Unknown
25 .Semaan Reserve	Governorate of Aleppo	Unknown	Evergreen Oak forest	Unknown
26 .Bustan Reserve	Governorate of Hama, Meseaf	115	Deciduous oak forest	Unknown
27 .Al - Lujate Reserve	Governorate of Derra- Sweida	Unknown	Wild almond	Unknown
28 .Kanawate Reserve	Governorate of Sweida	Unknown	Evergreen Oak forest	Unknown
29 .Syrian Derdar Reserve	Governorate of Hama	Unknown	Fraxinus syriacus	Unknown

30 .Joulan Reserve	Governorate of Kneitra	Unknown	Deciduous oak forest	Unknown
31. (2*) Hoeget Al Tabni Reserve	Governorate of Der –Alzour	129	Riparian forest ecosystem	Unknown

APPENDIX 6.4

Desirable Future Strategy for biodiversity conservation as outlined in the National Report for Biodiversity (2000)

During the development of the NBSAP there were three workshops, each included the contribution of more than 100 participants including senior staff members of Ministries, Researchers from universities, representatives of regional and international organizations, grassroots representatives and NOOs. There were three regional seminars and five sectoral meetings. Each of these included leading members of different sectors and classes of the society: children, students, farmers, and women. The development of the NBSAP included about 40 national consultancies and six international consultancies. The aim was to reach a national consensus on the conservation of Biodiversity and the sustainable use of biological resources. As result of these workshops a national consensus was expressed in workshops to do the following.

Institutional Obligations

The Ministry of Agriculture and Agrarian Reform is cooperating with the Ministry of Environment and the Ministry of Higher Education as well as with community based organizations in reviewing and evaluating current agricultural practices.

The concepts of sustainable development and conservation of biodiversity are being introduced into agricultural policy taking into consideration the local economic and social situation on one hand and the requirements of the International Trade Organization on the other.

The Ministry of Agriculture and Agrarian Refonn has convened a Supreme Council on Biodiversity and Genetic Resources in the Syrian Arab Republic Comprising of:

- Deputy Minister of Higher Education (coordinator)
- Director of Scientific Agricultural Research, MAAR. (secretary)
- Deputy Minister of Environmental Affairs (member)
- Deputy Minister of Agriculture member Director of Statistics and Planning (member) Director ofBadia (Steppe Directorate) (member)
- Director of Forestry and Afforestation (member)
- Director of Agriculture and Irrigation in SPC (member)

The responsibilities of the Council include:

1. Plans and Programs for the conservation, management and sustainable use of biodiversity and genetic resources of plants and animals and the formation of technical committees necessary for their implementation.
2. Supervision of projects related to biodiversity and coordination with other ministries and institutions and with regional and international organizations.
3. The Ministry of Agriculture is executing the Syrian Part of the regional project "Conservation and Sustainable use of Dryland Agro-biodiversity in Jordan, Lebanon, Syria and Palestinian Authority" RAB/G32-Afl G/7 I.

The Supreme Council of Afforestation

The policy of the Supreme Council for Afforestation aims to expand the area which is planted with fruit and forestry trees on mountain and hills areas enjoying high precipitation. These areas are not arable in their present state, farmers are not able to use suitable efficient equipment to make the land suitable for fruit trees at a reasonable price.

1. Every year an area of 24 thousand hectares are planted and equipped with forestry roads and isolation fire barriers in cooperation with the Directorate of Forestry in Ministry of Agriculture. This area is distributed in the different governorates. The total planted area during the period (1977-1998) amounts to 425 thousand hectares and about 1600-km long roads.
2. Other activities are the establishment of protected natural areas for the conservation of ecosystems, plants and animals and the regeneration of the original vegetation. The most important are *Abies -Cedar* forest on the coastal mountains, Jabal Abdel Aziz in Hassake region and Jabal Bela'as in Hama region and Thawra Island in Raqqa region.
3. Protection of the flora and afforestation sites through delimitation and property design in all forest and afforestation areas .
4. Execution of forestry roads and fire line barriers in the natural forest for the protection from wild fires and to facilitate transport in cases of emergency.
5. Establishment of central and off sites units in each governorate for the development of forestry and the use of production.
6. Gradual reclamation of afforestation sites on the mountains and hills enjoying high precipitation so that a natural protection for afforestation sites and its protection from desertification and agricultural expansion and facilitation of agricultural services through the establishment of forest roads.
7. Afforestation of roadsides, high ways, watershed of rivers dams and lakes.
8. Establishment of a green belt 800 km long and 10 km broad to separate the Badia from settlement areas with the aim of arresting desertification and the establishment of oasis around wells in the Badia.
9. Preparation of technical and economic studies for afforestation areas according to the principle of the best tree in the most suitable sites. These studies covered already 1.6 million hectares on the mountains and hills enjoying high rain fall to be planted with fruit trees or forestry; so that the annual planted area is not less than 24 thousand hectares according to available resources.
10. Expansion of fruit palm trees and upgrading of its nurseries and the establishment of a modem laboratory to try tissue culture in Palm propagation and others fruit trees, especially in the Badia.
11. Expansion of peanut and *Pinus pinea* plantation in the suitable sites and other agroforestry species which the country needs and are necessary for thus ambitious plan.
12. Syria produces annually 30 million plants of forestry and forestry fruit trees.

13. A special forestry research centre was established to build on a sound scientific basis.

***In- situ* Conservation**

The protected areas in Syria receive very good attention from the scientific community. Their legislation and administration are still at early stages and would need further development. The Ministry of Agriculture and Agrarian Reform is cooperating with the Ministry of Environment and the Ministry of Higher Education as well as with community based organizations in reviewing and evaluating *in-situ* conservation. Many areas hosting various biodiversity components were invariably suggested by the scientific community in Syria. The Ministry of Agriculture and Agrarian Reform has established a set of protected areas specialized in rangeland conservation practices.

Strategic Goals and Priority Options as suggested by consultees of the National Report on Biodiveristy

Strategic Goal l

Protecting Terrestrial Biodiversity

Short Term Plan

1. Promote cooperation between Syrian Government Ministries, Agencies and various community-based organizations in developing land-use policies that would guarantee the continued existence of natural areas for wild flora and fauna.
2. Limit construction of roads, dwellings and tourist resorts in critical areas around forests and productive rangelands.
3. Control forest fires through clearing and utilizing flammable debris in and around forests on a regular basis, employing early detection systems and upgrading fire fighting capabilities.
4. Establish a system of protected areas that provides adequate coverage of all remaining natural forests and selected rangelands
5. Ban illegal hunting, particularly of resident and migrating birds that play an essential role in a balanced agricultural production system.

Long term Plan:

1. Control the harvesting of edible plants and medicinal herbs by providing means to propagate these species for commercial exploitation.
2. Surround the system of protected areas or nature reserves with areas of sustainable land- use practices to promote the balance of nature and allow the survival of wildlife for the benefit of future generations.

Strategic Goal 2 To Conserve and Manage Freshwater Biodiversity:

Short term Pan:

1. Promote cooperation between Syrian Government Ministries, particularly the Ministry of Irrigation, Agencies and various community based organizations

in developing land-use policies that would guarantee the continued existence of natural areas for wild flora and fauna in wetlands.

2. Control pollution and treat all wastes to make sure they are safe before they are dumped into the nearest body of water.
3. Minimize the use of agricultural pesticides and chemical fertilizers. 4- Limit the number of boats, fishermen, nets in all fishing zones.
4. Actively enforce the ban on explosives, poisons and electric currents in fishing areas.
5. Establish a system of protected areas for conservation of natural wetlands.

Long term Plan

1. Breed and multiply the species of fish, which are threatened or have already become extinct in certain locations and re-introduce them to suitable locations.
2. Find better uses for salted lands such as converting Some of those areas to fish fanning.
3. Prepare Environmental Impact Assessments on future irrigation projects. 4- Prepare an integrated proposal for the rehabilitation of all Syrian rivers.
4. Surround the system of protected areas or nature reserves with major water catchment areas to conserve sources of freshwater, and introduce sustainable land-use practices to promote the balance of nature and allow the survival of wildlife for the benefit of future generations.

Strategic Goal 3-Generation of income from local wild plants

Short term Plan:

1. Conduct a scientific survey of the wild plants of economic value found in Syria and enter it into a GIS based computer network.
2. Determine the best method for the propagation and commercialization of these wild plants So as to help rural inhabitants to make best commercial use of them.
3. Establish protected areas where these wild plants are usually found So as to conserve and propagate them in their natural surrounding.

Long term plan:

1. Study the genetic Composition of these wild plants with a view to improving the performance of their varieties.
2. Investigate the possibility of. using other less known wild plants for medicinal and aromatic purposes, particularly in the more arid areas of the Badia.
3. Develop the cultivation of truffles and study the factors responsible for its growth.

Strategic Goal 4 Generaton of income from local wild animals

Short term plan

1. Commence serious and well-managed captive breeding program for certain local wildlife, such as game birds and gazelles.
2. Release captive bred birds and mammals into protected areas under expert supervision.
3. Release captive bred birds and mammals that do well in protected areas to open areas of the Badia and mountains during certain seasons of the year.

Long term plan

1. Involve the responsible hunters and their societies in the long and difficult process of wild animal re-introduction to the wild So that they may understand and support these.
2. Investigate the feasibility of allowing licensed and properly organized hunting during certain seasons of the year.

Strategic Goal 5 Using Agricultural Biodiversity Sustainably

Short term Plan:

1. Conduct a survey of agricultural development projects and take into consideration the results of environmental impact assessments conducted to measure the effect of those projects on conservation of agricultural biodiversity.
2. Continue rehabilitation and reforestation of marginal and desertified land using local species of plants.
3. Support forage production for livestock in rainfed areas.
4. Improve integrated pest management (IPM) for all irrigated crops.
5. Determine the fertilizer requirements for all crops and soil types throughout the country.
6. Review all laws and legislation with a view to suggesting amendments that comply with the requirements of sustainable agricultural production.

Long term plan

1. Develop agricultural rotations that serve the requirements of sustainable development and conservation of agricultural biodiversity.
2. Develop the technology to monitor the breakdown of agricultural pesticides and chemical fertilizers.
3. Develop a system of rewards and punishments that serves the needs of sustainable development.
4. Improve irrigation practices that reduce the amount of water used and prevent wastage of this precious resource.
5. Reclaim salted lands to make it productive in some capacity.

6. Upgrade agricultural extension services to enlighten farmers about the advantages of conservation of agricultural biodiversity

Strategic Goal 6 Using local varieties of cultivated plants

Short Term Plan:

1. Establish and upgrade seed collections of local cultivated plants
2. Support research into genetic origins of local cultivated crops & trees.
3. Implement laws protecting local varieties of cultivated crops and trees.
4. Establish seed & gene banks for long term preservation of local crops.

Long term Plan:

1. Support the cultivation of local varieties by farmers in their fields. c 2- Set up an information system for local progenitors of food crops.
2. Cooperations with regional and international organizations to conserve exchange and safeguard the national plant genetic resources.

Strategic Goal 7 To Conserve Valuable Animal Genetic Material

Short term Plan

1. Encourage and support fanners with local breeds of domestic animals.
2. Encourage and support livestock stations that specialize in local breeds.
3. Utilize the genetic variability of local domestic animals in breeding programs that aim at improving production.
4. Establish an artificial insemination and embryo transfer centres.

Long term Plan:

1. Compile a database on local breeds, their locations and production levels.
2. Enactment of laws and policies that prohibit the export of local breeds of domestic animals.
3. Support advanced studies on the genetics of local breeds of animals.

Strategic Goal 8 Use the Biodiversity of the Badia Sustainably

Short term Plan:

1. Determine, the carrying capacity of the different rangelands of the Badia taking into consideration the rainfall factor and season of growth.
2. Cooperate with community based organizations concerned with grazing lands to restore the vegetative cover of the Badia through conservation and replanting.
3. Utilize where possible the technique of rain or cloud harvesting.

4. Implement hunting laws and special directives concerning the principles and seasonality of proper hunting in the Badia in cooperation with the Ministry of Interior.

Long term Plan:

1. Expand conservation of biodiversity in the Badia to include all the degraded and desertified areas to allow time for the natural vegetative cover to re-establish itself.
2. Combine the distribution of feed and veterinary services in the Badia with the organization of grazing schedules that promote rangeland rehabilitation.
3. Utilize the ground water reserves in the Badia to increase the emergency forage reserves for sheep
4. Establish a research centre that studies and stores all data pertaining to the flora and fauna of the Badia, as well as the economic and cultural aspects of its nomadic population.

Strategic Goal 9 Using Forested Areas Sustainably

Short term Plan

1. Continue the afforestation program in areas that are bare or degraded in order to renew the vegetative cover and prevent erosion of topsoil.
2. Support the Forest Research Centre by hiring forest ecology specialists and providing them with the necessary facilities and equipment to cany out research into herbal and medicinal plants and agro-forestry programs.
3. Utilize remote sensing techniques and GIS technology to determine size and rate of growth of the afforested areas.
4. Establish new and expand the seed stock of existing tree nurseries to include local varieties of Syrian trees and shrubs.

Long term

1. Explain the environmental benefits and economic returns of properly managed forests and afforested areas to the agricultural community through conservation of soil and water.
2. Involve farmer organizations in the establishment and management of forests and afforested areas so the agricultural community adopts those areas as an important resource that need to be conserved.

Strategic Goal 10 To Develop Biodiversity Education and Public Awareness

Short term plan

1. Upgrade school and university textbooks to include biodiversity.
2. Upgrade the curricula of all institutes of higher learning to include national biodiversity Issues.
3. Upgrade the ability of television, radio and newspaper to create the necessary awareness of national biodiversity issues.

4. Increase the number of outdoor activities for students, military trainees and clubs that introduce them to biodiversity in Syria.

<u>Long term plan</u>

1. Establish clubs and organizations for conservation of nature in Syria.
2. Encourage publication and translation of books on biodiversity.
3. Establish natural history museums, botanical gardens and parks.
4. Promote eco-tourism for Syrians, Arabs and foreign visitors.

<u>Strategic Goal 11 Coordination of National biodiversity research</u>

<u>Short term plan</u>

1. Support the efforts of the Ministry of Higher Education and the national, Arab and international research institutions to develop a coordinated biodiversity research plan.
2. Orient and coordinate higher studies in biology, agriculture and veterinary science towards national biodiversity issues.
3. Provide adequate reference libraries and laboratory facilities.
4. Provide a computer system that includes the Geographic Information access to the Internet and a Home Page on Biodiversity.

<u>Long term plan</u>

1. Control research in the field of biotechnology to serve developmental needs and ensure national biosafety standards.
2. Investigate in depth the genetic biodiversity of plants and animals particularly those that have a potential economic benefit and enter all the above information on digital maps utilizing GIS and GPS technology.

<u>Strategic Goal 12 Controlling the Use of Biotechnology</u>

<u>Short term Plan</u>

1. Take precautionary measures against all genetically engineered organisms and their products to avoid any possible dangers to human and animal health and natural: biodiversity.
2. Encourage the use of native plants and animals, rather than introduced species, in agriculture and food processing industries to avoid introducing organisms of unknown genetic origin to Syria.
3. Appoint an expert committee or national commission with scientific and technical expertise to study and monitor genetically engineered organisms and their products, advise on regulatory requirements, advise whether they can be imported and what threats they pose to humans and animals.
4. Enact appropriate legislation for the import, handling, release and disposal of genetically modified organisms to Syria.

Long term Plan

1. Insist on certificates of origin and description of contents and methods of production prior to granting import permits.
2. Utilize modem techniques and environmental screening procedures for importation of plant and animal species to assist in determining genetic origin of products.
3. Take all necessary precautions against the importation of genetically altered organisms or their products. If they are imported make sure that these organisms and their products have been tested and tried for a sufficient period of time in their country of origin.
4. Request the cooperation of authorities involved in the importation and handling of modified organisms or their products to enhance human, animal and plant safety.
5. Support international protocols on biosafety that would guard against the dangers to human health and natural biodiversity from the dangers of genetically engineered organisms and their products.

Strategic Goal 13 Creating an Organizational Structure to Follow-up The National Biodiversity Strategy and Action Plan

The recommended organizational structure to follow-up on the implementation of the strategy and action plan is made up of four groups with effective communication links:

1. The Government Coordination Centre -is the Ministry of State for the Environment that prepared and presented the National Biodiversity Strategy and Action Plan (NBSAP) to the Government of Syria.
2. The Executive Committee is composed of the National Coordinator for Biodiversity in Syria, the Project Manager of NBSAP, and the Head of Section of the Biodiversity Unit at Ministry of Environment. .
3. Steering Committee -is composed of representatives of different Government Ministries; Community Based Organizations, Academic Institutions involved in biodiversity.
4. Technical Working Groups -composed of experts in the field of biodiversity conservation and sustainable use, who conduct studies, prepare and review reports.

Strategic Goal 14 Enacting Legislation for Biodiversity Conservation

Short and long term Plans:

1. Legislation to manage the growth of the human population
2. Legislation to protect agricultural lands from degradation

3. Legislation to protect water resources from pollution & degradation 4- Legislation to protect forest resources
4. Legislation to manage flor~ and fauna and their habitats 6- Legislation to establish protected areas of all categories 7- Legislation to safeguard intellectual property rights
5. Legislation to safeguard genetic resources of local plants and animals with economic value
6. Legislation to control introduced species of plants and animals:- 10- Legislation to promote use of environmentally clean technology
7. Legislation to safeguard against the hazards of genetic engineering
8. Legislation to require evaluation of the potential income generating capacity of commercially important plants and animals.
9. Legislation to promote cooperation between Ministries, agencies, organizations, and syndicates for the conservation of biodiversity
10. Legislation to amend the curricula of all teaching institutions so that they incorporate the subjects related to biodiversity conservation
11. Legislation to link human and socio-economic development with the conservation of biodiversity

Strategic goal 14 Strengthen International Biodiversity Links

Short and long term plans

1. Review all conventions, treaties, agreements and protocols regarding conservation of biodiversity with Arab, regional and international organizations to ensure compliance and be up to date on recent developments regarding their implementation.
2. Benefit from bilateral and multilateral assistance for the establishment of biodiversity conservation. Especially in projects such as a system of protected areas for all the different regions of Syria.
3. Attend national, Arab, regional and international conferences and meetings to promote the accomplishments of Syria in the field of biodiversity, and to benefit from recent developments in that field.