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<td>AF</td>
<td>Arab Fund</td>
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<tr>
<td>AREA</td>
<td>Agricultural Research and Extension Authority</td>
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<tr>
<td>CSO</td>
<td>Central Statistical Organization of the Ministry of Planning and Development</td>
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<tr>
<td>CTA</td>
<td>Chief Technical Advisor</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EPC</td>
<td>Environmental Protection Council</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>ESCWA</td>
<td>Economic and Social Commission for Western Asia</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GDFDC</td>
<td>General Directorate of Forestry and Desertification Control</td>
</tr>
<tr>
<td>GDI</td>
<td>General Department of Irrigation</td>
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<tr>
<td>GDP</td>
<td>General Domestic Product</td>
</tr>
<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>GNP</td>
<td>Gross National Product</td>
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<td>GOY</td>
<td>Government of Yemen</td>
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<td>GTA</td>
<td>General Tourism Authority</td>
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<tr>
<td>HCDCA</td>
<td>High Council for Desertification Control and Afforestation</td>
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<tr>
<td>HRD</td>
<td>Human Resources Development</td>
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<tr>
<td>HWC</td>
<td>High Water Council</td>
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<tr>
<td>ICARDA</td>
<td>International Center for Agricultural Research in Dry Areas</td>
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<tr>
<td>IDA</td>
<td>International Development Agency</td>
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<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<tr>
<td>IUCN</td>
<td>The World Conservation Union</td>
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<tr>
<td>LWCP</td>
<td>Land and Water Conservation Project</td>
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<tr>
<td>M&amp;E</td>
<td>Monitoring and Evaluation</td>
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<tr>
<td>MAI</td>
<td>Ministry of Agriculture and Irrigation</td>
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<tr>
<td>MLA</td>
<td>Ministry of Local Administration</td>
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<tr>
<td>Mm³</td>
<td>Million Cubic Meters</td>
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<tr>
<td>MOMR</td>
<td>Ministry of Oil and Mineral Resources</td>
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<tr>
<td>MPD</td>
<td>Ministry of Planning and Development</td>
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<tr>
<td>NAPCD</td>
<td>National Action Plan to Combat Desertification</td>
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<tr>
<td>NAPED</td>
<td>National Action Plan for Environment and Development</td>
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<td>NEAP</td>
<td>National Environmental Action Plan</td>
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<td>NGO</td>
<td>Non-Governmental Organization</td>
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<td>NET</td>
<td>The Netherlands</td>
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<td>NWRA</td>
<td>National Water Resources Authority</td>
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<td>PDYR</td>
<td>People's Democratic Republic of Yemen (former Southern Yemen)</td>
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<td>PMU</td>
<td>Programme Management Unit</td>
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<td>PSD</td>
<td>Programme Support Document</td>
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<td>ROY</td>
<td>Republic of Yemen</td>
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<td>SEMP</td>
<td>Sustainable Environmental Management Programme – YEM/97/100</td>
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<td>TCP</td>
<td>Technical Cooperation Programme</td>
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<td>TDA</td>
<td>Tihama Development Authority</td>
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<td>United Nations Convention to Combat Desertification</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNICEF</td>
<td>United Nations Children Fund</td>
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<td>UNSO</td>
<td>United Nations Office to Combat Desertification</td>
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<td>WFP</td>
<td>World Food Programme</td>
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<td>Code</td>
<td>Acronym</td>
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<tr>
<td>WB</td>
<td>The World Bank</td>
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<td>WID</td>
<td>Women In Development</td>
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<td>WTO</td>
<td>World Tourism Organization</td>
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<tr>
<td>YAR</td>
<td>Yemen Arab Republic (former Northern Yemen)</td>
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<tr>
<td>YEPS</td>
<td>Yemen Environmental Protection Society</td>
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<tr>
<td>YR</td>
<td>Yemeni Rial (US$1=YR165 as per exchange rate of November 2000)</td>
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Definition of Terms and Concepts Related to Drought and Desertification

Some definitions of terms given by the UNCCD are faithfully utilized in this report.

“Forest”: Dense canopy with multi-layered structure including large trees in the upper storey;

“Woodland”: Light canopy with single storey of small to medium sized trees with crowns more or less touching and a sparse grass stratum sometimes with herbaceous or shrub vegetation;

“Thicket”: Shrubby vegetation with more or less continuous cover, usually with continuous sparse grass stratum;

“Shrubland”: Shrubby vegetation more open (discontinued) than thicket, usually with continuous sparse grass stratum;

“Parkland”: Agroforestry system where individual, naturally occurring woodland trees are left within cultivated fields, with a canopy cover not exceeding 10% of the total area.

"Desertification": land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities;

"Combating desertification": activities which are part of the integrated development of land in arid, semi-arid and dry sub-humid areas for sustainable development which are aimed at: i) prevention and/or reduction of land degradation; ii) rehabilitation of partly degraded land; iii) reclamation of desertification land;

"Drought": the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resources production systems;

"Mitigating the effects of drought": activities related to the prediction of drought and intended to reduce the vulnerability of society and natural systems to drought as it relates to combating desertification;

"Land": the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system;

"Land degradation": reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: i) soil erosion caused by wind and/or water; ii) deterioration of the physical, chemical and biological or economic properties of soil; and iii) long-term loss of natural vegetation;

"Arid, semi-arid and dry sub-humid areas": areas, other than polar and sub-polar regions, in which the ratio of annual precipitation to potential evapotranspiration falls within the range from 0.05 to 0.65;

"Affected areas": arid, semi-arid, and/or dry sub-humid areas affected or threatened by desertification;
"Carrying Capacity": an ecological concept that refers to the maximum animal and human populations that can be sustainably maintained, given the energy, food, water and other necessary nutrients available or capable of being generated within limits of productive potential of a given land area. However, the concept should not be strictly confined to ecological capacities. It should also integrate the economical capacities (availability of capital, credit, work force, organization and innovation potentials, market etc...) of the region.
The National Action Plan to Combat Desertification (NAPCD) is the main output of Sub-programme 3 (Planning for Desertification Control) of the “Sustainable Environment Management Programme – YEM/97/100”. The programme was funded by UNDP and the GOY and was nationally executed. FAO provided technical assistance for Sub-programme 3.

The NAPCD is divided into eight chapters.

After a brief introduction, Chapter II gives the overall general information on the ROY. It includes brief geographical and environmental characteristics, human factors and socio-economic features of the country as well as the general settings, including administrative, political, legislative, and national development plans and policies.

Chapter III describes the causes of desertification. It focuses on direct and indirect causes of desertification.

In Chapter IV, manifestation of desertification is described. It includes physical and sociological aspects of desertification.

Chapter V gives an analysis and evaluation of the 1992 National Plan of Action to Combat Desertification. It includes a summary of proposed programmes, level of implementation, and the identified drawbacks in the plan.

Chapter VI describes the action taken to combat desertification. The Chapter includes national strategies, policies and legislative measures, international conventions and protocols, and the institutional set-up and measures to combat desertification. At the end, the Chapter gives the gaps in knowledge and know-how relating to desertification control.

In Chapter VII, a national strategic framework to combat desertification is elaborated. It includes institutional set-up framework, participation of civil society in conjunction with poverty alleviation, research and development, as well as monitoring of desertification and land degradation.

Finally, Chapter VIII presents the elements of the NAPCD. The Chapter describes the formulation of long-term regional programme. It also gives the priority programme for the period 2001-2005.
I. INTRODUCTION

Historical evidence indicates that the Yemeni people in the past, have been successful in managing and utilizing, on a sustainable basis, their natural resources and that the country enjoyed for the most, self-sufficiency in basic food items.

The new life style adopted since the mid-twentieth century has gradually disrupted the traditional norms of living, especially in relation to natural resources’ utilization, conservation and management systems. This disruption was exacerbated by uncontrolled and rapid population growth, which resulted in unsustainable pressure being exerted for the last decades on the country’s scarce natural resources.

Such changes were not accompanied by new approaches and modalities that could rationally accommodate the desertification process. Statistics show a steady growing deficit in food self-sufficiency, a reduction in wood and fuel-wood availability, and a dramatic decline and degradation in water, woodlands and, rangelands resources.

Several studies indicate that most of Yemen’s agricultural lands are subject to various degrees of degradation and that soil productivity is on the decline. Desertification threatens seriously the natural resource-base. This deterioration represents a major constraint to achieving integrated rural development. It is a challenge that the GOY is willing to face in order to achieve the objectives of the Social and Economic Development Plan. This is clearly illustrated by the following quotation from Yemen’s National Report to the “Earth Summit” in Rio de Janeiro, 1992: “Environmental problems and challenges have had a negative impact on the country’s development trends. However, the desire to deal with these problems comes at a critical turning point in the future of the Yemeni people”.

As many governments caught in the straightjacket of providing food for an exponentially increasing population, the ROY has had difficulties in promoting sustainable production systems. As a result the country has been confronted with accelerated exploitation of its natural resources capital as part of a survival strategy adopted by the rural world. However, faced as it is with the overall task of achieving national development, the ROY is devoted to adopt and promote environmentally sound and sustainable agricultural production systems, by developing and endorsing appropriate strategies and policies to improve living standards and protect the environment. In rural areas of Yemen, desertification is closely linked to poverty. It is also strongly correlated to the recent agricultural development, which has been initiated some 34 decades ago. Modern farming technology is quasi confined to the cultivation of qat, while agricultural production activities have not adopted effective resource-conserving farming practices. Such limitations are exacerbated by factors such as population pressure, loss of valuable riverbank land and lack of secure tenure for land and water use. Development has so far only concerned regions with generous endowments. People and communities in regions of lesser attributes live below the minimum acceptable for subsistence. They are mining soils, woodlands, rangelands, and other resources at rates that exceed sustainable limits for recovery or renewal. This has taken its a costly toll on the environment. However, attitudes are changing as more concern is shown for sustainable resource-use.
As was pointed out by Lester Brown (1991), "national accounting systems ignore the environmental
breakthroughs, and development achievements have taken place. The views on drought and desertification and the mode to control their effects, have drastically evolved. A number of planning frameworks related to rural development and natural resources' conservation were developed. The United Nations' Conference on Environment and Development (UNCED) has created many tools for the management, conservation, and sustainable development of natural resources. Among these instruments, chapters 11 (Combating Deforestation), chapter 13 (Sustainable Mountain Development) and chapter 12 (Combating Desertification) are all related to the topic of desertification and are all of concern to the highest degree to the country of Yemen. The last instrument developed is the United Nations Convention to Combat Desertification (UNCCD) to which the ROY has adhered. The UNCCD Parties are determined to implement the convention’s main objectives of combating desertification and mitigating the effects of drought, in order to achieve sustainable development.

Following the Government's request to UNDP for its support to the implementation of the National Environmental Action Plan (NEAP), the Programme Support Document (PSD) on Sustainable Environmental Management (SEM)-YEM/97/100 has been approved on 16th of March 1997. It focuses on priority actions within Land Resources, Habitat, and Biodiversity. The SEM is composed of seven Sub-Programmes, among which, Sub-Programme 3: "Planning for Desertification Control", which is directed by the General Directorate of Forestry and Desertification Control (GDFDC) of the Ministry of Agriculture and Irrigation with the technical assistance of the Food and Agriculture Organization (FAO). This Sub-Programme stems from the National Conference for Combating Desertification, which was held in November 1996 and sponsored through on-going projects of the World Bank, FAO, the Netherlands, as well as the UNCCD.

As recommended by the above-mentioned National Conference, the ROY ratified the United Nations Convention to Combat Desertification (UNCCD) on December 31, 1996. In addition, a National Workshop meant to review the 1992 National Action Plan to Combat Desertification and Land Resources Degradation was held in May–June 1999 in Sana’a. The National workshop was organized by YEM/97/100 (Sub-programmes 2, 3 and 4) and GCP/YEM/026/NET project. Its main objectives were to: i) assess the 1990 NAPCD; ii) evaluate the implementation level of the recommendations of the National Conference for Combating Desertification; and iii) prepare strategic guidelines to review and update the present NAPCD.

Following the National Workshop’s recommendations, community consultations were conducted in the affected areas and regional workshops were subsequently held in Seiyoun, Hodeidah, Aden and Dhamar, which represent the successive regions following order: Eastern Plateaus and Desert Region, Red Sea Coastal Region, Gulf of Aden Coastal Region, and Mountainous Region.

The preparation of the present NAPCD is based on the guidelines of UNCCD, consultancy and study reports carried out under YEM/97/100, as well as the recommendations formulated during the above-mentioned workshop (Appendix V).

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II. GENERAL BACKGROUND

2.1. Geographical and Environmental Characteristics

2.1.1. Brief geographical and historical description of Yemen

The Republic of Yemen (ROY), which covers a total area of 555,000 km² (excluding the Rub’a Al-Khali and the Islands), is located at the Southwestern edge of the Arabian Peninsula between 12° and 20° north of the Equator and between 41° and 54° east of Greenwich. The ROY includes more than 120 islands, the largest of which are Socotra in the Arabian Sea and Kamaran in the Red Sea. The country is bordered by Saudi Arabia to the north, Oman to the east, the Arabian Sea and the Gulf of Aden to the south, and the Red Sea to the west. Apart from the broad and flat coastal plains which border the Red Sea (Tihama) and the Gulf of Aden, the rest of the country reveals a very dissected and pronounced topography to the west and south and a more gentle, less pronounced topographic expression to the east of the country.

For millennia, the peoples of the present ROY were able to live with their environment in a sustained fashion. Historical sources bring evidence that Yemenis succeeded for centuries in optimizing the utilization of the highlands by constructing terraces to expand cultivable areas and reduce soil erosion, and by relying on intricate water harvesting systems, which conserved the generally scarce, and fluctuating water resource base. Throughout the area, functional systems for communal forest and pasture use were successfully developed. In recent decades however, the rapid population growth and the rapid modernization of the country lead to social and economic changes, which have made the task of managing the natural resource base increasingly complex and unsustainable.

2.1.2. Geology

Yemen geology is composed of quarterly deposits, volcanic rocks and basalt, as well as tertiary Jurassic and Cretaceous formations. Quarterly deposits are distributed over most of the country, especially in the coastal plains, the eastern plateaus, the Rub’a Al-Khali and Ramlat Sabatayn deserts and in Hadramout. This class covers over 30% of the republic. Volcanic rocks are found in most of the central and southern highlands, whereas basalt, which is found in central and southern parts, of the country does not cover more than 10% of the country's area. The cretaceous formation, which is composed of white calcic rocks, limestone and sandstone is principally, found in At-Tawila unit. The Jurassic formation is found mainly in Amran and Kuhlan units.

2.1.3. Physiography and soils

The territory of the ROY may be divided into four main physiographic regions as follows:

?? The coastal plains with a hot and humid climate and low to very low rainfall, 30-60 km wide along the Red sea and the Gulf of Aden. They contain numerous intermittent wadis enabling spate irrigation and important agricultural zones. They are subdivided in i) Tihama, ii) the Tuban-Abyan plains, and iii) the Ahwar-Meifā‘ah plains;

?? The Yemen Mountains with very irregular and dissected topography and elevations ranging from a few hundred meters, to 3,760 m. It is a volcanic region running parallel to the Red Sea coast and which comprises the Western, the Southern and the Eastern Slopes as well as the Highland Plains zone. The steep Western and Southern Slopes with rainfall ranging from 300-1 000 mm support high population densities practicing rain-fed agriculture on terraces, while the Eastern Slopes with smoother topography and low average rainfall decreasing eastward, are sparsely populated;

?? The Eastern Plateaus and Desert Region. The Eastern Plateaus are dissected in particular by, Wadi Hadramout and its tributaries. Their climate is generally hot and dry; with annual rainfall mostly inferior to 100 mm. Floods may be devastating. The population density is low, mostly
concentrated in pump irrigated agricultural lands of the Wadi Hadramout gorges. This region is subdivided into i) the Northern and ii) the Southern Plateau zones, iii) Wadi Hadramout and iv) the Al-Ghaydah basin. The Deserts located between the Highlands and the Eastern Plateaus, are the Ramlat As Sabatayn to the south, where rainfall and vegetation are nearly absent, and the Rub’a Al Khali to the north, which is among the most desolate deserts in the world; ?? The Islands (more than 120 islands), including Socotra with its unique biodiversity of exuberant fauna and flora in the Arabian Sea.

The principal soil types encountered in the various physiographic regions are as follows:

?? The coastal plains soils are either alluvial fans or coarse inter-wadi soils. In wadis and floodplains the soils are loamy to silt and clay and form good agricultural land. The inter-wadi areas are dominated by dune formations and coarse skeletal sandy soils subject to wind erosion. The coastal fringes of the plains consist of extremely saline tidal flats or sabkhas with a high water table;

?? The soils of the Western Slopes range from bare rock and very shallow soils near the mountain peaks, stony and very stony calcareous soils with PH around eight and low organic matter in the middle slopes. The lower slopes have generally deep silty and loamy soils. This region has relatively extensive alluvial loams and silt loams which make good agricultural lands. Around Ibb, thick loess deposits occur which have developed deep silty soils. The Southern parts of the Midlands are occupied by, rock outcrops with pockets of shallow soil;

?? The Highands have large stretches of plains between the mountains, which constitute extensive loamy, silty, and fine silty soils on level surfaces, one third of which bear organic matter within the surface layer. Associated with these soils are a minor component of clayey soils, which also have a dark layer rich in humus. These constitute very productive agricultural lands. On the lower slopes of the Highlands, silt loams and silty clay loams prevail, while the flat basins comprise silty and loamy soils;

?? The Eastern Slopes region comprises mainly rock outcrops, with some shallow soils confined to pockets. Deep loamy soils are only encountered within local depressions and wadis; and

?? In the Eastern Plains, the wadis adjoining flood plains have deep alluvial soils, which are medium textured, while the restricted areas where flooding takes place regularly, have stratified sandy loams and silt loams.

2.1.4. Climate

The climate is subject to two influential factors, the inter-tropical convergence zone (ITCZ) and the extensive highlands that cover most of the country. The ITCZ affects the amount and distribution of moisture from south to north, while the Highlands influence the amount and vertical distribution of moisture. Variants of sub-humid, semi-arid, arid, and hyper-arid tropical climates are encountered in Yemen. The prevailing winds are the South Western warm and humid winds, which persist in summer. They are the main rain-producing winds over the country. Of secondary effect on rainfall, are the North Eastern and northern, relatively dry and cold winter winds. In general, Yemen climate extends from the hyper-arid to sub-humid climate (very limited areas especially in Ibb and Hajjah governorates). It is estimated that 90% of the country has an arid to hyper-arid climate.

?? Precipitations in the Highlands are important, and distributed in two rainfall seasons, namely March/April and June/September. The western part of the Highlands, which generally exceeds 2000 m in altitude, has monthly mean temperatures situated between 10-18$^\circ$C and an average annual rainfall ranging from 400-600 mm. The rainfall decreases to the north, where frost is not uncommon. The central and eastern parts of the highlands have higher mean annual temperatures with considerable differences between day and night temperature. Frosts are only occasional;

?? Rainfall in the Western slopes ranges between 300-600 mm with mean monthly temperatures varying from 22-26$^\circ$C along the lower slopes and 16-24$^\circ$C at Higher slopes;

?? The Midlands (500-2000 m altitude), which drain into the Indian Ocean display an average annual rainfall ranging between 450 and 800 mm, with, mean monthly temperatures fluctuating from 18-25$^\circ$C;
The Eastern Slopes (1200-1800 m altitude) have average annual rainfalls ranging from 400 mm (in the west) to 100 mm (in the east). Mean monthly temperatures, which increase eastward, vary from 22-28° C.

Adjacent to the Eastern Slopes, the Eastern Plains constitute a dry region with mean annual rainfall of less than 200 mm and mean monthly temperature ranging from 22-28° C.

The hot and arid climate prevailing in the coastal plains is characterized by low mean annual rainfall of less than 200 mm with erratic and often localized precipitations falling either in summer (monsoon influence) or in winter (Mediterranean regime). The average annual relative humidity is very high (70%) reaching often 90% at night. Dew is common. The mean annual temperature is very high, reaching 30° C, with narrow seasonal fluctuations. Winds may blow at high velocities, causing sand movement and deflation.

Regarding evaporation\(^2\), “it is high and may reach up to 3 meters/year. It is distributed according to regions as follows:

\[
\begin{align*}
\text{Coastal Regions:} & & 1800-2700 \text{ mm/year} \\
\text{Western Mountainous Regions} & & 1500-2500 \text{ mm/year} \\
\text{Eastern Plateaus and Desert:} & & \text{up to} \ 3500 \text{ mm/year.}
\end{align*}
\]

### 2.1.5. Biological and land resources

**Flora and fauna:** It is generally admitted that Yemen was gratified with extensive vegetative cover in the past. At present, a great deal of this has been converted to cultivated land, bare lands, and open shrub land. Despite this degradation, Yemen comprises a quite diversified natural flora composed of some 3000 species ranging from common forbs to endemic species and from annuals to shrubs and trees. According to Al-Khulaidi (1995), 20% of the species are endemic. Socotra Island considered as the richest area, contains more than 680 species. Of these, 215 are endemic while 8 are endangered\(^3\). The regression of vegetation cover has resulted in a sizeable reduction of animal wildlife habitat. The fauna has furthermore been put under severe competition due to steadily increasing domestic livestock herds.

**Protected areas:** “Yemen, located at the intersection of the African, Asian and Palaearctic ecological zones … is endowed with a rich variety of habitat, species and genetic diversity…However, human settlement, transformation of the landscape and over-exploitation of biological resources has resulted in major reductions in plant and animal species and deterioration of their habitats”\(^4\)

The government of the ROY is undertaking efforts to establish a carefully selected network of protected areas. It is also attempting to support and engage local communities in the sustainable management of these areas. High priority sites have been identified in order to, be declared as protected areas. These areas include Socotra Island, Jabal Bura’a, Hugaira Qubayta, Jabal Iraf, Al-Mahara (Hawf area), Mounabih area, Tihama mangroves... During August 1999, the mountainous area of Ottma (Dhamar region) was declared by government decree as national protected area\(^5\). The government is presently seeking support from donor communities for the implementation of these activities.

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\(^3\) Registered in the red book/catalogue of the IUCN.


Woodland: The most recent assessment of woodland resources of Yemen has been completed in 1993\(^6\). The data have been captured in digital form, for possible inclusion in a future GIS, which would form the basis for any future monitoring of changes in woodland distribution. The total woodland area has been estimated at 2.4 million hectares, i.e. approximately 5% of the total surface area. Of this, some 0.4 million hectares are made up of agro-forestry and date palm formations.

In the escarpment and western mountain region, which host more than 75% of the total national woodland resource, traditional agricultural practices include significant areas of productive and well-managed multipurpose tree formations. In the central highland the woodland resources represent about 17%, in the coastal plains 7% and less than 0.7% in Al-Mahara.

The combined *Acacia-Commiphora* woodland and shrub-land class amounts to about 59% of the total woodland resource area. The woodland resources are mainly characterized by a very low crown density. Areas of crown density greater than 50% are very small; and pure woodlands are very rare as well (M. Houmymid, 1996).

**Agricultural land.** According to the MAI statistics (May, 2000)\(^7\), the total agriculture area was estimated at 1,668,858 ha, of which, 1,132,910 ha (68%) were cultivated during 1999 while the uncultivated area was 535,948 ha (32%). Out of the total cultivated area, 528,643 ha (47%) were rain-fed, 434,207 (38%) were well irrigated, 40,801 ha (4%) were spring irrigated, and 129,259 ha (11%) were flood irrigated. The arable land is divided in 1,115,515 holdings, of which an estimated 69% are small farms (<2 ha), 29% are medium size holdings (2-5 ha), and about 2% are large holdings (>5 ha).

Table 1 below gives detailed information regarding the distribution of agriculture land, type of irrigation used, and the number of holdings by governorate for year 1999.

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Total Holdings</th>
<th>Total Area</th>
<th>Cultivated Area</th>
<th>Irrigation Type</th>
<th>Uncultivated Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rain Wells Springs Floods</td>
<td></td>
</tr>
<tr>
<td>Hodeidah</td>
<td>113050</td>
<td>336613</td>
<td>302812</td>
<td>148673</td>
<td>118981</td>
</tr>
<tr>
<td>Sana’a</td>
<td>168707</td>
<td>380726</td>
<td>214062</td>
<td>138578</td>
<td>68219</td>
</tr>
<tr>
<td>Dhamar</td>
<td>111540</td>
<td>138220</td>
<td>87076</td>
<td>52489</td>
<td>31313</td>
</tr>
<tr>
<td>Ibb</td>
<td>159656</td>
<td>101521</td>
<td>80249</td>
<td>51594</td>
<td>23086</td>
</tr>
<tr>
<td>Taiz</td>
<td>157556</td>
<td>123432</td>
<td>62960</td>
<td>39220</td>
<td>15940</td>
</tr>
<tr>
<td>Marib</td>
<td>14488</td>
<td>91190</td>
<td>89615</td>
<td>10754</td>
<td>49704</td>
</tr>
<tr>
<td>Hajjah</td>
<td>86918</td>
<td>124594</td>
<td>57113</td>
<td>29128</td>
<td>23845</td>
</tr>
<tr>
<td>Al-Beida</td>
<td>37462</td>
<td>75895</td>
<td>27152</td>
<td>12748</td>
<td>13193</td>
</tr>
<tr>
<td>Sadah</td>
<td>41276</td>
<td>61030</td>
<td>53227</td>
<td>27146</td>
<td>15968</td>
</tr>
<tr>
<td>Al-Mahweet</td>
<td>38227</td>
<td>29168</td>
<td>26610</td>
<td>17588</td>
<td>6490</td>
</tr>
<tr>
<td>Lahj</td>
<td>54393</td>
<td>32017</td>
<td>19898</td>
<td>0</td>
<td>7587</td>
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<tr>
<td>Abyan</td>
<td>40304</td>
<td>38474</td>
<td>29288</td>
<td>0</td>
<td>10251</td>
</tr>
<tr>
<td>Hadramout</td>
<td>45638</td>
<td>39785</td>
<td>21473</td>
<td>0</td>
<td>13743</td>
</tr>
<tr>
<td>Al-Jawf</td>
<td>10564</td>
<td>69594</td>
<td>48320</td>
<td>725</td>
<td>26576</td>
</tr>
<tr>
<td>Shabwa</td>
<td>25843</td>
<td>21215</td>
<td>9001</td>
<td>0</td>
<td>5312</td>
</tr>
<tr>
<td>Al-Mahara</td>
<td>5466</td>
<td>1449</td>
<td>984</td>
<td>0</td>
<td>929</td>
</tr>
<tr>
<td>Aden</td>
<td>4427</td>
<td>3935</td>
<td>3070</td>
<td>0</td>
<td>3070</td>
</tr>
<tr>
<td>Total</td>
<td>1115515</td>
<td>1668858</td>
<td>1132910</td>
<td>528643</td>
<td>434207</td>
</tr>
<tr>
<td>% of Total</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>% of Cultivated</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td>47</td>
</tr>
</tbody>
</table>


---

\(^6\) By the Hunting Technical Company, on behalf of the Land and Water Conservation Project (LWCP).

Rangeland: “Rangelands cover 40% of the total land area of Yemen, i.e. 22.6 million hectares. This vegetation cover is made up of natural grasslands, forests and woodlands, and agro-forestry tree and shrub formations. It comprises a wide spectrum of woody species, grasses and forbs and includes, a number of succulent plants belonging to the *Euphorbia* and cactus-like species.

“Rangelands form an important resource in view of their environmental role, provision of forage for herds and flocks and due to its economic significance as a cheap source of livestock feed. Rangelands are quite variable in their condition judged from plant cover, species composition, and degree of use. They are adversely affected by over-use by grazing animals, uprooting of large quantities of plants for fuel, encroachment of urban and industrial development and lowering of groundwater table due to over-pumping in wadi-bottoms and lower deltas of coastal plains. The consequence of this is reduction in rangelands area, declined forage production and undesirable shift in species’ composition (decline in species’ diversity).”

Though they contribute significantly to livestock production and have an important bearing on rural economy, no regular and exhaustive monitoring of rangelands has been carried out to generate reliable data and to determine condition and trend, and to guide management plans. Forest, range and watershed development strategies need to consider the necessity to protect these major grazing/browsing sources and sustain their utilization through management.

The Yemeni coastline: Yemen has the most extensive and diverse coastal zone of the Arabian Peninsula (over 2,000 km). Inshore coastal areas are used primarily for agricultural purposes and increasingly for urban development. Wadi inflows to the sea are rare occurrences; consequently, estuarine ecosystems are rare. Some small areas of mangroves do occur in the inter-tidal zone. The critical coastal zone environmental issues include: a) over-exploitation/wastage of fishery resources; b) destruction of major marine habitats; c) saltwater intrusion into coastal-zone shallow aquifers, in areas of excessive groundwater abstraction; d) coastal rangelands degradation leading to sand movement; e) coastal dunes degradation resulting in inland movement of sands regularly deposited by sea currents; f) coastal erosion resulting in sea penetration inland and in destruction of palm plantations.

### 2.1.6. Water resources

**Surface water systems and drainage – Hydrographic network:** Wadis, which are the most important source of surface water in Yemen, flow in three main directions and are serviced by three major watershed divides whose catchments areas lie in the mountainous part of the country. They are:

- The Western catchment (36,900 km²) draining to the Red Sea. It composed of nine sub-catchments, all endowed with comparatively high rainfall and of the steepest terrain slopes of the country. Both elements favor high floods peaks. Surface outflow to the Red Sea is only occasional, as the water from the wadis continues moving towards the sea, but underground;
- The Southern catchment draining to the Gulf of Aden (11,200 km²) comprises the Wadi Tuban (5,000 km²) and Wadi Abyan (6,200 km²) sub-catchments. There is a great deal of similarity with the Red Sea basin, but an important difference is that surface water outflow into the Gulf of Aden occurs more frequently, because the plains along the gulf are steeper than along the Red Sea;
- The Eastern Catchments (53,100 km²) draining into the interior deserts. They are composed of five sub-catchments, of which the Rub’a Al-Khali basin is the driest.

---

10 Sea-grass, corals, mangroves etc.
11 Overgrazing, cutting and urban development.
12 In some areas of Southern Tihama.
Surface water flows throughout Yemen are limited to periodic flood overflows\textsuperscript{13} associated with occasional intense or extended rainfall, and to residual flows from seepage and/or springs. The surface waters are used primarily for spate irrigation and natural recharge of aquifers.

**Occurrence and characteristics of groundwater:** Groundwater systems are in a dynamic state, as a result of replenishment and discharge processes. Direct recharge of groundwater is generally very low in Yemen; it occurs mainly by infiltration of surface water from wadis. Groundwater discharge through abstraction has gained enormously in importance over the last three decades.

Estimates of groundwater storage and of current rates of abstraction and recharge for the major aquifer complexes are listed in Table 2.

**Table 2: Current abstraction/recharge rates and groundwater storage for the main aquifer complexes in Yemen**

<table>
<thead>
<tr>
<th>Aquifer complex</th>
<th>Approx. annual abstract (Mm(^3))</th>
<th>Approx. average annual recharge (Mm(^3))</th>
<th>Fresh groundwater stored (mm(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tihama quaternary aquifer</td>
<td>810</td>
<td>550</td>
<td>250,000</td>
</tr>
<tr>
<td>Southern coastal plains</td>
<td>225</td>
<td>375</td>
<td>70,000</td>
</tr>
<tr>
<td>Extended Mukalla complex</td>
<td>575</td>
<td>500</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Highland plains</td>
<td>500</td>
<td>100</td>
<td>50,000</td>
</tr>
<tr>
<td>Total</td>
<td>2,110</td>
<td>1,525</td>
<td>10,370,000</td>
</tr>
</tbody>
</table>


It is clear that, at national scale, groundwater abstraction is by far exceeding the groundwater recharge. However, for individual major aquifers, the situation is much worse. The most endangered aquifer systems in this respect are those of the Highland Plains whose volume of groundwater stored is limited and where abstractions amount to five times the recharge rates. The rates of decline of groundwater levels are alarmingly high in many zones, especially in the Highlands where declining trends between two and six m/year are commonly observed (Table 2). Agricultural water use in 1990, accounted for 93\% of total water use in the Republic of Yemen.

According to the Environmental Impact Assessment for Water Resources planning Sector\textsuperscript{14}, “in excess of 2,000 Mm\(^3\) are withdrawn from Yemen's northern, eastern and western basin aquifers annually.... The estimable depletion rate of 860 Mm\(^3\)/year in excess of annual recharge potential represents some 5\% of the usable storage of these aquifers...”. This depletion rate will increase drastically, when one considers the estimated water requirements for the year 2010 (Table 3).

### 2.2 Human Factor and Socio-economic Characteristics

#### 2.2.1. Population and demography

Population parameters: The ROY has an estimated population of 17.07 million (Table 4.) growing at an annual rate of 3.7\% (1998 statistics, NIC). Projection made the CSO showed that the total population reached 17.676 millions in 1999\textsuperscript{15} (Appendix IX). The Yemeni population, which is very young (about

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\textsuperscript{13} Intercepted for agricultural purposes.

\textsuperscript{14} Volume VIII published in 1992.

\textsuperscript{15} Statistical Year-Book 1999. CSO-MPD, June 2000
47% under age 15), has more than doubled in the last 20 years. Maintaining the present growth rate, the total population will double again in less than 20 years. The average annual population growth rate for urban areas was equivalent to 7.03% as compared to 3.74% in rural areas, during the period 1986/88-1994. This is an indication of the importance of rural-urban migration. Yemen’s Total Fertility Rate (TFR) of 7.4 births/woman is the highest in the Middle East-North Africa Region, while the female primary-school enrolment rate (37%) and life expectancy at birth (57 years) are the lowest.

Table 3: Total Water Use (1990) and Future Water Requirements (2010), in Mm$^3$/year

<table>
<thead>
<tr>
<th>Type of use</th>
<th>Northern Governorates</th>
<th>Southern Governorates</th>
<th>Total country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>1577</td>
<td>1991</td>
<td>1123</td>
</tr>
<tr>
<td>Manufacturing and</td>
<td>14</td>
<td>44</td>
<td>17</td>
</tr>
<tr>
<td>Mining</td>
<td>119</td>
<td>426</td>
<td>49</td>
</tr>
<tr>
<td>Municipal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1710</td>
<td>2461</td>
<td>1189</td>
</tr>
</tbody>
</table>


Yemen's density of population, which was estimated at 21 persons/km$^2$ in 1990, has reached 27 persons/km$^2$ in 1994. Three governorates (Ibb, Ta'izz, Al-Mahweet) display population densities in excess of 100 persons/km$^2$. Four governorates, which cover only 12% of the country's surface area, form 50% of the total national population. Their respective percentage of national population is as follows: i) Ta'izz: 14%; ii) Ibb: 12.4%; iii) Sana'a: 12%, and iv) Hodeidah: 11% (Source: National Census 1994).

The bulk of Yemeni society consists of tribe members. The tribal configuration of the Yemeni society has large implications for development policies and approaches especially when considering the strong influence of customary regulations on attitudes and behaviors. In the rural areas of Yemen, there is a long-standing cooperative ethic since Islamic and tribal customary laws emphasize cooperation according to consensus. In this general social context in which tribalism is a dimension of decentralization, a number of developmental and social issues will need to be addressed through decentralized community-based approaches, which attempt to set up grass-roots institutions and to define decision-making mechanisms at local level.

Spatial and temporal mobility of populations: The present population distribution is a reflection of internal rural-urban and urban-urban migration trends. It also results from external migration, mainly to the Gulf countries. There is at present a net annual transfer of some 40,000 persons from rural to urban areas. Emigration patterns are in fact very complex in Yemen and even when away, Rural Yemenis never lose contact with their keens and their land. The governorates with the highest rates of out migration have all a strong agricultural vocation and are facing intense pressures due to high propriety fragmentation and fast population growth.

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17 Source: Environmental Situation in Yemen. EPC, 1995.
### Table 4. Evolution of Population Distribution by Governorate (x1000)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sana’a Secretariat</td>
<td>972</td>
<td>1045</td>
<td>1120</td>
<td>1200</td>
<td>1284</td>
</tr>
<tr>
<td>Sana’a</td>
<td>1886</td>
<td>1924</td>
<td>1983</td>
<td>2043</td>
<td>2105</td>
</tr>
<tr>
<td>Aden</td>
<td>450</td>
<td>466</td>
<td>479</td>
<td>493</td>
<td>509</td>
</tr>
<tr>
<td>Taiz</td>
<td>2065</td>
<td>2105</td>
<td>2158</td>
<td>2214</td>
<td>2269</td>
</tr>
<tr>
<td>Hodeidah</td>
<td>1587</td>
<td>1704</td>
<td>1773</td>
<td>1843</td>
<td>1917</td>
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<tr>
<td>Lahj</td>
<td>600</td>
<td>606</td>
<td>617</td>
<td>630</td>
<td>642</td>
</tr>
<tr>
<td>Ibb</td>
<td>1805</td>
<td>1838</td>
<td>1883</td>
<td>1927</td>
<td>1974</td>
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<tr>
<td>Abyan</td>
<td>386</td>
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<td>411</td>
<td>422</td>
<td>435</td>
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<td>Dhamar</td>
<td>1000</td>
<td>1013</td>
<td>1036</td>
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<tr>
<td>Shabwa</td>
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<tr>
<td>Hajjah</td>
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<tr>
<td>Al-Beida</td>
<td>470</td>
<td>490</td>
<td>509</td>
<td>529</td>
<td>550</td>
</tr>
<tr>
<td>Hadramout</td>
<td>731</td>
<td>736</td>
<td>753</td>
<td>772</td>
<td>791</td>
</tr>
<tr>
<td>Sadah</td>
<td>490</td>
<td>507</td>
<td>523</td>
<td>541</td>
<td>557</td>
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<tr>
<td>Al-Mahwit</td>
<td>379</td>
<td>387</td>
<td>396</td>
<td>407</td>
<td>417</td>
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<tr>
<td>Al-Mahara</td>
<td>58</td>
<td>58</td>
<td>59</td>
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<td>61</td>
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<tr>
<td>Marib</td>
<td>186</td>
<td>194</td>
<td>205</td>
<td>216</td>
<td>229</td>
</tr>
<tr>
<td>Al-Jawf</td>
<td>172</td>
<td>184</td>
<td>204</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>14859</td>
<td>15369</td>
<td>15915</td>
<td>16482</td>
<td>17071</td>
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</table>

(*) Newly created governorates are not identified in this table.

The gender issue: Generally speaking, women care for small livestock herds and contribute to farm labor. In addition, they are in charge of household activities (cooking, fetching water, collecting fuel-wood, washing, child rearing etc.) In general, women are not recognized as farmers (except when left alone to manage the farm) and they do not have access to resources, inputs, and services (such as training, needed to strengthen their skills and increase their efficiency). Even though their share of work in the household and on farm is by far the most important, women are not decision makers and are not fully involved in development programmes, mainly in rural areas. However, during the last decade, the role of women, as an economically productive and effective force, has been increasingly recognized. Several women NGOs, associations, etc were established at national and regional level as well. As an example, a Women National Committee (WNC) has been funded in 1996 and approved by the Council of Ministers on 1997. The WNC is considered as a government consultative technical committee. It has 19 branches throughout the country with its Head Office in Sana’a. The WNC is concerned with women’s programmes and activities in various areas. It is also in charge of coordinating different efforts with local and international governmental and non-governmental bodies as well as national and international organizations dealing with women’s issues and activities, including environment issues (Appendix VIII).

Employment: Unemployment and over-employment were already chronic and worsening before unification. Since then, the situation has further aggravated as a direct consequence of: i) the 1990 Gulf War’s influx of some 750 000 returnee expatriate workers from Saudi Arabia and the Gulf countries; ii) the influx of some 700 000 Somali refugees in the early 1990's in the wake of the civil strife in the Horn of Africa; iii) the series of natural catastrophes which struck Yemen [earthquakes in Ibb and Saada during 1992 and floods in the South Eastern provinces (1992, 1993) and in much of the country in 1996]; iv) the 1994 internal military conflict and consequent damage to the national economy and infrastructures; v) the effects of the programme of major structural adjustment of the economy etc.
2.2.2. Economic features

Main production systems: There are four types of farming systems, based on various tenure and revenue sharing practices. These are: i) family farming; ii) limited partnerships, with instances of landowners who do not reside in the area (absentee partnership); iii) land-lease, where individuals or families lease land from others for farming; and, iv) farming cooperatives. Farming practices in Yemen are traditional, especially in the highlands, and farmers are only beginning to introduce new technology and diversify farming production systems to include higher proportions of fruits and vegetables, which provide better economic returns than traditional crops (Source: NAPED, FAO-Rome, March 1995)

The following agricultural production systems can be distinguished:

- **Wadi irrigated agriculture:** It takes place on a quite large scale by diverting floodwater and fertile sediments onto the fields.
- **Deep groundwater irrigated cultivation:** This system has been developed in the sixties and the seventies by transforming formerly marginal lands, rangelands, and woodlands into important cash crop producing areas.
- **Shallow groundwater irrigated cultivation:** This is a traditional type of irrigation centered on date production near the coast.
- **Rain-fed cultivation:** It takes place opportunistically by substitution of rangelands mainly, to subsistence rain-fed cultivation on sandy plains and dunes of the coastal plains.
- **Terrace cultivation:** Yemen has been characterized by its terrace cultivation system for many centuries. It is carried out in the rainy mountainous zones and represents an advanced farming system of water harvesting and soil and water conservation. Terrace cultivation has been negatively affected during the last decades, following social and economical changes. A shortage in labor has resulted in reduced maintenance and eventually terraces' abandonment, while the need to improve household incomes has pushed many to adopt cash crop cultivation (mainly qat) and introduce mechanization. Terrace cultivation is often associated with agro-forestry systems and multipurpose tree planting.

Role of the agricultural sector in national economy: While the agricultural share of the GDP was superior to 75% in 1975/76, it has declined to a mere 20% of GDP in 1991, and to about 17% in 1999. This could be a result from declining remittances and agricultural investment, shortage of and high cost of labor, steady degradation of agricultural lands and lack of competitiveness of local agricultural products with imported ones. The value of agricultural crops represents by far, the most important share in the GDP (YR 176,706 million), followed by livestock production (YR 37,396 million). Even though the livestock population is excessive in relation to the carrying capacity of the national rangelands, it does not meet the country's needs in terms of meat and milk production. Fisheries come third in importance (YR 19,333 million) within the agricultural sector.

Role of forestry in the agricultural economy and in combating desertification: The relatively small area of natural woodlands and forests relegates the importance of the forestry sector to securing the well being of the rural inhabitants by providing the essential products that are firewood, timber, fodder, fruits etc. Indeed, forestry's place in the economy (in monetary terms) is rather modest as it occupies a humble fourth place (US$ 55.7 million) within the agricultural sector, mainly because forest products being collected free of charge from natural stands, are considered without initial financial value. Furthermore, forestry’s numerous services are neither assessed nor quantified in economic or social terms.

In addition, the forest and tree resources of Yemen are rich sources of non-wood products, such as honey, tannins, gums, fruits and various medicinal plants and products. These are important for household consumption, and some of them make a major contribution to the rural economy.

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18 According to annual rainfall levels.
19 According to the Statistical Year-Book 1999. CSO, MPD. June 2000
Concerning forest products demand, and as the country suffers from a significant shortage of forest products, these must be imported to meet domestic needs. Import of industrial wood, cork, pulp, paper, and paperboard is increasing continuously owing to the growing population, urbanization process, and economic development during the last decades. The value of forest products imported into the country rose from about YR 550 million in 1985 to more than one billion YR in 1997. Imports of forest products will certainly continue to increase in the future.

### 2.2.3. Consumption trends

Food self-sufficiency ratio in Yemen has been on the decline since 1970 from about 75% in that year, to less than 30% currently. The major changes in food consumption patterns have resulted in increased dependency on imported food products.

**Food consumption patterns and trends**: Food consumption patterns have experienced drastic changes in less than 3 decades (1961/63-1988/90). Rural households have reduced their reliance on subsistence products and adopted new consumption patterns, which include among others, rice, sugar, wheat, vegetable oils etc. Wheat, the most popular cereal is largely imported and was heavily subsidized. Wheat subsidy in 1995 amounted to YR 10 billion and it was expected to raise to YR 34 billion (5% of GDP) in 1996. Wheat consumption has increased 8 folds. Rice follows in order of importance as its availability mainly through imports has increased by 5 folds. The per-capita availability of sugar also largely imported, increased by more than 50%. The per-capita vegetable oil supply increased by almost 600%. The per-capita poultry consumption increased from 0.4 kg/head/year to 6.6 kg/head/year.

To supply these products, farmers have introduced within their limited and often marginal holdings, unsustainable cash crop production systems (cotton tobacco etc) at the expense of the previous sustainable subsistence production systems, in order to dispose of the necessary cash money.

**Energy consumption patterns**: A World Bank mission estimated in 1983 that the total fuel-wood consumption in YAR was 5 million m$^3$ (3 million tons) in 1982; it projected that fuel-wood consumption would reach 8.5 million m$^3$ by the year 2,000, at which time; it was believed that fuel-wood supplies would have disappeared. Numerous other variable estimates have been proposed which indicated the negative impact of fuel-wood collection on the woody biomass and predicted also that by the year 2,000, the total available woody biomass would be exhausted (A.C. Millington for UNDP/WB Energy Sector Management Programme, December 1988).

**Qat consumption**: Qat’s consumption, which was confined to the elite in the past, has become widespread both in the north and in the south of the republic in recent years. Besides their negative impact on individual household budgets, qat issues are central to food security, water use, and agricultural growth in general. Though reliable statistics are lacking, it is estimated that qat is cultivated over 80,000 ha of very productive land. It is estimated to account for 30 to 40% of the total water use in Yemen.

### 2.3 General Setting

#### 2.3.1. Administrative set-up and organization

The present Republic of Yemen is born on May 22, 1990, as a result of the unification of the northern and southern parts of the country. The country is administratively divided into 19 governorates in addition to the Capital’s Secretariat. Nine governorates are costal (three on Red Sea coast and six on the Gulf of Aden and the Arabian Sea coasts).

The national institutions involved with assessing, monitoring, combating environmental degradation in general, and desertification in particular are:

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The Environmental Protection Council (EPC). Established in 1990, its mandate is to develop and propose general policies to protect the environment, formulate national legislations and regulations, set-up national environmental standards, coordinate and monitor national, regional and international efforts in environmental protection and promote environmental education and public awareness of environmental issues. EPC reports directly to the Prime Minister;

The General Directorate of Forestry and Desertification Control (GDFDC). Public institution of the present Ministry of Agriculture and Irrigation (MAI), the GDFDC has the responsibility of maintaining and protecting the forests, woodlands, and range resources as well as combating desertification;

The National Water Resources Authority (NWRA). Established in the mid-nineties, its mandate is “conserve the water resources, prescribing strategies, policies and plans to ensure proper management and sustainable development of these resources, within the context of socio-economic development”\(^{21}\)

The Agricultural Research and Extension Authority (AREA) is a national institution in charge of agricultural research and extension in Yemen. The forestry research started under the responsibility of the El Kod Centre, whose experience in natural forest improvement, sand dune stabilization, windbreak establishment as well as the assessment of the performance of forest tree species under particular ecological conditions, is appreciable;

Non Governmental Organizations, among which the Yemeni Society for Environmental Protection (YSEP), the Friends of Environment, the Beekeeping Association, Agricultural Unions, Women Associations…, have set their respective objectives on the promotion of public awareness of environmental protection issues and responses as well as on initiating some field work relating to environment and desertification control activities;

The Faculties of Agriculture have no specific mandate relative to environmental protection and desertification control. However, the Faculty of Agriculture (Sana’a University) has been active with the GDFDC in carrying out specific consultancies for the "Forestry Development in Yemen" project\(^{22}\). The Faculty, with initial assistance from the GCP/YEM/015/SWI project developed forestry curricula for the Faculty and other agricultural institutions.

At the local level there are: i) specific Projects [e.g. Tihama Environmental Protection Project]; ii) Regional Development Authorities; iii) Local Administration, coordinated under the Ministry of Local Administration, with Districts and Villages; Agricultural Cooperative Unions under the MAI, and iv) Community and Family-based Organizations.

2.3.2. Political and legislative framework

Most of the modern legislation is relatively new in Yemen, especially that relative to environmental issues. Inherited from the former YAR and PDRY, the legal system based on Islamic, French, English and customary laws is still valid and will be until new legislations are adopted. Among the modern laws, which have been passed or drafted, dealing with general as well as specific environmental issues, are: the comprehensive Environmental Protection Law, Governance Law, The Forest and Law, the Water Law, Water Irrigation Law, etc.

2.3.3. National development plans and policies

The awareness of the challenges of sustained development has grown over the last decade. The Government has stated that the inter-relationship between socio-economic growth and sound environmental management is a major item in the country's development agenda, and its growth-oriented development strategy. The latter aims at increased food production and industrialization, is based on sustained utilization of the country's natural resources. These concerns are documented i.e. in the General Economic Memorandum presented by the Government at the Round Table Conference in Geneva in 1992 and in the Five-year Development Plan 1996-2000. The latter focuses on the

\(^{21}\) Presidential Decree establishing NWRA.

\(^{22}\) GCP/YEM/015/SWI
challenges of environmental degradation as exemplified by water scarcity and pollution, degradation of agricultural land, range, and forest resources etc. The plan also states that environmental considerations have to be made in all phases and at all stages of development planning.

Regarding the agriculture sector, the Five-Year Development Plan (1996-2000) included the following strategic objectives:

1. “Raising the GDP from agriculture at the rate of 6% per annum through achieving increases in yields and better allocation of resources.
2. Controlling the deficit in the balance of trade for agricultural commodities through increased production and exports of commodities in which Yemen has a comparative advantage.
3. Conserving natural resources including soil, water, forests, and rangelands, and taking the necessary measures to halt their degradation.
4. Integrated development of the rural areas to provide these areas with the necessary pull factors capable of inducing reverse migration from urban to rural centers and causing an increase in investment and trained manpower, which will contribute to the required increases in agricultural production in rural areas.
5. Enhancing the role of the private sector in agricultural investment.

The above strategic objectives can be accomplished through reforming agricultural policies, taking the necessary organizational measures, implementing the public sector agricultural investment programme, and allowing the private sector to assume a basic role in agricultural production, marketing, processing, and supply of inputs.”

Presently, the GOY is preparing its Second Five-Year Plan (2001-2005). This exercise is based on a strategic planning process. In this process, the ministries, NGOs, as well as private sector “will undertake full responsibility in preparing their sectoral and regional plans, where each authority and each governorate has a strategic vision and scheduled sectoral work plans incorporating the objectives, policies, programmes, projects, and estimates for the financial requirements…”. The preparation of this Second Five-Year Plan goes along with the strategic option of decentralization the GOY is presently undertaking. The general and basic objectives of this plan are stated as follow:

?? “Diversify the economic base of the national economy.
?? Achieve actual and positive growth average and work towards their continuity.
?? Working towards stability of national economy and reducing the averages on inflation.
?? Continuity in adopting a practical and stable average of disbursement.
?? Decrease in the social and regional differences, and reducing generation of poverty in the society.
?? Expansion in services – health, education, and other social services – that will have a direct impact on increasing productivity and reducing the standards of poverty.
?? Development of the human force with its various components and aspects.
?? Develop labor market with a reduction in the structural unemployment of the national work force.
?? Promote and increase the role of the private sector, and creation of an environment favorable to private investment.
?? Develop pioneer areas or centers for growth.
?? Develop and enhance the basic economic and physical requirements.
?? Preservation of the environment with its various components and elements.”

III. CAUSES OF DESERTIFICATION

3.1. Desertification’s Underlying Causes: Key Issues Leading Indirectly to Desertification

These are the profound, though often unsuspected factors that contribute to the development of survival strategies among the rural poor, who meet their most urgent basic needs at the expense of sustainability of the resource base. They may also be factors that encourage the mining of natural resources by those seeking to make fortunes overnight. As such, they constitute social indicators of desertification.

3.1.1. Land and water ecology

Land and water tenure and users’ rights: Tenure over the resources is the critical issue in conserving biodiversity. Without secure tenure, rural communities can only afford to consider their short-term interests and are therefore compelled to exploit resources for the immediate maximum gain, regardless of future consequences for the resource base. The most notable feature of land ownership and operation in Yemen are the size of holdings and the amount of land fragmentation. In the past, neither the small size of farms, nor the extent of fragmentation appear to have had a negative impact on production, given the labor intensive methods of cultivation. With increasing mechanization however, both size and fragmentation can be constraints to increasing production.

According to certain authors among them, S.Z. Maczarski, oral sharecropping arrangements are not conducive to security of tenure for the tenant, which is the reason why many tenants are not keen to invest in farm inputs or in permanent farm improvements.

Land tenure changes which occurred in the southern governorates have had dramatic consequences as it is estimated that some 20,000 families may have been displaced as a result of the decision to return the land they had cultivated for some 20 years, to the original dispossessed owners.

Water allocation systems are at the origin of uncertainty about water rights. Water is a common property resource, which to a large extent, is used privately. Under such conditions, private preferences tend to diverge from societal or communal preferences. The present state of uncontrolled competition for water will lead to socio-economic problems due to inequitable distribution of profits from water use and economic collapse in the long term. Over the last decades, many land users experienced a loss of long-term rights to land and water, discouraging them from upholding traditional soil and water management practices.

Incentives/constraints in agricultural production: While subsidies can be used as a positive instrument of a national sector oriented policy, they are too often used in a manner that aggravates environmental degradation. Prime examples of subsidies, which should be carefully re-assessed in Yemen, include those relative to water resources, energy, and some foodstuffs imports.

Among the constraints affecting agricultural production are: i) the excessive fragmentation of agricultural holdings; ii) the migration trends that drain substantial amounts of male workers, resulting in decline of traditional subsistence agriculture and other agricultural systems, particularly on terraces; iii) the uncoordinated development of rural infrastructure; iv) development projects, which have not lived to farmers’ expectations; and v) the lack of viable and sustained participatory extension systems.

Incentives/constraints in woodlands/rangelands exploitation: The incomes derived from the exploitation of forests, woodlands and rangelands (livestock breeding) are exempted from tax duties, which not only encourages over-exploitation, but limits GDFDC’s possibilities to invest in forestry and range
conservation and rehabilitation activities. Being a common property resource, woodlands are, to a large extent, used privately, because traditional utilization and protection systems have been gradually abandoned. The protection of forest trees and woodlands depends essentially on individuals and communities, the State having no enforcement capacity or legitimate framework to act because of the absence of Forest Law and regulations. Individual protection can only concern privately owned trees within agro-forestry systems.

Incentives/constraints in water utilization: Water has become the most limiting constraint on the development process in Yemen. The factors that have contributed to the present water crisis are:

1. Institutional and legislative: The laws and rights governing water use constitute a compromise in which neither the modern or traditional systems have been able to cope with the sudden irruption of tube well technology. There is furthermore, no national regulatory process for either, water allocation and conservation, or for drilling. The private control on land rights leads ultimately to “private rights” over tube well drilling and water use;
2. Geographical and geological: The predominance of groundwater as a source for agricultural irrigation makes for individual exploitation. The fragmented geography and hydrology, and the predominance of dispersed rural water users make central control and planning difficult;
3. Economical: related factors are rooted in policies that provide incentives for excessive use of water and make agricultural overuse of water very profitable;
4. Technological: Wells (about 40,000 wells) have been dug and the total number is consistently growing out of any kind of control. This, added to lack of water use efficiency at all levels, resulted in abstraction levels exceeding by far the recharge capacity of the aquifers.

3.1.2. Poverty

Poverty assessment for Yemen is hampered by the existence of many data gaps, reliability problems, and inconsistencies between data from different sources. Poverty issues are just beginning to receive focused attention. Assessments based on the 1992 Household Budget Survey, indicated that 20% Yemenis were absolutely poor then. The same Household Budget Survey cited by the Interim Poverty Reduction Strategy Paper (May, 2000) indicated that poverty in Yemen has almost doubled between 1992 and 1998, with the number of households below the “food poverty line” rising from 9% in 1992 to 17% in 1998. The greatest concentration of poverty is in Dhamar, Al-Baidah and Al-Mahweet, where the incidence of poverty reaches over 30% of the population. Remedying this situation is a formidable challenge given the fact that only 35% of the population is economically active and the growth of labor force is estimated at about 4.5% a year while the economy’s growth rate is much below 24.

Unchecked population growth and limited environmental resource base: Because the population is very young, pressures for employment opportunities are strong. Because rural populations have expanded beyond the absorptive capacity of the agricultural economy, poverty has become a rural phenomenon as about 80% of the poor (representing over 60% of the total population) live in rural areas. Given the absence of off-farm job opportunities in the rural world, more people are compelled to depend on agricultural production and the exploitation of limited natural resources to survive. This is confirmed by the fact that the number of landholders has increased by 66% in the last decade, while the average size of land holdings has decreased by about 33%25. Further mining is therefore applied to the natural resource base leading eventually to desertification and environment degradation. This is dramatically illustrated by the fact that per capita water availability would drop to some 56 m3 over the next 25 years26, barely enough to cover basic human needs. In this context, the issue of food security becomes a matter of great concern, as agriculture productivity and production will decrease further. The dependency on food import is already steadily growing, passing from 57% of the country’s needs in 1970, to about 70% in 1998.

24 ROY/UNDP - PSD on Poverty Eradication and Employment Generation, 1997
26 Under the high population growth scenario, available at the CSO, provided that annually renewed water resources remain constant over the next 25 years.
Economic situation and consumption patterns: Since 1990, the Yemeni economic situation was adversely affected by several crises, among them: i) the Gulf war which resulted in the return of large numbers of migrants, amounting to about 10% of the population, loss of remittances and increase in unemployment and assistance to the returnees; ii) the arrival of large numbers of Somali refugees; iii) the Civil war of 1994, which led to a sharp increase in military expenditures, extensive damage to productive facilities.

The growing influence of the market economy on the rural world has led to new trends in consumption and resulted in conversions of production systems to satisfy the farmers' cash needs. This sudden and often inadequate metamorphosis of production patterns and approaches results in rapid loss of soil fertility, which in most cases leads to the spiraling process of land abandonment and increased soil erosion, more poverty and search for more marginal lands to be put under unsustainable agricultural exploitation to satisfy the farmer's immediate needs. Tragically enough, when rural households move from a subsistence livelihood, to a market dependent one, no backing up is possible as the process persists until no other alternative than land abandonment and migration is left.

Social response to poverty: Degradation of land resources in rural areas is often linked to poverty. Poor people have no secure choices to achieve food security. They are therefore forced to adopt short-term survival strategies within which longer-term management considerations cannot be accommodated. Poverty is a repercussion of the disintegration of traditional cultural and social systems. The substitution of a system based on community solidarity by a market-oriented one where individual interest primes the rest, has compelled the poor to exploit abusively the few resources available to them. The significant, relentless increase of pressure exerted over lands with steadily declining production capacity is not adequately compensated for, through renewed technology, investment, and production efficiency.

3.1.3. Inability to respond properly and timely to misuse issues

Economical and financial context: After unification, Government policy options remained constrained by scarce financial resources, which had to be used to meet short-term requirements, thus increasing dependency on foreign assistance. This was further aggravated because of the reduction in external financing that followed the unforeseen return of Yemeni expatriates from the Gulf countries.

Yemen is facing simultaneously the challenges of structural and economic policy reform and external debt servicing. To overcome debt effects, priority is currently given to active exploitation of domestic natural resources (mainly petroleum and minerals), with intense and unsustainable mobilization of water and agricultural land.

Despite efforts regarding the reform measures and substantial external support, the magnitude of the development trends, especially in the agricultural sector calls for significant resources, at a time when available funds from the government budget have been severely stretched since the Union. With the loss of remittances from Gulf countries, Yemen has grown more dependent on external assistance. Twenty-six donor countries and organizations meeting in Brussels to provide encouragement to the ROY for its reform programme reaffirmed their commitment to provide Yemen with $ 1.8 billion in aid over a period of three years.

Institutional capabilities/capacities: Commendable efforts have been made by EPC, GDFDC and other institutions and line ministries to fulfill their respective mandates. However, these efforts are hampered by the ambiguity of the mandate texts, which leave much room for contradictory interpretation, as to each agency's specific role and responsibility. Formulations, such as "concerned bodies" and "responsible authorities" lacking clarity of definition are opened to interpretation. Moreover, the sharing of responsibilities between agencies is usually not well specified.

The current over-centralized nature of the public administration system has marginalized regional and local authorities and lead to reduction of their capacity to plan and implement rural development projects/programmes. Indeed, the modern forms of development introduced within a few decades in Yemen, have gradually transferred the responsibility to government agencies, which have not yet

developed the resource assessment, monitoring and management capacity and the political influence to counteract the newly introduced and often misused technological capacity to exploit resources.

Lack of environmental information systems for planning sustainable development: According to Z.D. Kalensky (August, 1997), Yemen has considerable difficulties in allocating funds for the acquisition of reliable/timely geo-spatial data as a prerequisite to: appropriate planning/implementation of sustainable development strategies, management and protection of natural resources. Available maps are often outdated and the development of digital geo-spatial databases is proceeding slowly and without coordination. While most sectors lack the vital digital geo-spatial databases and the expertise in efficient use of Geographical Information Systems (GIS), there are several agencies, which are independently attempting to establish GIS for the assessment and monitoring of natural resources. This results in a proliferation of equipment, difficult to maintain and to operate, due to lack of training opportunities and candidates as well as funds and more important, due to lack of field data. Indeed, the geo-spatial databases available in the ROY display a considerable variation and an inefficient and unreliable data collection and utilization.

Information about deforestation, agricultural and rangeland deterioration, soil erosion and desertification is largely inadequate in Yemen. The same applies to information on the current utilization and potential of agricultural land resources as well as to forest resources and coastal zones. In addition, there is no historic data on degradation and desertification trends.

Legal, customary and regulatory instruments: The current legal system is undermined with legislative inadequacies as sector oriented issues are addressed by non-coordinated and non-harmonized sector-oriented legislations developed in isolation which may overlap and contradict one another. A global and integrated legislative approach to environmental concerns that would embrace modern legislation issues as well as traditions and customs has not been introduced. In addition, a very important issue faces various legal systems, as rights to natural resources can often not be authoritatively stated because customary as well as statutory laws are ambiguous, especially in the absence of any registration system. In fact one might say that "people's access to and control over natural resources may reflect their own status and power, rather than what can be found in legal texts." Because it is generally unwritten and informally applied, customary law tends to be forgotten, if not ignored when land policy and legislative decisions are formulated. When such government decisions intersect with tribal land tenure systems, confrontational situations may arise.

Weakness of community involvement: Community involvement in the process of rural development can only be achieved by avoiding the top-down approach and establishing negotiations between State and Community representatives, as to the content of the development strategy and the participation of each side (financial, material, physical etc). To insure true participation, tenure and user's rights security must be guaranteed. This is best done, by referring to already established and accepted customary tenure rights and their correlated laws. The negotiations should also lead to a long-term development programme in full partnership with related government institutions.

Weakness of progress in population reduction: The family planning and birth control still constitute a major issue in the development process of the country. The initiation by the Government, of a National Population Strategy and Action Plan, which recognizes population growth, as one of the most formidable and uncompromising problems facing Yemen has not yet fully achieved its objectives, as it still requires strong and substantial leadership and political commitment and substantial public expenditures in the social sectors.

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3.2. Direct Causes of Desertification

The previous paragraph has reviewed key issues, which all contribute to the initiation of situations whereby production systems, which were sustainable in achieving self sufficiency and self reliance, have progressively become inadequate for the present needs and conditions. The present paragraph deals with the direct causes, which may be due to natural causes or be linked to human activities.

3.2.1. Natural causes

**Climate**: Erosion as part of desertification processes is a natural phenomenon that is not restricted to areas modified by humankind. Under arid conditions, natural erosion processes can be intense. Higher rates of erosion are likely to occur in areas with mean annual precipitations lower than 300-400 mm, because the protective vegetative cover is generally restricted and discontinued and weathering of rock material is rapid and intense.

Yemen climate extends from hyper-arid to dry sub-humid, with very limited humid areas. Such climatic conditions are conducive to reduced vegetative cover, greater wind and water erosion hazard, thus higher desertification risks. Strong winds occurring mostly in the western and southern Coastal Plains are blamed for sand movement, dune formation, and encroachment on productive lands and infrastructures.

**Geology and soil**: With the exception of the quarterly basaltic and volcanic rocks covering 30-40% of the country area, which are not susceptible to erosion, the remainder, composed in large of sedimentary rock formations (sandstone, limestone, clay, marls and silt-stone) is very vulnerable to erosion and degradation. Soils susceptibility to erosion is also related to their chemical and mechanical properties. Soils with a high content of silt (frequent in Yemen) are less stable and often susceptible to erosion.

**Topography**: Topography and slope, both of which are much accentuated in Yemen, play a significant role in water erosion phenomena and ultimately in desertification processes over a large part of the country. In the areas of the country where landform is composed of plains and plateaus, unhindered wind action over barren fields results frequently in wind erosion and dune movement. Concurrently, the existence of a dense hydrological network facilitates degradation, erosion, and sedimentation.

**Natural calamities**: Severe soil erosion in various forms, destruction of resources and infrastructures, loss of productive land etc., which result from such disasters, as floods and earthquakes, tend to induce durable impoverishment, land abandonment, and migration and increased dependency on assistance. Negative impacts of floods are usually long lasting, as reconstruction/rehabilitation are time consuming and depend on the celerity with which required funds are made available. In the meantime, erosive forces remain in action, as protection of fields, wadi banks, irrigation channels etc, is non-existent.

Other natural calamities affecting the country are related to, attacks on vegetative cover by pests. Locust’s recurrent outbursts affect seriously agricultural crops over vast areas. Outbreaks of diseases and pests affecting natural vegetation may result in reduction of cover, thus in erosion. They may also result in reduction of species’ representation within given vegetation communities. In some instance, they even endanger the species, as is the case with *Juniperus sp*. Relic stands at Jabal Iraf.

3.2.2. Causes linked to human activity

The most well known causes of desertification are those stemming from demographic growth and linked to satisfying the primary needs of populations faced with ever increasing food, fodder, firewood, infrastructure etc. requirements.

**Infrastructure construction**: Hasty and unrestrained transactions for the acquisition of land for urban and industrial development have gained in momentum in all parts of the country, principally beside main roads and along coastal shores. Owing to this, and to steady and rapid rural to urban migration, Yemen faces immediate as well as long-term environmental problems. Along the shorelines of Abyan, Tuban, Hodeidah-Duraihimi etc., this is leading to very intense, erratic, and unforeseeable coastal dune erosion and sand movement. Due to lack of efficient urban planning, most agricultural land in cities and along
main roads is exploited for residential or other urban usages, resulting in loss of highly productive lands as can be seen between Lahj and Aden and between Sayeiu and Shibam.

**Misuse of natural resources:** environmental impacts are serious and often critical especially in Yemen where net population growth exceeds 3% per year, agricultural land is limited, holdings per family remain small, rainfall and surface water flows are erratic, and groundwater is being overexploited and used inefficiently. This leads to relentless pressures being exerted on resources and lands, regardless of their relative fragility or scarcity. Consequently, a spiraling form of resource degradation takes place, resulting in reduction of land productivity and of primary goods’ availability, as well as in the progressive abandonment of traditional community-based resource management systems.

> **Land use versus carrying capacity:** The present human and animal population levels reached in many parts of the country have by far exceeded the carrying capacity of the land. As a result, more land is reclaimed at the expense of rangelands and woodlands on very steep slopes of the upper mountain parts or on shallow and/or sandy soils in dry areas. The unsustainable operation of putting marginal land under production leads invariably to land abandonment after production costs prove to be uneconomical.

> **Misuse of woodland resources:** Depletion of plant cover through over-exploitation and clearing of woody vegetation for fuel-wood and construction wood is of major concern as these domestic products are highly demanded and their exploitation remains a very lucrative form of trade. Improved transport facilities and recent increase in gas prices have seriously curbed the substitution of fuel wood by alternative sources of energy. The natural annual wood increment represents only a small fraction of the population’s current needs of fuel-wood. Furthermore, woodlands have been and are still eradicated for agricultural land reclamation, particularly in the Tihama and in the mountain regions. The present depletion of the natural vegetative cover is in no way counterbalanced by afforestation activities. In addition to wood, shrub-lands and woodlands provide significant quantities of fodder often taken up in the form of early grazing of young trees and sprouts, which prevent vegetation recovery/regeneration.

Even though the largest degradations may have taken place in the seventies and eighties, the process is still underway. Studies of land cover change in the Tihama between 1973 and 1990 indicated that woodlands have undergone the following area reductions: 30% for *Acacia spp.*, and *Salvadora persica*; 17% for *Acacia nilotica*; and 21% for *Acacia ehrenbergiana*.

> **Misuse of rangeland resources:** Overgrazing of rangelands is regularly cited as a major cause of degradation. Yet, little is actually known concerning the grazing pressure on rangelands. According to official figures (Table 5.), the total animal population increase between 1990 (8,439,342) and 1999 (10,338,364) has not been so dramatic. It seems however; that it is between 1970 and 1980 that the grazing intensity exerted on rangeland was most dramatic, rising from 1.43 head/ha to a sudden 2.87 head/ha in the northern governorates. Therefore, it can be stated that dramatic extensive rangeland degradation processes were initiated during this period. This statement is supported by FAO Agrostat files, according to which, sheep population rose from 2.3 million in 1969-1971 to 3.8 million in 1988-1990, and the goat population from 2.7 million to 3.3 million for the same period.

Rangelands continue to be affected by very severe degradation processes, the extent of which needs to be evaluated. Uprooting of large quantities plant cover of various range species for fuel-wood, rangeland reclamation for urban and industrial development and rangeland depreciation through lowering of groundwater levels in the lower deltas of the Coastal Plains, have all contributed significantly to reduction of rangeland areas and decline in range biomass and species’ distribution.

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29 Carrying capacity as an ecological concept that refers to the maximum animal and human populations that can be sustainably maintained, given the energy, food, water and other necessary nutrients available or capable of being generated within limits of productive potentials of a given land area.

30 Hunting Technical Services.

31 1990 Agriculture Statistics Book. MAI, 1991

32 1999 Agriculture Statistics Book. MAI, 2000

Table 5. Livestock Evolution (Number of heads) during 1990-1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sheep</th>
<th>Goats</th>
<th>Cows</th>
<th>Camels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>3,756,190</td>
<td>3,333,090</td>
<td>1,175,272</td>
<td>174,790</td>
<td>8,439,342</td>
</tr>
<tr>
<td>1991</td>
<td>3,568,383</td>
<td>3,166,441</td>
<td>1,116,917</td>
<td>166,053</td>
<td>8,017,794</td>
</tr>
<tr>
<td>1992</td>
<td>3,639,751</td>
<td>3,229,770</td>
<td>1,139,256</td>
<td>169,374</td>
<td>8,248,151</td>
</tr>
<tr>
<td>1993</td>
<td>3,714,763</td>
<td>3,296,995</td>
<td>1,162,896</td>
<td>172,830</td>
<td>8,347,484</td>
</tr>
<tr>
<td>1994</td>
<td>3,677,257</td>
<td>3,263,382</td>
<td>1,151,076</td>
<td>171,102</td>
<td>8,262,817</td>
</tr>
<tr>
<td>1995</td>
<td>3,751,477</td>
<td>3,328,442</td>
<td>1,174,213</td>
<td>175,316</td>
<td>8,429,448</td>
</tr>
<tr>
<td>1996</td>
<td>3,922,359</td>
<td>3,557,523</td>
<td>1,180,934</td>
<td>179,020</td>
<td>8,839,836</td>
</tr>
<tr>
<td>1997</td>
<td>4,266,690</td>
<td>3,881,375</td>
<td>1,201,216</td>
<td>181,132</td>
<td>9,530,413</td>
</tr>
<tr>
<td>1998</td>
<td>4,527,094</td>
<td>4,088,895</td>
<td>1,263,483</td>
<td>182,936</td>
<td>10,062,408</td>
</tr>
<tr>
<td>1999</td>
<td>4,667,049</td>
<td>4,204,170</td>
<td>1,281,975</td>
<td>185,170</td>
<td>10,338,364</td>
</tr>
<tr>
<td>% Increase 1990 – 1999</td>
<td>24.3</td>
<td>26.1</td>
<td>9.1</td>
<td>5.9</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Source: Agricultural Statistics Books. MAI and Yemen National Information Center.

? Misuse of water resources: Because there are no networks monitoring surface water, the implications associated with runoff and storage have not been investigated or documented in any detail for Yemen. Even though no sediment transport monitoring has been carried out in the country, it is a fact that sediment transport by the wadis is considerable.

The already alarming groundwater situation has worsened since 1990, as the overall water consumption in 1995 has increased by 8-10%. The additional quantity of water was provided for, essentially through increase groundwater abstractions. Some drastic changes in land occupation and water abstraction have occurred in some southern governorates, particularly in Tuban Delta, which have not yet been fully assessed and accounted for. Typical problems associated with groundwater depletion include irreversible reduced basin storage, groundwater salinization, and seawater intrusion in the downstream aquifers. These plus other indirect effects such as increased soil salinity, drying up of numerous springs and wells and increased cost of groundwater abstraction for agriculture, result in abandonment of large areas of barren agricultural fields (not yet assessed) subject to acute wind and water erosion processes as well as in induced poverty and migration trends. Water quality deterioration and decline induce critical degradation mechanisms as well as significant and irreversible changes in phreatic vegetation in wadi courses and coastal zones. Groundwater exhaustion is in itself, the most acute form of desertification as it is an irreversible process in the sense that neither nature's resilience, nor man's curative actions can help sustain volumes of water for future generations. Groundwater depletion and sustainability of the resource are the country's dominant medium to long-term environmental problem. Almost all groundwater systems are being over-exploited at an alarming rate.

Increasing upstream water use, more intensive water diversion and widespread water harvesting have a definite influence on runoff water distribution downstream since runoff volumes reaching the lower areas are decreasing systematically. This, combined with important declines in groundwater levels and water quality changes, must without the shadow of a doubt, result in the alteration or even the destruction of extensive specific fauna and flora habitats, endangering numbers of species with specific environmental requirements.

? Inadequate agricultural practices: The application of an often mechanized and repeated single or double crop system in the rain-fed areas, has led to soil loss through wind and water erosion, decrease in fertility and subsequently decline in crop yields. More marginal lands being put under cultivation even during years with rainfall deficit fail to produce crops and are abandoned barren, ready to contribute to desertification, while new marginal lands, await to be cultivated. The result of such practices in the coastal plains and in Marib is that wind erosion takes place on formerly more or less stabilized dunes, which, are put under a continuous process of drifting thus increasing desertification by encroachment on
productive lands and infrastructures. Elsewhere in Yemen, this leads to water erosion, which affects all lands downstream and ultimately results in widespread degradation and desertification.

Misuse of coastal lands: The coastal plains are important fodder and firewood providers. The mangrove areas are a valuable source of forage for camels as well as fuel for fish smoking. Mangroves protect the coast from marine erosion. Woodlands, along wadis and gravelly plains are valuable sources of fodder, construction wood, and fuel-wood. Rangelands in the extensive inter-wadi areas are, characterized by high value forages, mainly grasses. The degradation of these habitats caused by man to satisfy his immediate needs in firewood, timber, charcoal, and grazing has been accentuated by the conversion of land cover occupations. Woodlands and rangelands have undergone extensive conversions to agricultural lands. Additional degradation has been triggered by the lowering of the groundwater table, which has put the rooting systems of several species out of reach of the permanent moisture zone. No national assessment of the extent of coastal degradation has been initiated to date.

Agricultural land abandonment: Yemeni agriculture has moved very quickly from subsistence (rain-fed and spate irrigated) agriculture to an ever-growing modern market oriented agriculture, without having had time to adjust and conform to environmentally friendly modern farming practices. Consequently, much cultivated land has been mined to the point of abandonment, resulting in one or a combination of serious soil degradation forms (salinity, alkalinity, loss of fertility, wind and/or water erosion etc).

Labor shortages due to massive migration of farmers have caused marginal, labor-intensive lands to be abandoned. Traditional farming systems based on intensive labor have been discontinued and a process of farming modernization has taken place which has encouraged intensification and expansion of farms at the expense of smaller, marginal holdings which were abandoned to unchecked erosion processes.

Abandonment of rain-fed agriculture land is a recurrent event, closely linked to levels of precipitation. However, rain-fed agriculture lands may be definitely abandoned following soil fertility exhaustion and erosion. This is generally very difficult to assess, as no continuous monitoring of land occupation exists and because these lands can degrade into mobile sand sheets and dunes or can improve to rangeland.

Irrigated agricultural land abandonment is also common though not assessed. It may result from intense water erosion on terraced and wadi agricultural lands in the mountain regions; it may also result from erosion due to flash floods affecting lands at the limit of wadi banks in the coastal plains in Wadi Hadramout and finally it results from soil salinization in arid parts of the country which is the outcome of erroneous irrigation practices, quality of irrigation water, sea water intrusion etc.

The current threat to rain-fed farming on hillside terraces is the result of: i) a decline in income from terraced crop production, combined with major socio-economic changes; ii) a tardy government recognition of their importance to the national economy; iii) competition from agricultural areas benefiting from highly subsidized groundwater irrigation; iv) subsidized imports as well as illegal imports of competing crops such as wheat; v) recent severe drought cycles, and specifically the most recent from 1989 to 1991. All of these combined factors lead to emigration of farmers to neighbouring Gulf countries as well as main Yemeni cities, in search for complementary incomes to support their families. This usually results in reduced terrace maintenance or in terraces abandonment.

The Mesquite issue: The mesquite issue is that of introduced species which should receive all due attention at all times, in order not to repeat the type of incidents experienced with the exotic mesquites. While introduced species may be of great importance to the country under specific conditions and for particular and well-defined objectives, insurances must be taken to monitor their evolution and take timely and appropriate measures to avoid unnecessary disturbances to the ecosystem.

The important presence and steady extension of mesquites on farms, fallow lands, irrigation channels, wadi banks, agglomerations, etc. is a result of the high dispersal rate of seeds encapsulated in animal droppings. Unrestricted animal movement and water transport constitute the main vehicles to the high rate of spreading of mesquites. While upstream wadi Hadramout’s tributaries are usually free of mesquite, its occurrence increases gradually downstream, where it gains in density of cover and forms very dense belts towards the lower reaches of the stream. In Hadramout, the regeneration ability of
Prosopis juniflora on farmland was found to range from 10,000 stem/ha, at Al-Qat’n state farm, to 60,000 seedling/ha on farm boundary in Hawta area. Prosopis juniflora, everywhere is spreading intensively on neglected and mismanaged farms.

**BOX 1**

**EVILO-DOER PROSOPIS OR THE MESQUITE ISSUE IN THE ROY**

Introduced with the best intentions several decades ago, Prosopis juliflora and P. chilensis are at the centre of a serious controversial issue in Yemen. As if gifted of conscious thought and will, they are accused by many, of being evil to humankind and to nature, and are considered harmful agents of destruction. It is a fact that since their introduction by means of plantings established along roads, farm boundaries and public gardens, the mesquites have become a nuisance to many agricultural fields, irrigation and drainage canals, and lower reaches of wadis.

Because of the damage caused to production systems and agricultural infrastructures, the above-mentioned species are increasingly assimilated to agents of desertification. While farmer victims may be psychologically entitled to over-react, no one should have the right to lay the responsibility on tree species, which in our case have simply displayed a weedy comportment. Any good farmer knows that weeds must be eliminated from the start if one wants to stay out of trouble. This has not been the case and it can be stated that the intensive spreading of mesquite in agricultural fields and infrastructures has its origin in the neglectful farming practices taking place on mismanaged farms. Furthermore, the lack of timely monitoring and assessment of the magnitude and consequences of its spread have contributed to the prevailing situation. As of today, no research has been undertaken to formulate appropriate responses, which could be extended to farmers for implementation.

From the initial introduction to the present uncontrolled widespread distribution of mesquites, Man's accountability is whole and he is the sole culpable agent of propagation, as he has displayed a serious lack of discernment and a total absence of appropriate and timely response during the course of events. In fact, the only action worth mentioning has been to interdict mesquite's propagation in nurseries. Forbidding Prosopis spp. propagation through plantings will not help, as mesquites constitute at present an important, essential, and dynamic element of the arid and semi-arid ecosystems, which will gain in spreading momentum in the ROY if nothing is done urgently.

Something is actually being done by some, who understand that total eradication of the species is at present neither economically nor technically feasible and who, as a result, attempt with success, to make the best of an un-wanted and un-planned widespread occurrence of Prosopis species. They have done this by closely observing the wide range of forest products provided by mesquites and gradually learned to master their utilization to a point of considering them now of great importance to their well-being. To these people, mesquite’s animal fodder and wood products offer potentialities that should constitute positive attributes everywhere in dry land regions. To the technicians who have been observing the systematic clearing of woodlands and rangelands for firewood production, it has become clear that mesquites' sustainable provision of very large quantities of wood, charcoal and fuel-wood, is greatly contributing to save significant areas of natural range and woodlands from degradation. They also know that, mesquites, which constitute good soil improvement agents, should undergo various treatments aiming at optimizing their presence in different forms for the benefit of people and the environment.

35 Prosopis cineraria, a native species, is increasingly being incriminated as a nuisance to agriculture.
IV. MANIFESTATION OF DESERTIFICATION

In spite of notable progress made recently, Yemen's statistical database remains embryonic, particularly in the domain of natural resources and environmental protection assessment. Data available on the extent and risks of desertification is generally very limited and often impossible to exploit as information sources are often neglected and data reproduction is inaccurate. Desertification in Yemen is assessed in very descriptive and narrative general terms only. It is often illustrated by the extreme consequences, such as surface area subject to sand encroachment. In fact, sand dune formation and movement are the outcome of very insidious and widespread desertification processes, which result from: reduction of vegetation biomass and species' diversity; soil degradation and erosion; continuous loss of land productivity etc. These aspects are seldom taken into consideration and are usually not quantified.

4.1. Physical Aspects of Desertification

4.1.1. Loss of land productivity and reduction of national income

Desertification is best expressed by the loss of land productivity, following mining of the resource. Monoculture in the absence of any farm inputs or rotations and erroneous farming practices constitute common features of Yemeni agriculture, which contribute greatly to the decline of agricultural yields and ultimately to desertification through loss of the resource productivity potential. Any reduction of the agricultural sector's importance in the national economy, will result in reduction of the national income, and eventually affect the pace of development of the country.

4.1.2. Resource-base degradation and decline

Reduction in woodland and mangrove biomass and in species diversity: Extensive exploitation and degradation of forests, woodlands, and scrub vegetation cover has occurred throughout Yemen. The Jabal Bura’a area exemplifies this, with an estimated 50% of the woodland being denuded. Some 85% of this became bare between 1973 and 1988 and an additional 3% was cleared in the 1988-1991 period (UNDP, 1992). The remaining forest area has experienced a reduction in biomass, which needs to be evaluated as should be assessed the number of species, which may have disappeared from the area.

Similar cases of woodland biomass and area reductions are common occurrence in the ROY. During the last decades, some of the most dramatic reductions in woodlands took place in the Tihama plain. The Tihama land cover study has determined the scale of land cover changes. In the coastal woodland classes, mangroves seem to have undergone a small increase in area (55 ha), while the *Hyphaene thebaica* woodland has experienced a dramatic loss in area (8,764 ha, i.e. 69% of the initial area). This area has been destroyed and largely converted to rangeland after being initially cleared for agriculture. The *Salvadora-Tamarix* thicket has lost 6,091 ha (29% of initial area), mainly to wadi agriculture. Situated on gravelly soils, which are improper for agriculture, the *Acacia-Commiphora* woodland has not been affected. However, the *Acacia* woodland has lost 2,637 ha (17% of its total area), mainly to agriculture. After several decades of Acacia woodland clearing for agriculture, one would have hoped to save the few relics left in Tihama coastal plain, but this does not yet seem to be the case.

Decline in range biomass and in species diversity: It is important, to remind that, rangelands are in part constituted by open woodlands and shrub-lands. The processes affecting woodlands as described above, affect similarly rangelands, which witness decreases in surface area. In coastal areas, they are

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36 Erroneous farming practices lead to organic matter depletion and soil loss through erosion, reduce soil fertility and moisture retention capacity, increase soil salinity and alkalinity and contribute to the degradation of the micro-climatic conditions.

37 Conducted by Hunting Technical Services, covering the period 1993-1990.
particularly affected as they undergo a sharp decrease in biomass and in species diversity\textsuperscript{38} as well. The Tihama cover change study has shown that between 1973 and 1990, the rangeland area of the coastal plain has decreased by 3\%. This small percentage amounts, nevertheless to a significant area of over 17,000 ha. It does not include rangelands that have degraded into bare sand sheet formations.

\textbf{Groundwater depletion and decline:} An eloquent example of environmental and social impact of excess water abstraction, is the environmental degradation of the village of Hadda, south of Sana’a, after the springs have dried-up a number of years ago. The socio-economic consequences of groundwater resources depletion are dramatic. Groundwater will eventually become too expensive for use in agriculture. Agricultural economies based on groundwater irrigation are doomed to collapse and farms to be abandoned, in turn, resulting in erosion of barren fields. Groundwater may in the future be at the origin of many conflicts between individuals and groups attempting to ascertain their users' rights on a commodity, which is becoming very scarce in many areas.

\subsection*{4.1.3. Water erosion}

Water erosion has always been a significant menace to the Yemeni farmers who cultivate erosion-sensitive land on steep slopes. It is however generally admitted that erosion problems have increased in the last 3-4 decades to become a major problem throughout Yemen. It concerns soil erosion associated with agriculture, topography, hydrology, geology, terrace abandonment, and tree and shrub removal in the upper catchments. It applies also to lowland watercourse erosion due to \textit{peak} flows. Erosion is integrally linked with catchments land use. Further land development\textsuperscript{39} incursions into upstream sections of escarpment valleys are also occurring. They are subject to erosion due to up-slope landslides associated with road cuts and fills and ineffective man-made drains. Such erosion can be of severe consequence not only to upstream resident landholders, but also downstream through erosion of valley terraces and floodplain lands. The ”domino effect” of aggravated wadi flash floods has caused destructions of economically viable terraces downstream and of wadi-bottom land. This has, in some places reached such proportions that a major part of formerly highly productive spate irrigated lands bordering most wadi channels have totally disappeared. Thus, the collapse of the upland terraced system is a threat to the entire system.

\begin{quote}
\textit{"In order to understand the ecology of Yemen, it is necessary to study the Highland terrace system and related wadi spate network…. The productive base of this wide region in which the majority of the country's population lives, has for centuries been in a delicate and vulnerable state of balance. Without maintenance of the terraces, farming systems and water management regimes, virtually all of the productive land would naturally revert to a rocky and barren landscape..."} (D.M. Varisco, J.P. Ross and A. Milroy, 1992).
\end{quote}

Though erosion has always been a major problem in Yemen, no quantitative assessment of the magnitude of the process is available. Following is brief qualitative assessment of erosion in the country:

\begin{itemize}
\item Water erosion in the Coastal Plains results in significant increase in wadi course sedimentation, which affects diversion schemes (weirs and canals) and results in widening of wadi beds and in loss of arable land through bank erosion;
\item In the rugged dissected mountains of the Northern Highlands, water erosion due to torrent floods affects seriously the neglected terraces networks, destroys woody vegetation, increasing bank erosion. In the Al-Mahweet area, road banks are collapsing as they have not been properly consolidated and through gully formation, big chunks of soil are washed off the banks;
\end{itemize}

\textsuperscript{38} Coastal ranges on sand are often constituted of one unique species, i.e. \textit{Odysseum mucronatum}.

\textsuperscript{39} Land development using earth embankments and higher, but easily breached bare bunds.
In the Central Highland Plains, erosion phenomena can exist along the banks of wadis entering the plain giving rise to serious branch gullies, which, through backward erosion, result in deep gullies rendering the area unfit for cultivation;

In the Southern Uplands, de-vegetation and abandonment of marginal agricultural lands is resulting in serious watershed degradation and major wadis are much affected by flood erosion.

4.1.4. Wind erosion

Wind erosion and sand encroachment on productive lands and infrastructures are common features of desertification in Yemen, especially in the Tihama, Al-Jawf, Lahj, Abyan, Shabwa, Hadramout, and Al-Mahara. These phenomena have not been thoroughly assessed and only descriptive and narrative accounts of wind erosion are made in very general terms. One study carried out by FAO in 1989-90 to determine the rates of sand movement and encroachment between 1976 and 1987, in the Wadi Zabid area, gave the following results: A definite reduction in productive agricultural area was seen across a broad front virtually along the entire southern length of the Wadi from close to the coastline, to the foothills. This occurred, basically because of wind movement in a southwesterly to a northeasterly direction. The initial productive land area was 20,400 ha in 1976. By 1987, some 970 ha, amounting to 4.75% of the total area, were lost or seriously affected following dune encroachment and/or movement representing an annual loss rate of 90 ha. However, most illustrative is the movement of the coastal dunes on an area of unproductive land in the southern part of Wadi Zabid, where dunes shifted 400-500 m to the north in the 11-year period between 1976 and 1987.

The Tihama land cover study has determined that coastal and inland dunes have gained 10% in surface area, which amounts to 20,414 ha. Inland dunes have contributed the most to this increase, with a significant positive change of 19,767 ha. These changes do not take account of areas, which have been transferred into sand sheets, or areas of bare sand that do not form dunes yet. The largest increase in dunes comes from rain-fed agriculture.

4.1.5. Saline water intrusion

Changing groundwater regimes has groundwater quality implications. Particularly in the case of coastal aquifers, where connate saline water up-cone under the wells, and where, high abstraction rates trigger seawater intrusion. In closed basins where groundwater outflow has ceased because of declining groundwater levels, salinity problems may occur. These phenomena have not been comprehensively assessed, but they are widespread in the coastal plains of Tihama, Tuban, and Abyan deltas.

4.1.6. Coastline erosion

Coastal zone erosion by winds, involving both fore-dunes and inner dunes, is a problem along the Red Sea and the Gulf of Aden coasts. The coastal area between Hodeida and Ad-Duraihimi is affected by general degradation processes due to indiscriminate clearing of the vegetative cover of *Avicenna marina, Hyphaene thebaica, Suaeda fruticosa* etc., and to overgrazing of *Odyssea mucronata* and other fodder species. As a result, vast areas are affected by intense coastal dune degradation and by marine erosion (in places). The outcome consists of impressive sand accumulations over extensive areas of agricultural and rangelands. Individual dunes frequently exceeding 10 m, in height, are an eloquent demonstration of the disastrous effects of combined marine erosion and coastal dune degradation, following unsustainable utilization of natural vegetation. This process, which affects agriculture, mangrove, range, and fisheries, may be further exacerbated in the near future, due to massive and systematic sale of land along the shoreline (beach and coastal range) for urban and industrial development.

4.2. Sociological Aspects of Desertification

4.2.1. Population groups adversely affected by degradation and desertification

Poverty in Yemen has spread beyond the “traditional” groups who for historical reasons or social customs, were economically marginalized. Besides the “traditional” underclass, the new population
groups affected by poverty are: the Yemeni return migrants, the rural-to-urban migrants, the landless and near landless, the disabled, and the rural female group (heading households and farms) and some dispossessed land tenants.

The major source of concern for resource sustainability is the continuously increasing demand for water. Because its availability is limited, all population groups will be more or less affected by the foreseeable water penury in the future. Drying-up of wells and boreholes, is causing great hardship to villagers and, farmers who are the least able to adjust to the changes, being generally poor and uneducated.

Rural people, who constitute the majority of the Yemeni population are often times directly affected by environmental degradation and desertification. Except for people with large land holdings and with diversified sources of income (business, industry, remittances etc), most rural people suffer from decline in amount and quality of soil, water, domestic fuel energy (firewood), range, woodland resources etc. Farmers and herders cannot produce enough to meet their needs and have to pay increasingly more to provide food from the market. Women and children constitute perhaps the most tragically adversely affected group because, as men chose to migrate, they are the ones who carry on with the hard and labor-intensive farm activities. General poverty and labor requirements keep the children (especially the girls) away from school. The people most heavily affected by environmental problems in towns and cities, belong to those who have already been victimized by degradation in their rural areas of origin. They belong to the poorer segments who, live without any sort of protection, often in areas prone to landslides and flooding. More men than women and children suffer from environmental degradation in towns as urbanization, is dominated by men who have left their families behind in rural areas.

4.2.2. Poverty expansion

The social and economic consequences of the terrace system collapse, of the range deterioration, and of all other forms of natural resource degradation have not been addressed. The essential question is why has there been such a sudden increase in erosion, degradation, and desertification. Why are the terraces literally disappearing with each new flood and why does the remaining scant tree cover continue to dwindle? In a social sense, the collapse of various production systems, will force a significant portion of the rural population to migrate to cities, which are already suffering from overcrowding in relation to existing services and in relation to employment. The option of work abroad has eroded as more Yemenis return from outside than succeed in establishing themselves out of the country.
5.1. Brief Overview

The National Action Plan to Combat Desertification (NAPCD) was jointly prepared by UNEP and ESCWA in 1992, at the request of the GOY.

Introducing the natural environment, the first chapter gives an account of the available resource-base and, of the misuse natural resources are, subjected to, by both men and livestock. It finally illustrates the impact such behavior is having in terms of deterioration of natural resources.

The second chapter addresses the social and economic situation of the country, particularly the economic resource-base, and the major macro-economic problems such as budget deficit, scarcity of foreign currency, the national debt, and national returns.

Discussing the desertification status in Yemen, the third chapter reports that it affects, to various degrees, 97% of the lands. The main factors contributing to desertification were highlighted as being: i) natural factors; ii) misuse of natural resources; iii) inefficient use of groundwater; and, iv) economic and social factors. Migration was pictured as a serious factor contributing to desertification, as it is often times followed by land abandonment and degradation. However, according to the NAPCD, the most important factors contributing to desertification are deterioration of vegetation covers, sand dune movement, soil erosion, and soil salinity.

The fourth chapter gives a brief review of previous and current efforts, which resulted in the implementation of 49 projects. Most of the agricultural projects aiming at increasing productivity through provision of improved inputs relied on groundwater and did not consider environmental impacts. Spate irrigation projects however were conducted with the objective to utilize and conserve natural resources (land and water). Forestry projects pursued desertification control objectives. Most projects were executed on an experimental and pilot basis. They demonstrated the importance of the biological approach to combating desertification. It was also reported that the coordination between different projects was low.

The NAPCD was presented in the fifth chapter in three parts. The first one dealt with the magnitude of desertification and its importance for the social and economic development in the five-year plan. The second part discussed the competing issues for priorities in finance and execution, while the third part developed the long-term strategy (1991-2010) for combating desertification.

5.2. Summary of Proposed Programmes

The specific objectives of the NAPCD were i) to ensure that desertification is fully stopped and ii) to change people’s attitude through increased awareness and understanding of the desertification issues.

The above objectives were to be achieved through eight long-term (1991-2010) programmes supported by 41 projects costing a total of US$ 41,250,000. Cost-wise, programme 4 dealing with the social and economic aspects of the plan was the most important. It was estimated at US$ 22,000,000 for two projects (credit and farmers’ education). The second in importance was programme 6 with a total allocation of US$ 9,100,000 for two projects (regional research and urgent training). The third most costly programme concerns the corrective measures to combat desertification. It is supported by 31, medium to very small projects costing in total US$ 7,850,000. Fourth, was the programme designed

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40 Incidence of growing poverty, lack of employment opportunities, lack of basic services etc.
for land-use mapping and to evaluate and map desertification (US$ 1,750,000). Public participation and institutional strengthening were estimated respectively at US$ 250,000 and 200,000. Insurance against drought risks and consequence as well as work and international cooperation were allocated each US$ 50,000.

The NAPCD considered that the task of supporting and coordinating efforts to combat desertification should not fall within the responsibility of the General Directorate of Forestry. Instead, it recommended to set-up a new apparatus to combat desertification that would include:

? A National Committee to Combat Desertification to be established by Presidential decree and to be composed of 17 members from relevant ministries;
? A General Directorate for Combating Desertification, within the Ministry of Agriculture to be created and entrusted with the coordination of efforts in desertification control, by national and international organizations; and
? Regional units within the existing Agricultural Development Authorities and Agricultural Offices.

5.3. Level of Plan’s Implementation

The political, social and economical difficulties that followed the declaration of Yemen’s unification, adversely affected the pace and momentum of the plan’s implementation. It has nevertheless constituted a reference in terms of diagnosis of desertification in the country. Notwithstanding funding difficulties, the followings has been achieved:

Legal and Institutional Aspects:

? Establishment of: i) The GDFDC to deal with combating desertification; ii) NWRA to be in charge of water strategy, policy, legislation and regulations;
? Issuance of the Environment Protection law;
? Establishment of a fund to support agriculture and fisheries;

Implemented Projects Related to Desertification Control:

? Two Regional Projects to which Yemen was associated. The Dune Stabilization and Afforestation Project (DP/RAB/89/034) implemented from 1991 to 1993, was to set-up a regional sand encroachment control cooperation machinery, based upon a network of national institutions. The Development of Forest Resources for Environmental Protection and Food Security (GCP/REM/052/JPN) implemented from 1991 to 1994 to review and evaluate the contribution of forestry to food security and environmental protection. The project was to generate a continuing programme of information exchange through the establishment of an appropriate network that would help increase public awareness and manpower capabilities.

? Strengthening Environmental Planning and Management Capabilities (YEM/91/004/G/01/99). This project implemented by EPC in 2 phases from 1992 to 1997 was to integrate economic and ecological considerations into development planning through strengthening the environmental planning/management capacities of the ROY and implementing some NEAP recommendations.

? Forestry Development Project (GCP/YEM/015/SWI). Implemented in four phases (1985-1997) this Swiss financed and FAO executed (FDP) Project has been the major forestry Project in Yemen. FDP played a key role in supporting institutional building and upgrading the Forestry Department to the General Directorate of Forestry and Desertification Control (GDFDC) and in strengthening and promoting forestry programmes as well as establishing pilot areas. These
pilot areas were established to promote better techniques/methods involving afforestation, desertification control, agro-forestry, and natural forest management. FDP was successful in establishing a forestry extension department and introducing the participatory approach in Yemen. The project was finally instrumental in setting-up an information and data collection system to assist the GDFDC contribute to policy development and to the formulation of plans, techniques and approaches in natural resources conservation and management.

Land and Water Conservation Project (UTF/YEM/022-023-024). Meant to implement between 1993 and 2000 a national programme for natural resource conservation, the LWCP addresses the issues of water and land conservation by improving irrigation management, setting standards for water and soil conservation, and developing a programme for sustainable watershed and natural forest management as well as of fuel-wood production. Organized into three main components (Training, Forestry and Water), the project supports the on-going water resources planning and monitoring activities, including the control and regulation of water exploitation in the agricultural sector. Its forestry component is meant to support agricultural production, protect land from erosion (pilot watershed management sites), and strengthen the capacities of the GDFDC.

Environment Resources Assessment for Rural Land Use Planning (GCP/YEM/021/NET). Funded by the Netherlands and implemented from 1994 to 1999 with the technical assistance of FAO, this project supported MAI/AREA in carrying out proper land resource studies and land use planning for agricultural development. FAO is providing technical assistance in the field, computer operations, and soil laboratory and cartographic facility operations.

Urban and Peri-Urban Forestry in Yemen (TCP/YEM/4554). This FAO-TCP executed between 1995-1997, aimed at the reuse of treated wastewater for forest/fodder tree planting in four cities (Sana’a, Dhamar, Hodeidah, and Aden). It established demonstration plots, for watershed management, wastewater irrigated peri-urban tree planting, schoolyard tree planting, farm windbreaks, forest nursery establishment, in addition to, training provided to forestry staff.

Environment Protection Project in Tihama (1996-2002). Funded by IFAD and implemented by the Tihama Development Authority (TDA), this project aims at achieving a sustainable increase in agricultural production, introducing land conservation measures to control sand dune movement and encroachment, improving irrigation efficiency, supporting women’s basic education needs, improving household incomes, and strengthening of TDA.

Sustainable Environmental Management Programme. This UNDP-government cost-sharing programme (1997-2000) aims at building the capacity of government and research institutions, NGOs local communities etc. in the fields of environmental protection, land degradation and desertification control, habitat and biodiversity to ensure the sustainability use of Yemen’s natural resources. The programme consists of seven sub-programmes among which those relative to the National Action Plan to Combat Desertification and the National Environmental Protection Action Plan bear high priority.

Sustainable Water Resources Management Programme (1997-2001). To overcome the confusion that prevailed in the water resources sector prior to 1996, the National Water Resources Authority (NWRA) was created, through a merger of four governmental departments, to be the sole national institution responsible of water resources planning, policy making, development, and management. Upon its creation, NWRA was lacking the capacity to achieve its mandate; hence the PSD on Sustainable Water Resources Management, whose primary aim is institutional building and capacity strengthening of NWRA and, to a certain extent, NWSA, MAI and GAREWS as end users of water resources. The Ministry of Agriculture and Irrigation is responsible of the implementation of the sub-programme "Agriculture Water Use and Conservation". The components of the sub-programme and its objectives are to develop the capacities of the General Directorate of Irrigation (GDI), the Agricultural Research and Extension Authority (AREA) and the General Directorate of Forestry and Desertification Control (GDFDC.)
Achievements to date consist of the following: 1) development of a National Water Strategy (passed in the council of government); ii) elaboration of a Water Irrigation Policy; iii) elaboration of the Taiz Water Resources Master Plan; iv) training of a large number of staff; v) establishment of Taiz and Aden branches of NWRA; vi) establishment of an hydrometric monitoring system; vii) establishment of a hydrological database in NWRA; viii) production of reports on technical issues and of public awareness materials.

Support to Yemen National Poverty Alleviation Programme (YEM/97/300). Building on its first Five-Year Development Plan, the GOY has decided to launch an ambitious five-year National Programme Framework for Poverty Alleviation articulated around initiatives in social development, agricultural development, social infrastructure development, and industrial development. The main objectives of UNDP’s support to the above mentioned programme framework, to be pursued through this PSD are to: i) assist in formulating a national policy framework on poverty alleviation and also establishing a national entity to manage it. ii) enhance efforts to streamline GOY’s institutional network and reinforce its capacity in the areas of labor policy formulation and data management; iii) promote the socio-economic integration of the poor, especially rural women; and iv) support the GOY to redirect development activities to the regions by assisting Regional Authorities develop their planning and implementing capacity;

Watershed Management and Wastewater Reuse in Pre-Urban Areas in Yemen-WWPU (GCP/YEM/026/NET). Funded by the Government of the Netherlands and the GOY and implemented with the assistance of FAO, the WWPU project (1998-2002) aims at assisting the Yemeni people and the GOY in their search for grassroots sustainable development. The intended watershed management, wastewater re-use as well as the agro-sylvo-pastoral management and development packages/interventions will provide for optimal natural resources use, income generation and environmental stability. The project will have a definite positive impact on food security because various mini-projects that have been initiated with the populations or are in the process on being initiated will result in income generation for the beneficiaries. In the long run, the benefits accrued from afforestation, watershed management, wastewater re-use, and rangeland management will help in improving the food security situation, environmental and ecological balance, and community organization.

5.4. **Drawbacks in the Plan**

Twenty-six projects related to corrective measures to combat desertification were proposed for a total of US$ 2,512,000 with project unit costs ranging from US$ 15,000 to 250,000. Such small and widespread projects are difficult to manage efficiently. Furthermore, they can hardly have any substantial impact on desertification control. Their regrouping into fewer projects, which would include all the interventions prescribed, would have been more sound in terms of their efficiency;

Budgets allocated to some other projects and programmes were largely underestimated, particularly for training (US$ 250,000), public participation and awareness (US$ 250,000), strengthening desertification control apparatus (US$ 200,000) etc;

The NAPCD indicated priorities in term of project implementation without specifying the local and institutional partners concerned. In other instances, it did name the implementing agencies without giving precisions as to their respective roles;

The NAPCD considered the period 1991-1995 sufficient to completely control and stop desertification in Yemen;

The creation of a new organization to be in charge of desertification control was unnecessary, as supporting and strengthening the GDFDC for the same purpose would have been more practical;

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41 According to the PSD on “Support to Yemen National Poverty Alleviation Programme” signed on June 12, 1997 between UNDP and MPD
The information contained in the NAPCD, is not always consistent in its presentation as it relates in some instances to the Northern governorates and in others, it concerns whole country. This created some confusion with regard to many issues addressed by the NAPCD;

The funds proposed for the education curriculum and for the credit component are of US$ 20 million each, which is largely superior to those proposed for the whole programme of corrective measures to combat desertification (US$ 7,850,000). Even the regional research component is superior US$ 9,100,000).
VI. ACTION TAKEN TO COMBAT DESERTIFICATION

6.1. National Strategies, Policies and Legislative Measures

At the national level, the ROY, with external assistance, has engaged its limited potentialities in adopting a number of policies, strategies, action plans, and legislative measures, which are contributing to environment protection in general and desertification control in particular. These measures can be summarized as follow:

?? National Environmental Action Plan (NEAP)
During 1996, and with the support of UNDP, the Netherlands, and the World Bank, the NEAP was prepared and approved by MPD and EPC. The NEAP presents the state of environment problems, national efforts to protect the environment against pollution, rational utilization of natural resources, conservation of natural and biological species, and dissemination of environmental awareness to overcome challenges and problems confronting the attainment of sustainable development.

The strategy of the plan is to promote sustained use of natural resources through a set of legislative, institutional, economic, and financial measures, improved information base and through community involvement. On the basis of this strategy, action plan to be implemented to ensure sustainable development was defined according to analysis of priority problems identified. The main environmental problems identified in the NEAP are: (i) water depletion, pollution, and supply; (ii) land degradation; (iii) habitat degradation; and (iv) waste management.

As stated in the NEAP, “the expected impacts of the plan are improved environmental management at local and national level, resulting in the protection of coastal and marine environment, sustained use of land, water and marine resources, conservation and sustained use of the country’s biodiversity and natural habitats and improved quality of life in rural and urban areas including public health”.

?? National Biodiversity Strategy and Action Plans
The GOY has recognized the necessity to protect natural resources and biological diversity as reflected by the ratification of the Convention on Biological Diversity. A draft of “National Biodiversity Strategy and Action Plans for Yemen” was prepared by EPC during end 1999. The main objectives of the Strategy are defined as follow:

1. Conservation of biological diversity in Yemen;
2. Sustainable use of biological diversity and related natural resources;
3. Development and enforcement of policies and legislation relating to biological diversity;
4. Community participation in the revival of traditional techniques and knowledge in natural resources management;
5. Participation equity and fairness in biological diversity in the country; and
6. Development of human resources and institutions in the field of biological diversity.

Presently, the finalization of the Biodiversity Strategy and Action Plans are under completion.
### Aden Agenda

Under the Aden Agenda, the overall goal of government’s policy in agriculture sector is to create sustainable and equitable growth in inputs and incomes from agriculture. This policy is directed mainly for the poor. In this context, MAI restructuring was proposed under the name of “Aden Agenda”, which started during March 1997, considers the following areas:

1. **Field Services Restructuring** that would:
   - separate the service provision function out from the investment function, bring services into line with national policy, and consolidate them for efficiency;
   - treat investment projects as limited in time, and adopt a project team approach; and
   - mitigate gradually towards a new institutional structure where the existing authorities and offices would continue in their present status but they would be restructured internally for efficiency and would have equal responsibility for providing services and equal access to resources.

2. **Human Resources Restructuring** that would work within the overall public administration reform framework to:
   - bring the ratio of MAI staff to farmers to 1:100, and of front line staff to farmers to 1:200;
   - reduce the overall staff of MAI by 37% through managed retirements and privatization;
   - improve skills and recruit more women; and
   - reallocate the savings from staff reduction to increase operating budget for field services, to training, and to paying performance related competition to staff.

3. **Budget Restructuring** that would work within the overall public sector reform effort and within existing levels of budget to:
   - increase annual operating costs per employee from current US$35 to 500;
   - increase average salaries from the current US$600 to 1000;
   - improve efficiency and value for money, using programme budgeting;
   - increase cost recovery and cost sharing; and
   - pursue privatization efforts.

To support this agriculture reform, the MAI is presently undertaking several restructuring studies (field services, budget, personnel…) as well as agricultural policies and strategies paper. These studies will be completed soon and will be presented to the Cabinet.

### National Wastewater Strategy

The high population growth, expansion of urban population, and an increasing coverage of domestic water supplies and sewage networks will give rise to greater quantities of municipal wastewater, which can become a new source of water irrigation. The reuse of such marginal quantity of water can be significant in terms of national water budgets, particularly in Yemen where water of good quality is limited. In this context, the MAI/GDFDC, supported by the FAO Project on “Watershed Management and Wastewater Reuse in Peri-Urban Areas of Yemen – GCP/YEM/026/NET”, prepared during March 2000 a draft “National Wastewater Strategy” in close collaboration with all concerned institutions. The proposed strategy would:

- contribute in strengthening sustainable agriculture;
- assist in better managing water resources;
- support complementary actions to ongoing water resources planning activities;

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42 “Aden Agenda-MAI Restructuring Proposal: Exposure Draft”. MAI, March 1999; and

- assist in setting-up mechanisms for the implementation of legislative and other measures to regulate and control wastewater reuse; and
- improve on-farm wastewater reuse.

Among the main strategies, policies, and laws approved or awaiting approval, the following:

- The comprehensive Environmental Protection Law enacted in 1995 builds on the above-mentioned legislative systems but lacks accompanying regulations and standards. The comprehensive Environmental Law includes certain fundamental aspects dealing with forest resources for which the GDFDC has formulated regulations, which have been submitted to EPC for promulgation. The Environment Protection Law has many articles that are related to the protection of the natural resources and the rational and sustainable management of the renewable and non-renewable resources. It is worth to highlight the measures included in Article 14. This Article deals clearly with conservation and protection of the natural renewable resources. It states, “…It is prohibited to exercise any activity, which affects the quantity and quality of the vegetation in any area causing desertification or to deface or mar the natural environment…. It is prohibited to cut, remove or damage any tree, shrub or bush from the forests unless a permission from the competent bodies is granted.”

- The Forest Policy and Forest Law. A concise statement for Forest Policy had been officially declared in the Third National Plan (1987-1991) whose principles are embodied within the present Five Year Plan (1996-2000). A corresponding Bill of Forest Law has been drafted and updated in 1999 and submitted to the Ministry of Legal Affairs for further action. The objectives of the Draft Forest Law are defined as follows:  
  (1) forest protection and preservation;
  (2) forest development;
  (3) management and regulation of forest formations;
  (4) erosion and desertification control; and
  (5) contribution to the national economy.

  In addition, six items constitute specific harmful actions that are prohibited by the Draft Forest Law, i.e. (i) forest fires; (ii) forest land cultivation, leveling and reformation; (iii) river dams’ construction and river course modification; (iv) settlements and constructions on forest land; (v) harvesting, transporting forest products and grazing; and (vi) modification of forest boundaries and signs and of public infrastructures.

- The Water Strategy and Law: While its traditional water rights and customs deal mainly with surface water, with no or very limited concern for groundwater, Yemen has not yet an operational water law that regulates the overall development and management of water resources nationwide.

  A Water Strategy was prepared and adopted by the Cabinet during 1998. The Water Strategy is aiming, in general, at:

  (1) protection of water resources from over-exploitation,
  (2) sustainable use of water resources, and
  (3) responding to the needs of community and different sectors for water resources

  A Water Law was developed in 1999; it was cleared by the Cabinet of Ministers and is awaiting debate in Parliament. The Water Law focuses more on conservation and sustainability than on

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the development of water resources. It recognizes existing rights and makes future exploitation subject to a license beforehand, particularly for groundwater. The anticipated law puts the National Water Resources Authority (NWRA) as the sole national institution in charge of planning and elaborating national strategies and of supervising their implementation. It also gives NWRA the power to license and regulate both the development and use of water.

The law bears a significant limitation, however as it does not build on communities' local rules and hence may prove to be difficult to enforce in the present context. The positive aspect of interest related to drought mitigation and desertification control is that it encourages the creation of associations of beneficiaries and of councils/committees/groups of stakeholders at various levels, particularly that of basins and watersheds. It also gives NWRA the ability to delegate its powers to such groups as well as to decentralized management institutions to self-regulate water use.

Water Irrigation Policy and Law: The Water Irrigation Policy was adopted by the Cabinet on March 1999. The policy is aiming, in general, at:

1. “Optimization of the use of the limited water resources allocated for irrigation. Economic and sound use of water to be practiced to reach the highest yield and income from the unit of water and land in irrigated agriculture.
2. Gradual and practical increase of the very low overall irrigation efficiency (30-40%) should be achieved through the mid-term plans.
3. Establishment of strong institution to form the central body fully responsible for irrigation in the country. It should be supported with clear mandate, which will be, in the mid-term, limited to planning, control, supervision, awareness, and transfer of technology. In the short-term, this institution should be structured to achieve the decentralization role by delegating the execution activities to the regional authorities, project units, agriculture and irrigation offices in the governorates….”

Accordingly, and in order to implement the Water Strategy and the Water Irrigation Policy, a Water Irrigation Law was drafted and waiting for debate and approval. The draft law recognizes the need for (i) re-arrangements of irrigation institutions to work with clear mandate, which defines the duties and responsibilities of the central and regional entities; (ii) cooperation and coordination among the inter-related agencies to replace the scattered efforts, avoid duplication, overlapping, and competition; (iii) establishment and enforcement of water irrigation standards to avoid pollution; (iv) ensure water rights and irrigated areas tenure in order to solve problems related to water and land disputes; (v) collection and assessment of data and information on water irrigation activities including water irrigation charges; (vi) improvement of water irrigation efficiency as well as the productivity of irrigated lands; (vii) enforcement of the role and involvement of farmers and private sector; and (viii) preparation and elaboration of public and farmers awareness campaigns and programmes dealing with water conservation and environment protection.

National Watershed Management Policy and Action Plans: Integrated watershed management approach is newly introduced in Yemen. This integrated approach, not only considers the socio-economic aspects, but is also a mean to sustain natural resources utilization. Watershed management is considered among the top priorities of the MAI. A National Watershed Management Policy was prepared by MAI/GDFDC and NWRA. The Cabinet endorsed this Policy on May 2000.

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46 In close collaboration between two FAO implemented projects: YEM/97/200-Watershed Management Component and GCP/YEM/026/NET-Watershed Management and Wastewater Re-Use in Peri-Urban Areas of Yemen.
The National Watershed Management Policy aims to achieve the followings objectives:

1. Protection and development of natural resources as they represent the basic element for economic and social development.
2. Implementation of an Integrated Watershed Management. This concept consists of a comprehensive planning, which takes into consideration the technico-socio-economic aspects that ensure natural resources protection and development aiming at improving the socio-economic conditions of the communities.
3. Enhancement of institutional and legislative measures through the establishment of adequate institutions able to implement the plans and programmes resulting from the developed policies and the development and elaboration of appropriate legislation that organizes the use and exploitation of the natural resources.

Accordingly, and in order to implement the approved policy, Action Plans have been elaborated and presented to the MAI for further action.

Decentralization and Local Governance Law: The concept of decentralization or local governance is not new in Yemen as it has been the subject of numerous debates, particularly the last years. It was in fact included to some degree in the constitution, through its articles 142 and 144, which stipulated respectively that: i) administrative units enjoy juridical personality, provided that they have freely elected councils at governorate and directorate levels; and ii) administrative units and local councils are integral parts of the state’s authority. There is in any case, a wide consensus in Yemen to consider decentralization as a vital demand. The Law on decentralization – local administration - was accordingly passed on February 2000.

“Decentralization assumes the necessary support from central government to poorer regions… It may increase the economic participation of local people through employment, implementation of local projects and the decrease of the concentration of people in urban areas, but may lack the necessary measures and criteria to implement them and sustain them.” The measures to implement them are political and institutional. They consist in the empowerment of local communities, particularly women, local institutions, and aid organizations. The means and criteria to sustain them consist in creating conditions for local substantial investments and funding capacities, which in turn require direct external assistance.

6.2. International Conventions and Protocols

In order to contribute to the existing collective international activities and efforts to confront the problem of desertification and environmental degradation, the ROY has concluded a number of international conventions and protocols relevant to desertification and environment. Among others, these are:

  The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to...
climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (Article 2 of the Convention).

  The Convention on Biological Diversity’s objectives are “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources” (Article 1 of the Convention). The Convention is thus the first global, comprehensive agreement to address all aspects of biological diversity: genetic resources, species, and ecosystems. It recognizes – for the first time – that the conservation of biological diversity is “a common concern of all humankind” and an integral part of the development process.

?? Montreal Protocol on Substances that Deplete the Ozone Layer, as adjusted and amended (London, 1990; Copenhagen, 1992; Vienna, 1995; Montreal, 1997; and Beijing, 1999), approved on 3/12/1995.
  The Protocol recognizes that “world-wide emission of certain substances can significantly deplete and otherwise modify ozone layer in a manner that is likely to result in adverse effects on human health and the environment”.
  The Protocol aims at protecting the ozone layer by taking precautionary measures to control equitably total global emission of substances that deplete it, with the ultimate objective of their elimination on the basis of development in scientific knowledge, taking into account technical and economical considerations and bearing in mind the developmental needs of developing countries.

  The Convention is aiming at “to secure a general treaty to tackle ozone depletion” and to take “appropriate measures… to protect human health and the environment against adverse effects resulting or likely to result from human activities, which modify or are likely to modify the Ozone Layer.”
  Also, the main thrust of the convention was to encourage research, cooperation among countries and exchange of information.

  The Convention was principally devoted to setting up a framework for controlling the “transboundary” movements of hazardous wastes, that is, the movement of hazardous wastes across international frontiers. A central goal of the Basel Convention is “environmentally sound management” (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever possible. ESM means addressing the issue through an “integrated life-cycle approach”, which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery, and final disposal.

?? Convention to Combat Desertification approved on 31/12/1996.
  Article 2 of the Convention states “the objective of this Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach, which is consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in affected areas. Achieving this objective will involve long-term integrated strategies that focus simultaneously, in affected areas, on improved productivity of land, and rehabilitation, conservation, and sustainable management of land and water resources, leading to improve living conditions, in particular at community level.”
6.3. Institutional Set-up and Measures

6.3.1 Prior to the Five-Year Plan (1996-2000)

EPC was established by the ministerial cabinet decision No.: 95 of 1990. The role of EPC was strengthened by the adoption of Environmental Protection Law No.: 26 of 1995. EPC is an advisory body accountable to the Prime Minister. It has the following responsibilities, among others: (a) propose policies to protect the environment; (b) coordinate the efforts of national, regional, and international agencies involved in environment protection; (c) formulate standards to control air and water pollution and land degradation; (d) formulate national environmental legislation and regulations; (e) develop recommendations for ratification of international environmental agreements, conventions and protocols; (f) set-up effective international cooperation and accommodate international environmental funds; and (g) collect information and undertake environmental assessments. In addition, the institutional strengthening of EPC was provided through different organizations among which the Netherlands government and UNDP.

Also, during 1990 the forestry section (within the Plant Production Directorate) was upgraded to General Directorate of Forestry and Desertification Control (GDFDC) with the assistance of the FAO Forestry Development Project (GCP/YEM/015/SWI).

The responsibilities of the GDFDC can be summarized as follow: (a) proposal for policies and legislation and formulation of plans and programmes needed for the protection and development of forestry rangeland resources and desertification control; (b) supervision and participation in the implementation of plans and programmes related to forests, rangelands and desertification control; (c) assessment and inventory of natural forests and rangelands as well as elaboration of required technical and economical studies for their protection and development; (d) elaboration and implementation of training programmes for the forestry and desertification control staff; (e) promotion of beekeeping activities.

6.3.2 During the Five-Year Plan (1996-2000)

Additionally to the above, the Five-Year Plan (1996-2000) has face up to a number of institutional issues, contributing further to the development of the national institutions, whose set-up is fundamental to desertification control in Yemen. Among these:

The water resources institutional issue: Prior to 1996, the water resources’ sector was under the authority of several Ministries and institutions. The situation was characterized by diluted and unclear responsibilities as well as by duplication of mandates. Lacking any sort of coordination, these institutions had basically the common objective, of development, exploitation, and use of water resources, with little concern for protection and conservation. In addition to the above, there existed several Regional Development Authorities, Directorates at governorate level and autonomous projects, all handling water related matters, with no coordination. The consequences of this, were groundwater, reduction of drinking water supply, water pollution and reduction in water quality and desertification (saline intrusion in coastal aquifers, soil salinity, degradation of vegetative cover etc.).

The creation of the National Water Resources Authority (NWRA) aimed at controlling better the situation. NWRA, however, is still not in a position to implement fully its mandate (initially derived from those of other water-related agencies). While still far from achieving this goal, NWRA is being held back, as other institutions and agencies continue to operate in the water sector, with the usual conflicts and confusion. To make the situation worse, additional institutions are being created, having conflicting mandates with NWRA.

Weakness and fragmentation of responsibility is also found within the MAI, where various bodies deal with water-related matters in the absence of either vertical or horizontal coordination. Additionally, these agencies, which lack manpower capacity, tend to operate without adequate preliminary studies, aiming their interventions towards use and productivity rather than conservation and sustainability.
In addition, during 1999, a Water and Environment Centre was established within Sana’a University. The main mandate of this specialized Centre is to provide short-term training courses and to undertake research and studies in the field of water resources and environment related issues.

Certain number of funds (Agriculture and Fishery Fund, Social Fund for Development…) were also established and created to assist and support rural communities, small farmers, agricultural unions… dealing with their environment and poverty alleviation issues.

6.4. Desertification Control Activities: Magnitude and Significance in Terms of Checking the Process

Attempts to combat desertification and protect land and infrastructures are not recent in Yemen as individuals and communities alike have always had to cope with and develop some resilience to drought and desertification phenomena. However, during the last decades, national efforts in combating desertification have been initiated.

Unfortunately, no specific evaluation/assessment of the above desertification control efforts seems to be available, either at central, regional, or local level. It may be said that among the many projects initiated, some were not designed to combat desertification (agricultural development through marginal land reclamation etc) and some lead to excessive groundwater abstraction, thus contributing to desertification. Another group of projects concerned with wadi bank protection and flow management did contribute to combating desertification.

More specifically, forestry achievements have been gradually building up, starting as isolated experimental activities, to attain presently a national dimension with major implication in desertification control. In the southern governorates, prior to 1967, forestry activities consisted mainly in introducing exotic species for amenity purposes. From 1968, more work was initiated, such as the establishment of windbreaks for crop protection and sand dune fixation. Until recently, activities in the north were oriented essentially towards amenity plantations in major towns and villages. In the seventies and eighties, attempts were made to introduce fast growing species and to expand the objectives and the magnitude of afforestation programmes. Central and regional nurseries were established. Seedlings were provided to farmers for amenity and windbreak establishment and to municipalities and institutions for afforestation of barren slopes and roadsides. These small and dispersed efforts contributed little to large-scale protection and to production needs; they did however make tree planting more popular and attractive. In the south, a team of qualified national researchers assisted by FAO experts, undertook larger efforts in establishing experimental designs relative various types of plantations and by launching significant programmes of windbreak establishment and sand dune stabilization.

The "Forestry Development in Yemen" project has introduced a new dimension in its approach to implementation of forestry programmes in the country. Recognizing that only those who own the land are in a position to achieve collectively substantial and significant results in forestry, through their cumulative individual efforts, it introduced with success the participatory approach. A concerted effort has been made to launch afforestation, agro-forestry, and natural forest management activities. Demonstration plots for woodlots, shelterbelts, windbreaks, sand dune fixation, watershed management and terrace rehabilitation, improvement of traditional agro-forestry systems and home gardens have been set up. Perhaps, more significant has been the effort accomplished to develop independent village and private nurseries to increase the communities' autonomy in undertaking their forestry related activities. Here again, the magnitude of the efforts was limited in terms of area treated, but the project has set the ground for further significant forestry development in the country.

The Land and Water Conservation Project, building on and reinforcing the achievements of the previous cited project is concentrating its efforts in watershed protection, terrace rehabilitation, sand dune movement control, wadi bank protection and wadi-training and in forest management, all of which shall greatly contribute in the various desertification control activities to come.
The project “Watershed Management and Waste Water Reuse in the Peri-urban Areas of Yemen” – GCP/YEM/026/NET – has developed further the participatory approach and introduced the concept of village development based on participatory local development plans (Master Plans).

The latest UNDP programmes (among others) on “Sustainable Environmental Management”, “Sustainable Water Management”, and “Poverty Alleviation” are expected to have direct and positive impacts on land resources, habitat and biodiversity conservation, as well as capacity building in the above-mentioned fields. In fact, these programmes reflect priority actions developed by the government to support land resources protection/development and to respond to rural community needs.

Afforestation efforts which, have not been assessed to date, have been limited for several reasons: i) the forestry department is very recent and its capacity and means of implementation are still limited; ii) the restricted land area under State ownership makes it difficult to imagine, as elsewhere, the initiation of large scale afforestation projects; iii) lands being mostly privately owned, any attempt to encourage afforestation efforts requires long lasting extension contacts and persuasive efforts. In fact, the afforestation projects were the most viable in terms of activity participating to desertification control. Many were of experimental and pilot nature and were therefore modest in magnitude, but they did produce positive results, the most important being the fact that tree planting has become a popular activity which, except under limited conditions has the approval of rural as well as urban people.

An expanded programme is required in the long-term, involving community plantations for firewood and building materials, agro-forestry and multipurpose tree plantations, dune and wadi bank stabilization, shelterbelts, greenbelts and windbreaks for wind erosion prone areas, fodder production and watershed management and protection. Pilot projects and institutional strengthening to meet these needs are still in progress through the “Land and Water Conservation Project” and the GCP/YEM/026/NET project. In general, afforestation activities should be included in any type of rural development project as well as water resource projects that involve major surface storage, require catchment protection, or focus on management of recharge zones.

6.5. Gaps in Knowledge and Know-how

6.5.1. Brief overview

In the south, decades of state-controlled land use planning, which put limits to private initiative resulted in forsaking and eventually, totally discarding traditional soil and water conservation practices. In the north, massive emigration during the 1970’s and 1980’s had a similar effect especially as regards terraces’ maintenance and improvement. Presently, people are trying to revive old practices and traditions but are faced with increasing scarcity of knowledge and experience, which remain principally with the most traditional and conservative groups and communities.

Yemeni professionals with the ability to deal with the integrated land management and biodiversity issues are scattered within different institutions. Knowledge about appropriate technologies and participatory approaches to development is present with some individuals. There is, however, no specific institution dealing with issues pertaining to technology transfer, and to development of appropriate technologies. Access to information is limited mainly because available documentation is lost, due to neglect and lack of appreciation of the fact that documents belong to all and should therefore be available to all. This "document-minded culture" is lacking among borrowers who withhold unique copies representing institutional memories. It is lacking among document archivists and librarians who do not manage properly institutional archives and document centres.

The country has not yet been covered by a general forest survey. However, it is clear that the significantly important wood resources that existed in the past have largely disappeared and that the remaining scarce open woodlands and shrub-lands are also disappearing at increasing rates. Information on the available woody biomass is needed for a rational management of national forests and woodlands.
Woodland resources have always played and shall continue, for a long time to play a major role in rural households by their decisive contribution to domestic energy and as an important source of fodder. The latter contributes significantly to livestock production, which has a notable, though unknown bearing on rural incomes and economy. In spite of pessimistic projections, no methodical appraisal of fuel-wood consumption levels and trends at national level has been attempted. There is much concern about the fact that the decrease in woody biomass is real and that it tends to be considerably greater than the already important decrease in forest area. It is therefore necessary to assess the fuel-wood consumption in the ROY and attempt to increase and sustain wood supply and consumption by teaching farmers how to: i) establish village, community and individual woodlots; ii) manage community forests and woodlands; iii) cut trees without killing them; and iv) improve the efficiency of wood burning stoves which are still commonly used in rural households. Forests/woodlands are rich sources of NWFPs. Important for household consumption, particularly in the rural world, they need to be thoroughly assessed.

By far, the most crucial role of forestry and of the forest and woodland resource relate to their decisive contribution to environmental stability, to sustaining agricultural production and participating to rural development and well-being. Given the particular nature of terrain, soils and climate of the ROY, forests and woodlands perform essential functions in protecting the land resource from erosion and in regulating the hydrology by preventing destructive floods and by mitigating the effects of drought. These aspects of forestry are insufficiently documented.

6.5.2 Extent of desertification and desertification risk

The information on desertification is descriptive, narrative, and too general. The little data that exists, relative to its extent at the national level, is generally very variable from according to the author, and it rarely gives reference as to the source of information. There is also little useful information on the aspects and dynamics of desertification. The causes are described in such general terms that they can be of little help in devising appropriate response approaches and activities. There is therefore an urgent need to assess at national level the extent of desertification and to monitor, on a regular basis, changes in order to be able to react to any situation change on a timely basis.

Qualitative information on desertification risk in the ROY does not exist. A recent consultancy report dealing with records collected on desertification, monitoring and capacity building (Talaat Abdel Hamid Omran, September 1996) seems to indicate that the only information available in terms of desertification risk dates from 1983 and concerns only the Northern Yemen. It indicates that 37% of the region is at high risk of desertification, with about 27% of the area in the semi-arid region and 10% in the sub-humid region. Furthermore, about 56% of the area was considered to be at very high risk of desertification, with 52% in the arid region and 4% in the semi-arid region. The remaining 7% is desert. It is also reported that about 3.63% of the total area is affected by wind erosion, 12% by water erosion, and 3.83% by salinization.

6.5.3 Consequences of desertification

The cumulative effect of years and perhaps decades of neglect of the terrace-rain-fed and spate production systems, of rangelands, and woodlands, cannot be offset within the short-term. There is increasing recognition of the overriding significance of environmental degradation to the future of Yemen's productive base. The question is how can the development policy shift away from a quasi-exclusive focus on increasing irrigation out of declining water resources, to a development policy based on revitalizing environmentally friendly production systems. The latter would support, the majority of Yemeni farmers achieve the long-term objective of sustainable agricultural production within a stable
ecosystem. In connection with this, several questions need to be answered, such as: i) what criteria to select for the determination of priority action? ii) what criteria to choose for the selection of beneficiaries? iii) to what extent and under which conditions is it possible to rely on nature’s resilience to achieve environmental rehabilitation? and iv) what are the environmental consequences of the newly adopted alimentation trends? etc.

6.5.4 Capturing farmers’ experience

Indigenous Technical Knowledge (ITK) is a valuable, but highly underestimated and not well-known asset. ITK should constitute a valuable supplement to new technology. Like science, it is based on careful observation, in fact, continuous observation, which allows it to provide information not accessible to orthodox researchers. ITK is also based on local field-testing, but it lacks facilities for systematic experimentation. Any innovation that is to serve individual or community development should whenever feasible be first based, on existing knowledge available locally. In this respect, it is essential to capture farmers’ knowledge, experience and proven managerial skills. It is also necessary to conciliate farmers’ innovation capacity with scientific on-farm research and experimentation as well as with modern technology. The present gap in knowledge related to ITK needs therefore to be filled up not only by research institutions, but also by extension and technical services.

6.5.5. Initiating participation and rural community partnership in local development

"The importance of participation in effective delivery of local public goods is well recognized, and it is central to community provision of services\textsuperscript{55}. While this is increasingly being acknowledged, there remains a major gap in the knowledge of how to bring from the initial stage (identification/formulation), various donors with different but complementary sector oriented interests and, together with beneficiaries and grass-roots organizations, to combine efforts within a specific zone to satisfy the complementary short, medium and long-term needs of a given group of beneficiaries within a sustainable approach to local development.

6.5.6. Establishment of a network of decentralized environmental information systems

While several institutions are attempting to establish environmental information systems for natural resources conservation and use, they all suffer from a lack of expertise and from their inability to combine efforts in establishing a decentralized environmental information system network. Furthermore, the vital ground data which is essential in any information system, is not available as most institutions have not developed the capacity to undertake inventories, collect, and analyze field data. The GDFDC for instance cannot monitor the changes occurring in its forest resources without being able to assess regularly, through the analysis of field data the available woody biomass.

6.5.7. Awareness of environmental degradation and desertification

There is a lack of qualitative and quantitative data on the status of natural resources in the country. Consequently, public awareness of environmental degradation and its implications is fragmentary (deficient) and not founded on complete information on ecosystems and land use systems. While people in the primary sector may clearly see the effects that depletion of land has on crop, animal production etc., neither the gravity of the problems nor the causes and the processes involved are always well understood. There is still a lack of understanding of the value of biodiversity, even when it is admitted that the situation was better in the past, in terms of biomass production and in terms of number of species present. There is a lack of understanding as to how over-exploitation of one species can affect the well-being and the productivity of the ecosystem as a whole.

Nevertheless, environmental awareness is growing among the public, thanks, in good part, to the important extension efforts carried out within forestry projects, which target large and specific publics (mainly rural). Thanks to this, farmers, recognize much better the negative impact of growing populations and of increased pressure on land and natural resources. They also acknowledge the role of bad management decisions and have a better perception of the limited availability of the resource.
VII. NATIONAL STRATEGIC FRAMEWORK TO COMBAT DESERTIFICATION

7.1. Rationale

Environmental impacts are serious and often critical in Yemen, where net population growth exceeds 3% per year, agricultural land is limited, holdings per family remain small, rainfall, surface water flows are erratic, and groundwater is being overexploited and used inefficiently. The desire to deal with these problems comes at a critical point in the future of the country. The approach through complementary programmes targeting the most sensitive issues is correct and amply justified. It should lead to success, provided foreign assistance and national and community (local and migrant) solidarity are made available when and where most needed.

7.2. Principles

The following constitute guiding principles to the formulation of a strategic framework for the NAPCD. They are partly inspired from Agenda 21 and the UN-CCD, to which the ROY has adhered. They are also a manifestation of some strengths of the Yemeni context, which should constitute a solid base to support the NAP. They characterize finally the expression of some weaknesses of the same Yemeni environment, to which remedies need to be found in order to develop an efficient strategy aiming at combating desertification.

7.2.1. National framework

It must be recognized that combating desertification is an act of development to be undertaken within an integrated and holistic multi-sector-oriented and long-term approach. Within this, the NAP should:

- Address adequately the underlying causes and the basic factors of natural resources’ deterioration;
- Be based on comprehensive and active community participation, in partnership with NGOs, Popular Organizations, Government Organizations, donors etc.
- Devote consequent efforts to, and set-up practical mechanisms to ensure active coordination and collaboration and cooperation between all bodies concerned with addressing the desertification control issue.

Reinforcing people’s control over, and assuring them long-term access to resources is of prime importance if we are to ensure their long-lasting commitment through participation. Measures for combating desertification should also consider the following:

*Productive investments:* Yemen is, and will be benefiting from relatively high oil revenues. The country should take advantage of this opportunity to spare and protect its critical land and water resources and establish adequate mechanisms for the protection and sustainable utilization of these resources, thus implementing its obligations under the United Nations Convention to Combat Desertification

*Priorities:* Priorities should be to ensure that short-term economic benefit is not given priority over long-term sustainability. Protecting non-degraded, productive resources merits priority action, together with “tackling reversible damage to remaining resources”.

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**Traditional knowledge:** Too often ignored, underestimated, or neglected in the past, Indigenous Technical Knowledge (ITK) and experience should get more attention from government institutions, development agencies and NGOs. Because of the long time needed between starting conventional research work and the uptake of improved technologies that eventually flow from that work, it is essential to resort to traditional knowledge and experience. Only this allows gaining time in reaching tangible levels of sustainable achievements through introduction of improved technologies relating to land resources’ management. Therefore, “traditional knowledge and experience should be carefully studied and promoted where it is shown to protect and improve local land, but certain damaging practices, resorted to by local societies as means of survival during stress periods, should be replaced by alternative non-destructive solutions”\(^{58}\). Proven ITKs constitute a national heritage and a national resource to be systematically collected, analyzed, registered, and extended when necessary.

**Land and resource tenure rights:** Farmers should be involved in the formulation of policies on land tenure and on users’ rights over woodlands/rangelands etc. They should be involved in the formulation of communal development, rehabilitation, and/or management efforts in such domains as torrent control, dams construction and maintenance, soil and water conservation etc. In this regard, “more attention needs to be given to customary rules that parallel modern systems, and to different types of resource users including marginalized groups, in order to deal better with potential conflict. There is a need for clear understanding of rights, and for strong local institutions to sanction them”\(^{57}\).

**Land Systems or Units:** The main Land Systems or Land Units should be distinguished with regard to their physical characteristics and in respect of their potential for human occupation. The division of Yemen in main Land Units needs to be formally normalized to avoid the present confusion. The country is divided in Geographical Regions, Landscapes, Ecological Zones, Physiographic Zones, and Agro-Ecological Zones etc. These zones vary from 4 to 8 according to the classification adopted.

**NGOs as intermediaries:** Non-Governmental Organizations (NGOs) can be invaluable in reaching rural communities in an effective, efficient, and sustainable way. The inclusion of NGOs as well as Women Associations, Interest Groups, Agriculture Unions, etc. as partners is most effective if it takes place during project/programme design or immediately after. NGOs, particularly national ones, often need to be strengthened in order to provide optimal services. Donors and multilateral agencies should therefore consider the need to provide them with financial support, technical assistance, and training.

**Local institutions and organizations:** Institutional capacity building deserves equal importance with physical aspects of projects/programmes in terms of budgets, activity plans, and impact expectations. Therefore, local institutions and village organizations ought to stand out as the essential foundations for scaling-up impacts of successfully tested methods and techniques. Upgrading basic skills in local communities is a prime condition for local institutions to ensure their new responsibilities, as is the promotion of legal and regulatory frameworks permitting their genuine participation. Equally important is the need to assist in defining the role of each stakeholder, and to ensure, as far as possible, effective participation of the partners in all activities supporting sustainable local development.

**Enabling environment:** Yemen’s experience in land resources’ management shows clearly that the “enabling environment” is still inadequate as it does not yet allow enough for, or does not promote either sustainable management or long-term development initiatives. Policy reforms are needed to further improve the “enabling environment”. Some, such as decentralization, are already underway, but need to be pushed further, to ensure local communities’ empowerment in self-development. Decentralization, “decontrolling”, and partial disengagement of government functions in favor of regional and local control should bring rule setting, decision-making, arbitration, and effective enforcement of user rights to the local level. Communities should be given an enhanced role in public administration and development planning and decision making especially is the domains of sustainable management of agricultural, forest and range production systems and resources. Legislation needs to be placed in a broader perspective, with clear objectives in terms of integrated and community-based

\(^{57}\) Lessons from the field for the implementation of the UNCCD. The case of the UNSO/SIDA Sahel Programme, 1997
development. Furthermore, conditions favorable for long-term investment should be analyzed and framed into supportive policies. In the same line of thought, producers’ organizations and resource users’ associations need to be given full recognition, so they can exercise full control over resources and enter business arrangements as legal entities.

Population in development plans: The Government’s views towards population growth and dynamics vis-à-vis economic development as indicated from its response to the World Populations Enquiry (the Eighth) are as follows: Population growth and fertility levels are too high and the government will intervene to lower both…. the internal migration rate is high, and the government policy is to decelerate the trend. Immigration rate is too high, and the government policy is to lower it. The level of emigration is viewed as satisfactory and the government policy is to increase it.

The National Population Action Plan (1996-2000) re-emphasized that population growth was one of the most serious problems facing the socio-economic development programmes in Yemen. The Plan indicated that reductions in fertility are a matter of individual choice, to be applied within the context of Islam. However, given the downward trend in public expenditures in the social sectors, it is believed that many of the National Plan’s targets will not be completely achieved by the year 2000. This is a clear indication of the efforts that still need to be deployed to raise awareness and facilitate appropriate individuals choices in terms of family planning and fertility reduction. In reality, besides a strong leadership and political commitment, the family planning and birth control issues need a solid commitment and backing on the part of the religious, the traditional and the cultural leadership of the country. Furthermore, more substantial funds need to be allocated for better socio-economic programmes, without which no progress is possible.

This is to be completed by promoting a real integration of women in rural development, through enhancing and supporting their full membership in all type of people’s organizations, as well as effective participation in planning, implementation and evaluation of rural development programmes.

7.2.2. International framework

Having ratified the UNCCD, Yemen has become officially a Party of the UNCCD. As such, it is committed to its obligations. The general commitments listed in Article 4 of the UNCCD, call for the Parties, in their effort to combat desertification and mitigate the effects of drought, to:

- Adopt an integrated approach;
- Integrate strategies for poverty eradication;
- Promote cooperation and strengthen it at sub-regional, regional and international levels;
- Determine appropriate institutional mechanisms; and
- Promote the use of existing bilateral and multilateral financial mechanisms and arrangement to mobilize and channel substantial financial resources.

In addition to their obligations pursuant to Article 4, the obligation of the affected countries comprise five clearly stated articles, among which:

- To give due priority to combating desertification… and allocate adequate resources;
- Establish strategies and priorities, within the framework of sustainable development plans and/or policies;
- Promote awareness and facilitate the participation of local populations;
- Provide an enabling environment by strengthening…. relevant existing legislation.

Also, Article 8 states that “the Parties shall encourage the cooperation of activities carried out under the UNCCD and other relevant international conventions”. In this regard, the ROY would cooperate with and offer assistance to Asian CCD regional networks under implementation, such as: i) Agro-

forestry and soil conservation network hosted by India; ii) Dune fixation and range management network hosted by Iran; and iii) Desertification assessment and monitoring network hosted by China.

7.2.3. Mobilization of resources

“Resource mobilization and funding mechanisms are instrumental in implementing the NAP process and the CCD. Finding relevant and sustainable financial mechanisms to fund this process is critical as no specific fund for environment was put into place by the Convention… The rationale behind not creating such a Fund was that this would encourage countries to make better use of existing internal and external financial instruments as well as develop mechanisms for mobilizing domestic resources, rather than solely mobilizing external resources.”

Article 5 (a) of the UNCCD calls upon affected countries to “…allocate adequate resources in accordance with their circumstances and capabilities”. Therefore, it is primordial for the GOY to explore innovative methods and approaches in order to mobilize and channel resources for the implementation of the NAPCD and the UNCCD.

Therefore, the challenge in this respect is to insert desertification control related activities into the Yemen development plan and strategy and give priority to funding the NAPCD. This funding priority can be articulated through national budget allocation, private sector, NGOs, and local community contributions. Other sources of contribution are also to be envisaged such as Agriculture and Cooperative Credit Bank, Agricultural and Fisheries Production Promotion Fund, etc.

Article 4 (h) of the UNCCD stipulates that the Parties shall “promote the use of existing bilateral and multilateral financial mechanisms and arrangements that mobilize and channel substantial financial resources to affected developing country Parties in combating desertification and mitigating the effects of drought”.

In addition, the government/MAI has to study the possibility of creating a National Desertification Fund (NDF) to support desertification control activities at community and NGOs levels. The government/MAI should assess what are the existing mechanisms and instruments available to respond to community needs regarding the implementation of regional programmes to combat desertification. The needs, objectives, and areas of intervention and use of the NDF are to be clearly outlined. It should be understood that the NDF is a funding mechanism to promote community and civil society, including NGOs in the field of desertification control activities.

7.3. Institutional Set-up Framework

7.3.1. Human resources’ development and capacity building

Capacity building through training: There is a real and urgent need for building human capacities in the field of desertification control planning. This should be done through provision of specialized training to the staff working in the field of desertification control, forestry, and range at central and regional level. This type of training could include, among others:

- Desertification control planning,
- Stabilized sand dune management,
- Desertification monitoring and desertification impact evaluation,
- Utilization of GIS and remote sensing techniques

Human resources’ development through extension and awareness raising: Sustained programmes relating to extension and awareness raising in the field of desertification are still very week. AREA

and NGOs working in related fields of environment, especially in the scope of desertification control activities, should put more efforts and devote their resources (even limited) to increase public and government awareness on the impact and danger of desertification effects on socio-economic aspects. Therefore, a national strategy for extension and awareness raining should be developed in the field of desertification.

### 7.3.2. Institutional strengthening and development needed

GDFDC and Regional Forestry Sections have been created, expressing the Government's commitment to promote forestry issues and combat desertification. To guarantee the effectiveness and sustainability of their services, these institutions need to be further strengthened by:

- Providing it with adequate financial support within Government annual budget;
- Revising the forest law and speeding its endorsement by the Parliament;
- Establishing formal administrative relationships between GDFDC and the Regional Forestry Sections in order to unify the planning and implementation of National Forestry and Desertification Control programmes and facilitate circulation and exchange of information in both directions.
- Pursuing forestry activities in the light of existing demo-plots and extending them to the rest of the country, particularly the southern, eastern, and western Governorates. Priority should be given to agro-sylvo-pastoral and desertification control activities.

AREA, which is an institution responsible of agriculture/forestry research and extension need to be more strengthened through provision of adequate resources and mechanisms to focus and give more priority to desertification control related activities and to promote applied research in close cooperation with farmers as well as concerned institutions (GDFDC and Regional Forestry Sections). In addition, It is of great importance to establish, within AREA, a research center for renewable resource.

To ensure national and regional coordination as well as follow-up of desertification control programmes and activities, a High Committee for Afforestation and Desertification Control (HCADC) should be established as part of implementing the NAPCD and the UNCCD. This HCADC should be composed of all concerned government and non-government institutions.

The government/MAI should also study the possibility of creating a National Authority to Combat Desertification (NACD). This institution would be responsible for assessing, monitoring and evaluation the desertification and drought.

The National Network to Combat Desertification, recently established, should be reactivated and strengthened. This Network can play a very important role in providing useful information relating to desertification aspects.

### 7.3.3. Policy and legislation needed

**Policy needed:** In addition to the existing policies (Water Irrigation, Watershed Management…), there is a real and urgent need to formulate other national policies dealing with and supporting desertification control activities (Water Resource Policy, Forest Policy, Policy to consolidate Traditional Knowledge in land resource management…)

**Legislation needed:** The legislation in place is incomplete. There is a need for the preparation and/or adoption of additional laws (Water Law, Water Irrigation Law, Forest Law etc) as well as for the development of specific by-laws. In addition, decrees and regulations need to be articulated. Furthermore, legislation needs to be placed in a broader perspective, with clear objectives in terms of integrated and community-based development and management, to promote sustainable economic growth and enhanced social and environmental conditions. The basic legal requirements should aims at securing (within a decentralized and community-based context) land tenure and supplying security for
resource and water rights, to regulate allocation and utilization of the resources and provide for protection against abuses.

Knowing that "established local traditions provide a sound basis from which to elaborate a programme linking the conservation of renewable resources with sustainable national development" (IUCN, 1980), and to avoid the destruction of one of the main supports of social and environmental stability in the Yemeni rural sector, regard must be given to the existing systems of tribal ownership and their correlated laws. Efforts must be undertaken to "legitimize" customary rights through new or revised legislations. To this avail, it is necessary to evaluate the tribal ownership systems as well as the customary land laws, which provide the framework for those still in operation, and formulate ways of merging the existing and future statutory laws, with the existing customary rights.

7.3.4. Coordination, Integration, and Harmonization needed

The strategic framework should allow for further consolidation and coordination of different national strategies and policies and of complementary programmes (Poverty alleviation, Water resources etc.) within the overall national planning and budgeting.

Generally, it has been proven that “at the local level, people did not divide themselves sectorally, and that participatory approaches were more easy to use to provide integrated outcomes. At higher levels of governance however, areas of overlapping need to be identified, along with a recognition of synergies, an understanding of institutional capacity and with respect to desertification, a mainstreaming of dryland development into national development agendas”.

A coordinated global and cross-sectoral effort should also be undertaken. This global vision would certainly to increasing the knowledge-base and consolidating the data available in compatible form, and to obtaining an improved base of information for a better understanding of the desertification issues and consequently for better planning and action.

Therefore, there is an urgent need to establish a National Body to be in charge of approving, coordinating, facilitating and monitoring all desertification control programmes/projects, activities, efforts etc. from various institutions and organizations concerned at national level. This forum is an opportunity to coordinate, integrate, and harmonize different development actions relating to desertification control.

7.4. Participation of Civil Society and Poverty Alleviation

7.4.1. Decentralization

The current system of centralized government services has limited the ability of local administrations and development institutions to provide effective services both at municipal and rural levels. Communities should therefore be given an enhanced role in public administration and development planning and decision-making especially in the domains of sustainable management of agricultural, forest and range production systems and resources. Environmental management responsibilities should be assigned to the lowest possible administrative level, so as to fully involve local communities, village organizations and individuals, within a community-based approach, to be undertaken in full partnership with the local private, governmental and non-governmental institutions and organizations.

The mandates defining the role and responsibilities of the different monitoring and regulatory authorities and institutions in the assessment of environmental issues and enforcement of environmental laws must be clarified and coordination mechanisms defined. In addition, standards must be specified together with the technologies and timetable to meet these standards.

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60 Philip Dobie (UNSO). Capacity Building Workshop for Dryland Management and CCD Implementation in the Arab Region. Beirut, Lebanon. 3-5 May 2000. UNDP
7.4.2. Revival of useful traditional/customary resource management systems

Because community based tenure systems are usually more cost effective than State sponsored forms of management, it is often most appropriate for government management authorities to focus on playing a regulatory, facilitating and coordinating role in managing biological resources, while communities would invest in improving and protecting the resource base. Involving local communities in efforts to manage and conserve natural resources makes good sense because they know and understand the local environment, observe changes affecting it on a timely basis and are able to respond to any crisis situation equally on a timely basis. Furthermore, activities planned and undertaken by communities guided by local knowledge are certain to be more culturally sensitive and less disruptive than centralized programmes, which tend to operate in terms of highly aggregated and simplified information.

“Established local traditions provide a sound basis from which to elaborate a programme linking the conservation of renewable resources with sustainable national development” (IUCN, 1980). This is particularly true of Yemen, which has developed fine customary systems of tribal ownership. Founded on the principle of community of interest, some have under particular circumstances, become less secure and even fallen into disuse. Their revival as policy, legislative, and management tools is essential, as they constitute a “national heritage” and basic components of community subsistence production and conservation.

Among the most useful traditional and customary management systems that need to be urgently and thoroughly investigated and re-instated within the present Yemeni context are the long-established: i) soil and water conservation and utilization systems; ii) agro-forestry systems; iii) natural resources’ protection systems; and iv) terrace rain-fed agriculture systems.

7.4.3. People’s organization/public awareness and participation

Following are some basic principles to be reckoned with in the course of implementing desertification control measures and programmes:

**Popular participation and partnerships:** The importance of preserving local people's knowledge of dry-land management and survival strategies should be recognized. Their full involvement in the rehabilitation and sustainable development of their lands needs to be ensured from the early start of the process. The notion of community participation needs to be understood as a whole package, which refers to small-scale projects, flexible in their design and ultimately based on local knowledge in addition to the introduction of proven new technologies that are socially accepted.

Long-term partnership arrangements between local communities, represented by their leaders and local organizations, central, regional, and local government institutions, Donor agencies, NGO's, Aid Associations etc. are needed to enhance security and sustainability of development efforts and investments. These organizations should further define their respective roles, comparative advantages, cooperative mechanisms, and levels of intervention and corresponding resource allocations in the implementation and control of the long-term follow-up of the global development programme.

**Farmers’ organizations:**

“Small-scale farmers in developing countries are not usually politically and economically strong, and can not easily influence governments and other actors. Strengthening their organizations and influence is one of the priority areas… Such strengthening requires not only pro-active farmers’ groups at the grassroots, but also effective farmer representation at all levels – local, district, national, regional and global – through farmers’ organizations… In recent years, there has been a paradigm shift within development circles. One talks less about participation, per se, but participation through civil society organizations in general, and farmers’ organizations in particular… Today, important structural changes are in motion at all levels… Farmers are inextricably linked to food security, to sustainability and vitality of rural communities, to the environment…

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Farmers have to be strong at all levels, and as well vis-à-vis their partners, to eradicate rural poverty and hunger."

**Global awareness:** There is a need for the global public to be led to understand and acknowledge that affected zones, their remaining resources and their peoples are important to the stability, the unity and prosperity of the nation and it is indispensable for it to demonstrate solidarity and cooperation through the establishment of active Aid Associations, NGOs etc. to help them outlive the present dramatic crisis;

### 7.4.4. Poverty alleviation

Since poverty and threats to the environment are linked, it follows that strategies, which, do not address both issues simultaneously, are likely to fail. It is obvious over all Yemen that if the poor find no alternative, they will use land and water resources in ways, which will drastically, impair future productivity, and induce irreversible desertification. While participatory approaches to development and environmental issues are the surest way to warrant success, it must be remembered that they require that beneficiaries participate to costs and investments besides providing labor. This would tend to exclude the poor whose investment capacities are weak. It is therefore necessary to conceive an approach based on adequate social and community organization that is able to revive the traditional solidarity responses to hardship and indigence, and contribute to a better efficiency of the State’s efforts towards poverty alleviation. Only then, will the poor actively contribute to the protection of the resource and the enhancement of the production systems.

Reminding that the rural populations have expanded and will continue to augment well beyond the absorptive capacity of the agricultural economy, it is clear that investments and improvements in agriculture production will not be enough to entirely offset population upsurge and poverty expansion, particularly in the rural world. For sure, the alarming and relentless increase of pressure exerted over lands displaying steadily declining production capacities must be adequately compensated for, through renewed technology and production efficiency in the agricultural economy. However, it remains factual that complementary choices must also be secured to the rural poor to achieve food security. Off-farm job-creation and investment opportunities are indispensable in order to prevent that the rural jobless and landless be further compelled to desperately and uncontrollably fall back on agricultural production and mining of increasingly limited natural resources to survive. Creating off-farm jobs for the poorest will: i) reduce the pressure on natural resources, ii) alleviate poverty and improve food security, and iii) maintain the population in place in order to participate to agricultural activities in periods of intense labor requirements and avoid swelling rural migration to the urban centres.

In response to this, the IPRSP suggests among others the following:

**Sector-based Policies:**

“Focus is to be directed to potential sectors that could lead economic growth, such as small and medium scale industries (garments, handicrafts, etc.), fisheries, tourism, and agriculture. In this context, macro as well as sectoral economic policies will be directed to promote investments in these sectors, which are promising and at the same time serve directly low-income groups”.

**Institutional Reform Policies:**

?? “Implementing local governance would support the civil service reform and broaden participation and monitoring. Expanding people’s participation leads to mobilizing public as well as official efforts. It also provides further incentives for the realization of economic

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62 Agricultural economy is taken in its broadest sense, to include agricultural production, livestock breeding, forestry production, fisheries, etc.

development and a conducive environment to alleviate poverty, especially in remote and deprived areas”;

“Continue to support private initiatives to increase the role of the private sector in the economic development process, through reconsidering and amending the Investment Law as well as other related legislation”.

This is particularly important in the Yemeni rural context of extreme poverty, where off-farm job creation and investment will undoubtedly contribute positively to poverty alleviation.

**Strategy for reducing poverty:**

“Create income-generating opportunities through economic growth and revise the development approach to include expanding economic opportunities for the poor”;

“Enhance the capabilities of the poor as well as increase the return on their assets through some social policies and measures”;

“Promote specific policy and programme support measures that address issues that limit women’s access to economic opportunities and resources, capacity building and social security programmes”.

Further, the IPRSP recommends to:

“Enhance human capital assets of the poor. Public investment in human capital and providing access to productive assets are effective tools to protect households from chronic poverty”;

“Expand economic opportunities for the poor in the agricultural sector and in rural areas. This will assist in addressing food security issues. Accelerating growth in the regions… should be in line with labor intensive modes of production that are very much suited to the development model for Yemen”.

These proposals and recommendations shall, no doubt, require massive and recurrent funding and since the GOY “will remain unable to finance the necessary anti-poverty programmes that would achieve anticipated goals due to lack of domestic resources, it will resort to the generous donations and soft credit from multilateral and bilateral donors…”64. The latter will hopefully live up to their commitments as expressed in Agenda 21.

### 7.5. Research and Development

Yemen’s agricultural research system is oriented towards raising production of the better-off farmers and has difficulties reacting to the growing problems of small farmers and unsustainable land use practices (Dr. Theda Kirchner, Sana’a, 1997). The "Innovation Development in the Agricultural Sector" (IDAS) Project was conceived with the objective of mobilizing farmers' self-help capacities and to introduce and support participatory research approaches in Yemen’s agricultural research system. Using the SWAP (Success-Weakness-Aims-Problems) method, IDAS has had a significant impact with participation, and self-help in some villages; the shortcomings being mainly due to deficiencies in training and evaluation. However, the Project, in its two phases, did not reach the point where it could capture farmers’ experience, technical and managerial skills, and above all, conciliate farmers' innovation capacities with AREA’s scientific approach by developing a consequent on-farm research approach.

Therefore, AREA needs to develop methods that make farmers, particularly those who, depend on small-scale subsistence agriculture, participate to research by incorporating their needs and their capacity for observation as well as for innovation and experimentation as a complement to the present “high-tech” transfer of technology trend. There is also a need to consider the farm and individual field plots as the main sites for experimental design and action.

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Regarding forestry, the GDFDC activities should rely on sound forestry research in the country. This research is presently stagnant if not inexistent. Many pertinent and practical questions raised at field level, remain unanswered. In close collaboration between GDFDC and AREA, a National Applied Forestry Research Programme should be urgently initiated and developed.

7.6. Reconnaissance and Monitoring of Desertification and Land Degradation

7.6.1. Initiation of national surveys and cartography of forests and rangelands

The roles of forests, trees and rangelands are multiple and often unnoticed. From production of wood, forage, and fodder, to protection against erosion and soil fertility improvement, there exists a wide spectrum of major and lesser services provided by these natural formations, which need to be recognized, improved and sustained through management.

Everyone agrees that significantly important forest and range tracts have been cleared and that the remaining, frequently dispersed and open-woodlands and rangelands, are being steadily degraded. Thus far, we know little about the propagation and the magnitude of this phenomenon. Very pessimistic predictions have been made about such strategic products as firewood and yet, we are unable to take appropriate decisions, simply because we have no precise idea about the situation.

Planning management activities and programmes according to economic, social and environmental objectives and priorities, requires a good knowledge of the composition and condition of forest/range formations. The same is true when it comes to managing the remaining resource and rehabilitating the degraded and extinct formations. Developing national forest and range policies, which decide the priorities of action and the magnitude of intervention programmes requires a thorough knowledge of the resources in quantitative as well as in qualitative terms (area, state of degradation, spatial distribution etc.).

This knowledge is at present not available, as the country has not yet been covered by general forest and range surveys. Current policies and programmes are developed, based on partial, if not inaccurate and perhaps erroneous information. Within the framework of the NAPCD, this situation must imperatively change, as policies are interdependent and require to be based on accurate and reliable information. It is therefore indispensable and urgent to have the country covered with general forests and rangelands surveys. The institutions in charge must build-up their capacity to undertake such surveys, keeping in mind that a number of services and activities can be delegated to other institutions. The NAPCD should aim at renewing these national surveys and inventories every 5-7 years.

7.6.2. Consolidation and coordination of the national environmental information systems for national resources’ monitoring, conservation and use

Among the many providers of information on environmental variables at national level, there is fragmentation and lack of coordination (NEAP, 1996). Several national organizations are independently attempting to establish GIS for the assessment and monitoring of natural resources. Overlapping mandates, absence of coordination mechanisms and of standard data collection systems, processing and transfer formats, result in inefficient and unreliable data collection and utilization. The available maps are often outdated and the development of digital geo-spatial databases is processing very slowly. Though, there it is urgent to rationalize the exploitation of the existing Environmental Information Systems (EIS), no coordination and networking, are planned for the near future.

There is therefore, a definite and urgent need for consolidation and coordination of the national EIS, for adequate natural resource conservation and use. What is required to achieve this is, a “National

65 EPC, Yemen Survey Authority, GDFDC, AREA, CSO, MHUP.
Spatial Data Infrastructure, which would establish policies, technical standards, and linkages to facilitate multiple use of geo-spatial data among its participants” (Z. D. Kalensky, 1997).
8.1. **Objectives**

8.1.1. **Development objectives**

The NAPCD is aiming at contributing to sustainable development of the country through reinforcing capacities and ensuring full and active participation of civil society (local communities/groups, NGOs, group/village associations, cooperatives…) in desertification control activities.

8.1.2. **Specific objectives**

- Ensure a sustainable and integrated management of land resources in order to promote food security;
- Improve socio-economic environment to participate in poverty reduction;
- Improve institutional organization and mechanisms as well as legislatives environment for an efficient desertification control; and
- Improve knowledge of desertification phenomena, monitoring and evaluation the effects of desertification and drought.

8.2. **Approach**

Experience gathered in implementing the participation concept in Yemen and elsewhere, has generated a different approach of transferring the initiative from the State, the project, or the programme agent, to the local resource users and ultimately managers. This empowers the latter to take active part in testing new concepts and systems, and in searching for, and identifying possible solutions to local problems in land resource management. The NAPCD should be based on such an approach if it is to generate new attitudes and practices with local land users, as well as with the government / project / programme agents towards more responsible, concerted, and sustainable land use planning. “The goal is to engender a sense of responsibility and ownership for the environment among all parties, and a belief that local investments in improved natural resources’ management will be rewarded in the future”\(^66\).

However, the sustainable management of dry-land environments is difficult to achieve as their ecological carrying capacity is by far, exceeded by the present human and animal populations they support. The concept of carrying capacity should be broadened to integrate the economic capacities/potential (higher capital/credit availability, local innovation/organization/marketing potentials, food and financial aid from remittances, NGOs and Donor community etc.) that can finance desertification control programmes and help create off-farm jobs and enterprises as a support to local development (S. Rouchiche, 1997).

The participatory approach should be applied under a new management system. The “Gestion des Terroirs” as, it is called in West Africa, where, it has been developed and successfully tested and adopted.\(^67\) The “terroir” concept comes from geographers, who use it to define a cluster of communities with common socio-history. An identified “terroir” becomes a territorial unit for negotiated land use planning purposes (forest/range/agricultural areas’ negotiated delineation, private versus communal shared uses of resources etc.). This “community land resources’ management

\(^{66}\) Lessons from the field for the implementation of the UNCCD. The case of UNSO/SIDA Sahel Programme, 1997.

\(^{67}\) This approach has, recently been introduced in Yemen by the GCP/YEM/026/NET FAO-Project.
approach\textsuperscript{68} provides the opportunity for all local major stakeholders and resource users to express their visions and priorities and reach a consensus in taking in charge certain land-use planning functions. The “community land resources’ management approach” constitutes a sound basis for the formulation of local long-term development programmes. As such, it should be approved as the approach for the formulation of the NAPCD.

\textsuperscript{68} This is the translation of “Appoche terroir” as adopted by the GCP/YEM026/NET Project.
The Community Land Resources Management Master Plan (CLRMP) approach of the Watershed Management and Wastewater Re-use in Peri-urban Areas of Yemen (WWPU) project encompasses gender-responsive participatory planning, implementation, and management processes. It supports community-based and demand-driven land resources’ management interventions. The CLRMP approach, as carried out within WWPU promotes regular dialogue with the beneficiaries and their organizations. It fosters the integration of their needs and requirements as well as of their interests and sense of ownership of the natural resources, into their development and management programmes.

Putting the CLRMP into practise is done by proceeding through a cycle of interventions which commences by a preparatory phase and incorporates a number of successive components including community mobilization and organization, diagnosis and priority setting, document preparation and approval of plans, preparation of intervention files and implementation and management followed by monitoring and evaluation.

Selecting one “priority community” among several candidates is done after the multidisciplinary team members have been approved and trained. They subsequently set the selection criteria and, using the Rapid Rural Appraisal method, proceed in all transparency to the selection of the beneficiary community. Taking into consideration its socio-cultural background, the community is then requested to nominate two committees (one male and one female), whose task will be to mobilize community members and facilitate decision-making processes. The selection process takes place after the whole community has been informed about the expected role of the committees and the quality expected of the members about to be selected.

Mixed technical committees composed of project agents and qualified local people possessing adequate traditional knowledge in given technical aspects, are set-up. Using the Participatory Rural Appraisal method, the mixed teams undertake, based on a pre-established checklist, a detailed investigation of the community’s resources, constraints, strengths etc., before formulating a detailed community setting diagnosis. During this process, the project staff (male and female alike) is to stay and live a few weeks with the community.

Thereafter, the community, assisted by the project, establishes under majority consensus, the listing of its main problems, priorities, and alternative solutions. The project assists likewise in supporting gender responsiveness, by establishing “problem-cause trees” and mediating between various categories. Sorting priorities in order of importance is the next step before elaborating the Community Master Plan (CMP), which formulates the objectives, anticipated activities, inputs, and expected outputs to be approved by all concerned.

Assisted by project agents, the community translates the CMP into separate technical intervention files comprising: proposed actions, technical design and specifications, and required inputs. The contribution of various partners is detailed and if needed, contractual agreements are established. Prior to initiating the implementation phase, a management body is established for the intended intervention.

The CLRMP approach has proven useful in generating significant participation of the various target clients. Increased productivity and improved sustainability of the programme and of its results appear to be the outcome of the process, which will offer soon, the possibility to replicate the positive actions and results.
8.3 **Regional Action Programme**

8.3.1. Objectives

Regional Action Programme (RAP) should be understood as part of the NAPCD. It is the key operational tool for transforming the national strategies and policies into concrete actions and measures to combat desertification at regional level. The overall objectives of the RAP can be stated as follow:

- Enhance sustainable livelihoods and regional/local socio-economic development with a view to eradicating poverty.
- Protect the environment and manage natural resources through sustainable production systems designed to control/stop desertification.
- Develop human resource through enhanced participation of local communities in planning, implementing, and monitoring development projects and programmes at regional and local levels.
- Increase knowledge and inculcate a sense of community responsibility and ownership of natural resources.

8.3.2. Principles

Degradation incidents, which tend to mushroom and affect entire ecosystems, through “domino effect” destructions, require to be urgently challenged and with resolve. Areas affected this way should be classified as priority zones of action. Consequently, degraded rain-fed, highlands terrace systems whose deterioration affects downstream sections, devastating agricultural production structures, constitute a priority issue. Likewise, coastal sand formations, which continuously feed inland dunes, encroaching on productive land, are to be considered as priority zones for action. Another area of concern relates to “closed ecosystems” such as the Wadi Hadramout flood plains, where forms of degradation and ecological changes initiated upstream, may affect the whole ecosystem. These areas need to be regarded as priority zones when they are strongly affected by major disturbances, as Wadi Hadramout is already affected by the uncontrolled spread of *Prosopis spp.*

Unlike conventional approaches to rural development, the one adopted in the NAPCD’s principles, aims at consulting the rural poor in development planning and at conferring them with an active role in development activities. The vast majority of the poor needs to be provided with organizational structures to represent their interests and, priority requirements, win them greater access to resources and markets and prevent them from being excluded from the benefits of development by fully participating to its success.

8.3.3. Formulation of long-term regional programmes to combat desertification

The formulation of National Action Plan to Combat Desertification requires studying and ascertaining the relationships between rapid population growth and the constituents of environmental deterioration. Proposals to mitigate the situation through long-term integrated action programmes should then be formulated for the critical “priority areas” identified at the regional and community levels.

The process through which the regional action programmes have been formulated and prepared is given in Appendix X. This iterative process was conducted through participation of all stakeholders at all levels (national, regional, and community). This participation included selection of priority areas (sites) and identification of desirable and feasible interventions.

Among others, the following important and priority domains have been considered:

- **Sand dune stabilization and management**: Protection plantations in arid, semi-arid and part of the sub-humid zones are mainly initiated for sand dune fixation, windbreak and shelterbelts establishment and
BOX 3

DAR MANSUR: PARTICIPATION AND PARTNERSHIP IN PRACTICE

Dar Mansur, a relatively small representative peri-urban community of Aden depends basically on subsistence land resources’ management in a hyper-arid environment. In the course of implementation of the Community Land Resources Management Master Plan approach, Dar Mansur came second to El Emad village in the selection process. Considered later unsuitable to start with at this stage, El Emad, which encountered social conflicts was, replaced by Dar Mansur owing to the latter’s poverty, high social cohesion, limited land tenure problems, and to its environmental as well as land resources degradation.

The critical first weeks of introduction and exchanges between the project and the community revealed the latter’s desire to become a full partner for the development of its resources and to build its capacity and be able to move from the present high poverty level, to being able to sustain the satisfaction of its basic needs. Putting the partnership principle into action, the community nominated two gender representative committees and agreed to set-up mixed technical field teams to conduct the PRA. In the process, different sets of priorities were diagnosed. A mediation initiated by the project brought the male and female representatives to agree on a common list of priorities taking account of the major concerns expressed on both sides.

The master plan was then prepared by the mixed technical field teams and discussed with the community to reach agreement on the priorities, the interventions, the beneficiaries etc. Intervention technical files were prepared with the community and special activity groups were set-up to be responsible for implementation, management, and coordination with the project. One key aspect of the process initiated at Dar Mansur is the new interest it has motivated in an alternative rural development strategy: A belief in people’s participation through organizations controlled and financed by the community. This is clearly confirmed by the fact that income-generating activities are partly supported by community funds managed by the village committees. All related arrangements (degree of financial support, land and water leasing etc.) are made in written agreements. The second crucial feature in the participatory methodology is that the committee representing women is empowered to voice the problems and needs of the community as perceived and identified by women. Moreover, it ensures that development options include those proposed by women who are firmly motivated in maintaining a high level of participation in different community actions and interventions.

road-side, urban and shade tree plantations. Referring more particularly to sand dune fixation, the main objective of the management of such plantations is the protection of human settlements, agricultural lands, and infrastructures. The objective of such operations, which concern a great deal of Yemen’s coastal areas and inland plains is to maintain the dune everlastingly stable through mechanical fixation followed, wherever feasible with biological fixation. However, even if protection is more crucial than production, any products or services derived from biological stabilization plantations should be considered as by-products not to be neglected as they contribute to maintenance and sustainability of the protection structure. They should therefore be managed accordingly, through population involvement and participation.

It is important to remind that the stabilization of denuded and mobile dunes is a very slow and lengthy process. “The stand changes gradually the soil and microclimatic conditions, allowing natural regeneration of many weed, shrub and tree species” (M. Malagnoux, March 1994). The emergence of natural regeneration occurs in successive waves, starting with the pioneer species. It is only after the species making up the final stand have developed and the upper horizon of the soil has undergone the
process of humification, that the dune may be safely considered as stabilized. In the meantime, several
management options, to be studied by forestry research, may be considered; they are:

- Giving preference to supporting a natural stand evolution through protection of natural
  regeneration;
- Planning successive different vegetative covers;
- Maintaining the artificial stand as long as possible and replant it identical etc.

There is a need for a comprehensive approach to combating sand movement and dune encroachment
as well as a necessity to identify priority and strategic zones of intervention, taking into consideration
the importance of assets to be protected, and the maximum impacts likely to be achieved per unit area
reated.

Prevention and reduction of land degradation: Capital, which could be used to purchase the necessary
inputs for resource management, is generally in short supply, particularly among farmers. Yet, many
effective community-based resource-management practices require some local capital. Moreover, poor
rural communities, having great difficulties in generating even the smallest amounts needed to
purchase basic materials or hire labor are for the most, in no condition to generate enough capital to be
invested in local economic development. Consequently, providing farmers, particularly the poor ones,
with the basic capital required to manage properly their resources and upgrade their assets,
corresponds to a preventive measure aiming at reducing land degradation risks. Furthermore,
endowing rural communities with adequate capital resources to be invested in off-farm employment,
income-generation and economic activities for local development, needs to be highly encouraged as a
preventive measure that brings about positive impacts on production systems and sustainable land
resource management, both of which are supportive in combating desertification. Decentralization
constitutes a favorable factor in the process of supporting local development. It needs to be further
supplemented by meeting the capital requirements through mobilization of donors, ONGs etc.

Watershed management and terrace rehabilitation and conservation: The Highland terrace system and
related wadi spate network have, in many areas, lost their century-long delicate and vulnerable state of
balance. Attempts by returnees to rehabilitate terraces have illustrated the colossal physical efforts
needed as well as the considerable financial investments required for terrace rehabilitation. This
reveals the challenges as well as the tangible limits related to this activity. It also gives an indication of
the incomparable difficulty and unfeasibility of undertaking systematic terrace rehabilitation in
Yemen. It is therefore clear that priorities must be set-up according to production objectives and
expected returns, as well as subsequent levels of investments required and available. In non-productive
sites, cheaper and less effort/time-consuming protection measures must be applied, as an alternative or
a complement to terrace rehabilitation. Classical integrated watershed management approaches would
then be most appropriate and affordable both in ecological, social, and economic terms.

With respect to watershed management and terrace rehabilitation and conservation, it will be
necessary to address issues related to the following: i) absence of a national policy and legislation
based on participatory community planning in watershed management to be integrated with water
resources’ management; ii) need to increase people’s awareness towards the dramatic state of
degradation of watersheds and promote their participation to their management and conservation;
iii) need to stimulate populations in sharing costs for water harvesting as well as water and soil
conservation; iv) need to support capacity building through training, practical research and

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69 M. Malagnoux, March 1994
70 Some sites, such as Hagda (Taiz), have been the focus of terrace rehabilitation for the benefit of returnees, with the
assistance of the FAO “Forestry Development in Yemen” Project – GCP/YEM/015/SWI.
71 Example of the “Land and Water Conservation” project – UTF/024/YEM – in Mahweet region.
72 These issues partly derived from Component 3 of sub-programme 4 “Agriculture Water Use and Conservation”, have not
yet been fully addressed.
73 This can be done by building on the experience acquired within the GCP/YEM/026/NET project.
development of watershed techniques and practices, including traditional systems; vi) need to establish clear mandates and responsibilities for institutions committed to watershed management.

Range development, rehabilitation, and management:
Large scale, rangeland development, rehabilitation, and management activities are new in Yemen. Besides a number of issues (degradation by over-grazing and cutting, progressive abandonment of traditional systems, competition with agriculture etc.), which constitute serious limiting factors, rangeland development and rehabilitation suffers from the non-existence of a long-term strategy. The following interventions need to be considered in approaching national rangeland development:

?? The formulation of a long-term strategy is urgent in order to define priorities and ensure optimum co-ordination to guarantee the sustainability of the future national range development, rehabilitation and management programme;
?? The management of traditional grazing reserves and interventions related to rangeland fall under the mandate of the Range Management Directorate (RMD) of GDFDC with which sub-programme four should be officially linked (M.G. Zaroug, July 1998). The RMD needs to be staffed with qualified profiles, while existing personnel require urgent training and capability strengthening;
?? All data dealing with rangelands and extensive livestock production systems need to be collected and analyzed in order to evaluate the current situation and define the gaps that should be filled in the future;
?? On the basis of the above, a national rangeland development, rehabilitation, and management programme would be formulated.

The well established, Hima or Mahjur tradition ought to provide a sound basis from which to elaborate a programme linking conservation of renewable range resources with their sustainable development at national level. The Hima needs to be revived and/or reintroduced in order to:

?? Allow the controlled utilization of resources, ensure their proper conservation and use, for particular purposes, while preventing their abuse, thus making sure that the system is and remains ecologically sustainable;
?? Ensure that protected areas are widely recognized and respected, and that benefits are allocated among the community members, following a socially acceptable and equitable set-up;
?? Provide, through allocating fodder and other resources, the necessary incentive for community discipline and investment in the preservation of the resource.

Revival and extension of the Hima concept should have far reaching implications for the better protection of the resource base. Easier to accept and introduce among local, tribal-based communities of the ROY, the Hima should also provide a great opportunity for setting-up a socially and ecologically adapted and adequate decentralized system of protected areas.

Agro-forestry: The ecological and socio-economic importance of traditional agro-forestry systems is now widely recognized. These, often ancient land-use systems provide useful products for household as well as for local and national economies. Such commodities range from food and medicinal products for humans and animals, to construction and fuel-wood, and cash income. They furthermore, “contribute to the sustainability of soil nutrient and water cycles and buffer climatic extremes”.75

Yemeni agro-forestry systems are very old and varied. They are encountered in most ecological areas supporting farming land use systems. Numerous indigenous tree and shrub species are associated either individually or combined to the main crops which may be summed-up as: cereals, fruit, date palm, vegetables, fodder etc. In his classification of agro-forestry systems in the Southern and Eastern provinces of Yemen, Ibrahim Nahal (1992) describes nine major types of agro-forestry systems according to the main functions and products to be expected from them. In these systems, trees are

74 Community Participation in Land Resource Management – Management of Traditional Grazing Reserves.
there to perform various functions ranging from protection against: sand encroachment and sand blasting, drying wind effect, water erosion, sunshine, animals etc. They are also there to provide various products including: fruit, construction wood, fuel-wood, fodder, honey etc.

These abundant Yemeni agro-forestry systems, which are very important to local populations in terms of food security, income generation and environmental protection have not been sufficiently documented and evaluated. They are furthermore being increasingly neglected in the modern farming systems, which make essentially use of exotic and fast-growing tree species. It is therefore crucial to take into consideration this long-lived traditional knowledge. This is to maintain and develop further the traditional agro-forestry systems and introduce indigenous multipurpose trees and shrubs in the modern farming systems, contributing, in a sustainable way to environmental protection, food security and in one word, desertification control. GDFDC, AREA, Agricultural Services, and Development Authorities need to actively contribute to this objective. AREA, in particular needs to better document the local agro-forestry systems and develop with its partners, a consequent experimentation programme, to develop modern agro-forestry systems, based on traditional knowledge and modern farming requirements. AREA has the mandate to undertake this task, since the “development of improved systems for sustainable and productive farming”, which includes agro-forestry systems, constitutes one of the 19 strategic national research priorities identified by this institution.

Natural woodlands and forest management: In Yemen, as elsewhere in the world, agricultural land has been gained on natural forest/woodland formations. Given the adverse environmental conditions that prevail in the country, these formations have been preserved, for the most, on the poorest sites, where agriculture would be marginal and unsustainable. With few exceptions, these natural stands suffer much strain and are little productive especially in terms of wood commodities. They nevertheless, play a major role in environmental protection and fulfill many other economic and social functions by providing a wide spectrum of products and services.

Their protection, improvement, and extension, through management, should constitute a key contribution to desertification control in Yemen. Following completion of the natural forest resources’ survey, it will be possible to determine at national, regional and local levels, the priorities in terms of sites and objectives as well as the magnitude of management interventions to be planned. The main objectives can be chosen from the following: i) forest conservation for environmental protection, biodiversity and wildlife habitat preservation, water conservation etc.; ii) fuel-wood and charcoal production to meet domestic and industrial energy needs; iii) fodder production; iv) production of other non-wood forest products etc.

While it is generally recommended to aim at a multipurpose type of management, one must keep in mind that in combating desertification, preserving existing forests and woodlands, and sustaining their protective role, are of major importance. In addition, it must be considered that for the most, natural forests and woodlands are, either private or communal possessions. Their management should therefore be decided and implemented by individuals or communities. The State should however play a very important facilitating role by taking in charge the following operations:

?? Training local people in surveying, sylviculture, management and conditioning/marketing forest products;
?? Studying the forest formations to help establish a listing of possible objectives;
?? Undertake research and experimentation aiming at improving the stands and at developing appropriate sylvicultural techniques etc.;
?? Create adequate marketing conditions for the commercialization of wood and non-wood forest products;
?? Provide incentives to encourage the preservation, management, and extension of forests and woodlands.

Sustainable water management programme: The Sustainable Water Resources Management Programme (SWRMP) was launched in January 1997. Executed by NWRA, it includes sub-

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76 Agricultural Research Strategy - Prepared by AREA, supported by ASMSP and ICARDA, DEC. 1997.
programmes implemented in conjunction with NWSA, MAI, and GAREWS. Despite important achievements, the PSD on sustainable water resources management has not yet reached its main objective of capacity building and institutional strengthening as well as of creating national leadership in water resources development and management. Because it does not seem likely to improve the situation in the near future, this programme ought to benefit from additional long-term funding and efforts and should constitute an upcoming key priority agenda. More important, however, NWRA should have the necessary political support and institutional capacity to fulfill its mandate as sole national institution in charge of policy making, of planning and elaborating national strategies, and of supervising their implementation. This presumes reviewing of the mandates of all institutions dealing with water resources with the purpose of eliminating the prospect of diluted and unclear responsibilities as well as the risk of duplication of mandates, which are at the source of the present confusion.

Responding to the mesquite issue: It is urgent to formulate long-term management programmes for *Prospis juliflora*, *P. chilensis*, and *P. cineraria* in Wadi Hadramout valley and the Coastal Plains aiming at: i) the promotion of the species' products (fuel-wood, timber), especially fodder to be processed and commercialized to livestock breeders; ii) controlling their undesirable spread on agricultural lands, irrigation canals and along wadis; iii) developing a specific sylviculture to insure safe utilization of these species in agro-forestry systems (soil improvement, live hedgerows, shade, controlled fodder production and processing etc); and iv) utilization of mesquites in desertification control (sand dune fixation, shelterbelts etc).

8.3.4. Framework for Regional Programmes

As directed by the MAI and the GDFDC, one national programme for desertification control is set-up. This national programme includes corrective measure to control desertification and parallel activities and measures to support its implementation. The national programme is composed of three regional sub-programmes to be implemented in each of the three priority regions as indicated in the following tables.
### Table 6. STRATEGIC FRAMEWORK FOR REGIONAL ACTION PLANS – COASTAL REGION

<table>
<thead>
<tr>
<th>REGION</th>
<th>MAJOR FORMS OF DEGRADATION</th>
<th>SOLUTIONS ENVISAGED</th>
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<tr>
<td>COASTAL ZONE REGION</td>
<td>- Sand dune movement&lt;br&gt;- Wind erosion&lt;br&gt;- Water erosion&lt;br&gt;- Coastal erosion&lt;br&gt;- Soil salinity/alkalinity&lt;br&gt;- Vegetation cover degradation&lt;br&gt;- Mesquite uncontrolled spreading&lt;br&gt;- Groundwater depletion&lt;br&gt;- Urbanization extension on shore dune areas</td>
<td>- Sand dune mechanical and biological fixation and management&lt;br&gt;- Greenbelt establishment and management&lt;br&gt;- Windbreaks establishment and management&lt;br&gt;- Efficient water management&lt;br&gt;- Torrent control&lt;br&gt;- Wadi bank biological and mechanical stabilization&lt;br&gt;- Coastal fore-dune construction and management&lt;br&gt;- Forestation and management&lt;br&gt;- Range rehabilitation and management&lt;br&gt;- Field drainage and introduction of salt resistant species&lt;br&gt;- Natural forests and woodlands management&lt;br&gt;- Urban planning and land use management</td>
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### Table 7. STRATEGIC FRAMEWORK FOR REGIONAL ACTION PLAN – EASTERN PLATEAUS AND DESERT

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<th>REGION</th>
<th>MAJOR FORMS OF DEGRADATION</th>
<th>SOLUTIONS ENVISAGED</th>
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<tr>
<td>EASTERN PLATEAUS AND DESERT REGION</td>
<td>- Sand dune movement and encroachment&lt;br&gt;- Water erosion&lt;br&gt;- Soil erosion&lt;br&gt;- Wind erosion&lt;br&gt;- Vegetation cover degradation</td>
<td>- Sand dune mechanical and biological fixation and management&lt;br&gt;- Torrent control, wadi-training and maintenance&lt;br&gt;- Small dams construction and maintenance&lt;br&gt;- Greenbelt establishment and management&lt;br&gt;- Biodiversity: Establishment of Natural Area Protection; Forest/Range&lt;br&gt;- Establishment and management of agro-forestry parks</td>
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### Table 8. STRATEGIC FRAMEWORK FOR REGIONAL ACTION PLAN – HIGHLANDS REGION

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<thead>
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<th>REGION</th>
<th>MAJOR FORMS OF DEGRADATION</th>
<th>SOLUTIONS ENVISAGED</th>
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<tbody>
<tr>
<td>HIGHLANDS REGION</td>
<td>- Water erosion&lt;br&gt;- Soil erosion&lt;br&gt;- Terraces’ degradation&lt;br&gt;- Vegetation cover degradation&lt;br&gt;- Degradation of existing waterworks&lt;br&gt;- Groundwater depletion</td>
<td>- Torrent control, wadi-training and maintenance&lt;br&gt;- Terraces’ rehabilitation and maintenance&lt;br&gt;- Forestation and management&lt;br&gt;- Range rehabilitation and management&lt;br&gt;- Small dams construction and maintenance&lt;br&gt;- Rehabilitation and maintenance of existing water works&lt;br&gt;- Natural forests management&lt;br&gt;- Establishment and management of woodland/forest protected areas&lt;br&gt;- Efficient irrigation water management&lt;br&gt;- Watershed management</td>
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8.4. Priority Actions for the Short Term 2001-2005

8.4.1. National Level

(A) Setting-up evaluation and monitoring capacity

It is necessary to strengthen the institutional capacity of national planning bodies to evaluate environmental and conservation projects and to incorporate environmental impact evaluation into standard project analyses. In reality, capacity is minimal at present, and the Government faces serious constraints when trying to recognize and evaluate potentially harmful long-term effects of development projects (NAPED, FAO Rome, March, 1995). In addition, there is no satisfactory coordination, cooperation, and adequate exchange of information and data between all institutions involved in environmental matters (EPC, AREA, GDFDC, etc.) It will, therefore, be necessary to agree on status, level and type of responsibility of each institution in originating, stocking, distributing and exchanging environmental information products. Normalization and standardization of information and indicators should also be considered rapidly.

EPC should have a clear mandate regarding its responsibility, nationwide, for environmental assessment. Its institutional capacity for effective use of advanced geo-information technologies would be further strengthened. EPC would as well be in charge of establishing a national environmental monitoring capacity by securing, through networking, the participation of other institutions with a capacity in specific environmental assessment and monitoring. This would set the foundations for future efficient policy making, and effective planning for timely responses to environmental degradation issues.

Among the many environmental issues that need urgent monitoring, are the following: groundwater monitoring (Appendix VII), sand movement and encroachment, natural forest and range degradation, watershed degradation, sustainability of the woody biomass for the satisfaction of household, institutional, commercial, and industrial fuel-wood-based energy needs, etc.

In his context, it is urgent to establish a National Center for Desertification Control (NCDC) activities with its branches in the three regions (Coastal, Highlands, and Eastern Plateaus). This Center, in close collaboration with all concerned institutions (AREA, GDFDC, EPC, NWRA…), would have the main responsibilities of continuous and permanent assessment of desertification and land degradation nationwide.

(B) Establishment of a National Body for assessing and mapping desertification

In order to be able to elaborate priority programmes of action relating to desertification control, it is urgent to assess nationwide and on a continuing basis, the extent, levels and forms of desertification processes and to evaluate their consequences by appraising their intensity and the impact(s) they exert on one or a combination of production systems. As stated above, again, it is urgent to establish a National Center, for Desertification Control (NCDC), with its branches in each of the three mentioned regions.

The NCDC should have a clear mandate and responsibility for assessing and mapping desertification at country level. Its institutional capacity for effective use of advanced geo-information technologies and ground data collection would be further strengthened. The NCDC, along with other institutions (AREA, GDFDC, EPC, NWRA, Universities…), would have the lead in determining the criteria that would help define the key actions and priority areas of intervention. Likewise, AREA, GDFDC, NWRA, and EPC would cooperate with the NCDC and work in partnership with other institutions concerned by desertification matters. They would determine and delineate respective competences, mandates, and responsibilities in originating desertification-related information products. The NCDC in collaboration with the GDFDC and AREA would further be in charge of setting-up a national desertification assessment and mapping capacity by establishing a network accordingly. This would set the foundations for future effective production and exchange of desertification related information as well as of efficient policy-making and planning for desertification control.
(C) Setting-up institutional and coordination body

Public initiatives to protect the environment, combat desertification etc, are not founded on consistent policies, regulations, and standards. In fact, responsibilities for regulation, planning, and management are fragmented among several centralized agencies and the private sector. The coordination of national and international agencies involved with environmental protection programmes is weak. Enforcement procedures of existing legislation are not clear and the capacity for their execution almost non-existent. The development of an appropriate institutional and legislative framework to support the implementation of environmental protection and desertification control with clear mandates and responsibilities is clearly a high-priority issue in Yemen.

In addition, the UNCCD provides, under Article 9 of the annex, “...that parties shall designate an appropriate National Coordinating Body (NCB) to function as a catalyst in the preparation, implementation, and evaluation of its NAP.”

To be effective, in following-up the implementation of the NAPCD and thus meeting the obligations towards the UNCCD, the NCB should ideally be a body, which is legally established or (at least) operate under legal instruments. To be efficient, The NCB should have clear mandate, financial autonomy, and institutional framework. This will allow the NCB to efficiently coordinate different efforts in combating desertification through the implementation of the NAPCD and thus satisfying the commitments made to the UNCCD.

It is in this context that the MAI has initiated the process of establishing, through a Presidential Decree, a High Committee for Afforestation and Desertification Control (HCADC) at the central level and regional committees at the governorate level. In this proposal, the HCADC and its regional bodies would be composed of representatives of different related and involved ministries and institutions including NGOs (Cooperative Unions, Women Associations…)

(D) Updating of legislations and policies

Policy on Land-Use Planning: Desertification is about land and land degradation. A land-use planning policy would therefore greatly enhance efforts towards combating desertification. It also would ensure proper coordination of sector issues between different ministries and institutions. Therefore, it is suggested that MAI/AREA take the lead, in close consultation with related ministries and institutions in order to establish a comprehensive land-use guidelines. These guidelines would promote land-use practices that will participate to alleviate land degradation and increase food security.

Domestic Energy Policy: Though not precisely known at national level (related data are very variable), fuel-wood's contribution to total domestic energy consumption in Yemen is very important and unsustainable. In order to avert the destructive environmental effects of fuel-wood over-exploitation, the State must contribute to reduction of firewood demand through adopting an energy substitution policy by switching to LPG for domestic energy, which constitutes the most promising alternative for Yemen.

Water Policy and Law: Water policy has been prepared and approved by the Cabinet during March 1999. The corresponding Action Plans are presently under preparation and should be finalized as soon as possible in order to implement the terms of the adopted Water Policy. Concerning the Water Law, which has been prepared, it is presently within the Chamber of Representatives for discussion and approval.

Water Irrigation Policy and Law: Given the important part of water used for agriculture (about 87% during 1999), MAI prepared a Water Irrigation Policy aiming at increasing water irrigation efficiency by all possible means. The Water Irrigation Policy was endorsed by the Cabinet on March 1999. Accordingly, a Water Irrigation Law has been drafted and will be submitted to the Chamber of Representatives for approval.
National Watershed Policy and Action Plans: The watershed policy has been adopted and approved by the Cabinet during May 2000. GDFDC/MAI and NWRA, in close collaboration with all concerned institutions, are presently preparing corresponding Action Plans in order to implement the terms of the adopted National Watershed Policy. It is of great importance that these Action Plans be operational as soon as possible in order to enhance the implementation of NAPCD.

Forest Law and Forest Policy: an FAO Legal Consultant prepared a draft of forest law. It was also reviewed and put into a legal framework by the General Directorate of Legal Affairs of the MAI. This draft law was then cleared by GDFDC and MAI. Presently, the proposed forestry law is within the Ministry of Legal Affairs for their review and endorsement. The MAI and GDFDC are presently following-up the process relating to the promulgation of the forestry law. Regarding forest policy, the GDFDC assisted by the Forestry Development Project, prepared the Forest Policy Principles, in 1988. This Forest Policy Principles were endorsed and declared by the Ministry of Agriculture on April 27, 1989. The economic, social, environmental, and political variables since have made it imperative to formulate an updated comprehensive forest policy to accommodate the new changes at national and international levels and to go along with national strategies/policies as well as international conventions. The following broad objectives could be considered when updating the forest policy:

- Increase the tree cover of land to ensure the sustainable supply of forest goods and services to satisfy the basic needs of current and future generations and to enhance the role of trees and forests in socio-economic development.
- Participate in the control of environmental degradation, soil and water erosion, and desertification.
- Support of food security by sustaining agriculture and animal rearing activities through soil conservation, protection of water sources, and protection of agriculture land and holdings.
- Conserve and sustain the management of what is left of location of special ecological/biodiversity importance.
- Enhance of government's quest to benefit from and comply with relevant international, sub-regional, and regional conventions and treaties.

Traditional Knowledge on Land Resources Management: Nationwide, there is no clear policy relating to the use of traditional knowledge in managing land resources. As stated above, Yemeni people in the past have been successful in managing and utilizing, on a sustainable basis, their natural resources. A national strategy is therefore an urgent requirement in order to study, compile, and document this full heritage of traditional know-how.

(E) Integration process

Given the fact that combating desertification is a long-term process and that desertification is also an environmental and a socio-economic phenomenon, therefore, it is very crucial to integrate desertification issues within other national ministries’ mandates as well as within other nation strategies and development plans. Also, desertification is considered as a multi dimensional and cross-sectoral reality. For this reason, and at the stage of project/programme formulation, combating desertification should be integrated within other related national programmes. This integration should take into consideration other international Conventions as well.

8.4.2. Regional Level

(A) Refined zoning and participatory identification of priority activities for the regions

The zoning recommended by the “National Workshop to Review the NAPCD” held in Sana’a from May 30 to June 02, 1999, has been considered in the preparation of the present NAPCD (i.e. Costal Zone, Highlands/Mountainous Zone, and Eastern Plateaus and Desert Zone). This proposed zoning takes into account similarities in terms of desertification causes threatening the region as well as solutions proposed for the zone.
The process of identifying the priority activities to be considered in the elaboration of the regional/local action programme was based on participatory approach, which involved affected communities, NGOs, and regional government officials. The diagramme given in Appendix X gives detailed steps followed toward the preparation of regional/local action programmes.

In this process, and according to the conclusions reached by the regional workshops held in Hodeidah and Aden for the coastal region, in Seiyoun for the eastern plateaus region, and in Dhamar for the Highlands region, a total of 31 (Table 9) areas/sites were identified and selected as top priority sites for interventions (corrective measures for desertification control). These priority sites are to be considered during the period 2001-2005. These top priority sites were chosen based on three basic criteria: protection of human settlements, protection of agricultural lands, and protection of development infrastructures (roads, dams,…).

Table 9. STRATEGIC FRAMEWORK FOR REGIONAL ACTION PLAN – PRIORITY SITES

<table>
<thead>
<tr>
<th>Region</th>
<th>Governorates</th>
<th>Number of priority sites selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>COASTAL ZONE</td>
<td>Hodeidah</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Lahej</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abyan</td>
<td></td>
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<tr>
<td>HIGHLANDS</td>
<td>Taiz</td>
<td>10</td>
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<tr>
<td></td>
<td>Hajja</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Addala’a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al-Mahweet</td>
<td></td>
</tr>
<tr>
<td>EASTERN PLATEAUX AND DESERT</td>
<td>Hadramout</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Marib</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al-Jawf</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shabwa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al-Mahara</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>31</td>
</tr>
</tbody>
</table>

The total area to be protected (during the period 2001-2005) through the implementation of corrective measures is about 26,000 ha. This concerns about:

- 6,000 ha of sand dune stabilization;
- 2,000 ha of afforestation - green belts and farm boundaries tree planting- (agroforestry);
- 2,500 ha for gabions’ work and terraces rehabilitation (watershed management);
- 700 ha for wadi control; and
- 15,000 ha for forest and range protection and development.

(B) Decentralization, population organization, public awareness, and participation

Decentralization has become an important process for achieving rural development in Yemen. It and must take into account the needs of local institutions. If the process of decentralization lacks a
creative, legal and political outlook vis-à-vis local traditional institutions, its impact will remain limited…  

Decentralization must be translated into progressive, but effective technical, financial, and administrative hand over of power and capability. In order to put the delegated authority to efficient use, local institutions, administrations, communities, and individuals must benefit from training and capacity building. Equitable decentralized local development requires the inclusion of women, poor populations groups and the landless within the processes of resource management and of local economic development.

The introduction of participatory, community-based activities and programmes should be preceded by steps to open-up a permanent dialogue with the concerned communities, whereby views, information, needs and interests can be communicated and negotiated in both directions within a true partnership exercise for long-term sustainable development. Community leaders should constitute the main beneficiaries of training and awareness-raising programmes. These would address environmental and development issues, community involvement in rural development, mobilization of migrants' investment capacity to participate to the local rural development effort etc. The requirements for successful community and family participation consist in involving communities from the start and insuring them of their tenure and users' rights on a long-term basis.

Organizations of local people that operate for the benefit of the group are a form of social assets, consisting of shared knowledge and experience, understanding and trust among the members of the group. This social wealth tends to appreciate rather than depreciate with time and gained experience, since the more people are able to work together, the stronger and more effective they become as a group. This is most certainly among the best ways in which, the rural poor can be empowered to work for sustainable local development. The Agricultural Union, Women Associations… should be given important attention and should play a great role in the implementation of the regional/local programmes to combat desertification.

In addition, the role of extension services is too often confined to passing-on information to farmers about technologies and government programmes. This needs to be completed by awareness-raising about, sustainable local development. However, the potential role of extension personnel, as vehicles to convey information from rural communities to scientists, planners, and policy-makers, is too often overlooked and most probably inexistent. Therefore, sustainable development depends heavily on the participation of extension personnel in a two-way information and awareness raising flow.

Finally, rural development and sustainable livelihoods should not be strictly confined to the limited ecological capacities of the land. The carrying capacity concept should also integrate the economic capacities (availability of capital, credit, work force, organization and innovation potentials, market, food and financial aids, remittances etc.) of the region. Such a concept opens the way to off-farm production opportunities, which contribute to the local development. Off-farm activities generally feature positive impacts on farming systems by: i) reducing the pressure on the natural resource base; ii) making production systems more sustainable; iii) supplementing farm incomes, thereby resulting in improved living and health conditions as well as greater possibility to invest on farm inputs to improve production; iv) earning substantial income to improve farm management and maintenance through terracing, tree planting operations etc.; v) reducing risks and increasing security through multiplied income earning possibilities; vi) allowing the economically non-viable landless and "near landless" families to remain in the rural sector and participate to its development, while reducing pressure on the environment.

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BOX 4
COMMUNITY PARTICIPATION AT ITS BEST

Based on watershed management activities to be undertaken in Hameel village, within the framework of the GCP/YEM/026/NET\textsuperscript{78} project, and according to approved community priorities, a technical torrent control study was carried out by a civil engineer. A meeting held subsequently with the community, generated a rich debate as to the objectives, approach, technology, cost and materials recommended. It was pointed to the fact that the study did not involve the community enough and that it focused essentially on classical torrent protection, overlooking the need to provide water to the adjacent spate-irrigated agricultural fields. It was further indicated that the proposed technology would require much industrial and not locally available material (gabions, cement etc.) as well as very qualified labor, heavy, and costly supervision efforts.

It was subsequently decided that three farmers with commendable experience in torrent control, would team-up with two project specialists (watershed management and community participation) to design and implement a new study based on indigenous technical knowledge and experience. The result was a strategically correct and cost-effective design, which was moreover technically feasible, socially acceptable, and economically profitable. From the strategic viewpoint, the community study integrated the protection as well as the irrigation objectives. The wadi was divided into three sections, according to channel gradient and to erosion risks. Suitable and appropriate interventions were proposed accordingly for each section, and transversal check dams, and diversion weirs were designed to, respectively reduce speed of flow, and guide water towards agricultural fields.

Conceived according to traditional knowledge and experience, the technological package, now well under implementation, is made-up of simple, efficient, and easy to execute interventions that require essentially locally available materials. This exercise, which demonstrates the importance of traditional knowledge, represents also a contribution to its preservation and improvement. Further, it reinforces the confidence and mutual support between the project and the community, thereby contributing to a sustainable partnership process. Finally, this performance of huge proportions, which requires manipulating over 5000 cubic meters of stone and sediment over a distance of 1300 meters and necessitates some 3500 man/days of hard work is a clear indication of the community’s capacity to participate actively and take responsibility for its development when given, the opportunity to express its views and to decide for itself, as well as a chance to appropriate its resources and achievements.

\textsuperscript{78} FAO Project on “Watershed Management and Wastewater Re-use in the Peril-urban areas of Yemen.” 1998-2001
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EPC, 1995. Environmental Situation in Yemen


Othman Souad Abdurrahim, 1997. The role of women in the farming systems in parts of Ibb and Dhamar Governorates.


Royal Dutch Consul. Engineers and Architects, Sept. 1990. Support to the Secretariat of the EPC (Review of Government programme activities concerning soil erosion)


Poverty "Depth" in Yemen by Governorate
(Based on Data from 1992 Household Budget Survey)

Notes/Documentation
2. The map shows the "Squared Poverty Gap Index" (reflects "depth" of poverty).
3. All boundaries are approximate and unofficial, and do not imply UN recognition.
4. Analysis and graphics by UN WFP Vulnerability Analysis and Mapping Unit, Cairo, Egypt, April 2000
5. For more details (full documentation), or for comments on the map, please contact: john.mcharris@wfp.org

Gulf of Aden
APPENDICES
# Appendix I

## Priority Sites for Intervention during 2001-2005

<table>
<thead>
<tr>
<th>Region</th>
<th>Governorate</th>
<th>Name of the Selected Site</th>
<th>Proposed Interventions</th>
<th>Equivalent Estimated Hectares</th>
<th>Estimated Cost (YR’1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highland</td>
<td>Hajjah</td>
<td>Sharis</td>
<td>Water control structure (WCS)</td>
<td>15 ha</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qaryat Al-A’yaniyah</td>
<td>Flood control, terrace rehabilitation, community tree planting</td>
<td>3 ha</td>
<td>15,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wadi A’yan</td>
<td>WCS + gabion works</td>
<td>30 ha</td>
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<tr>
<td></td>
<td></td>
<td>Addahabshah +Wadi Sari’</td>
<td>WCS + wadi bank tree planting</td>
<td>120 ha</td>
<td>3,500</td>
</tr>
<tr>
<td></td>
<td>Al-Mahweet</td>
<td>Wadi Al-Haymah</td>
<td>Wadi rehabilitation</td>
<td>100 ha</td>
<td>34,000</td>
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<tr>
<td></td>
<td></td>
<td>Wadi Nakhlah</td>
<td>Gabion works</td>
<td>150 ha</td>
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<td>Dhamar</td>
<td>Bani Fallah</td>
<td>Gabion works and tree plantation</td>
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<td>Dalaa</td>
<td>Khallat (Al-Hasein)</td>
<td>Gabion work</td>
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<td></td>
<td>Wadi Matar</td>
<td>WCS and terrace rehabilitation</td>
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<td>Taiz</td>
<td>Wadi Al-Haymah</td>
<td>Wadi rehabilitation</td>
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<td>Wadi Nakhlah</td>
<td>Gabion works</td>
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<tr>
<td></td>
<td></td>
<td>Al-Qanawees</td>
<td>Tree planting</td>
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<tr>
<td></td>
<td>Al-Beidah</td>
<td>Qayyah (Rada’a)</td>
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<td>Coastal</td>
<td>Hodeidah</td>
<td>Al-Mutaynah-Atta’afaf’</td>
<td>Sand dune fixation</td>
<td>730 ha</td>
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<td></td>
<td></td>
<td>Azzaydiyah</td>
<td>Tree planting</td>
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<td>Al-Mounirah</td>
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<td></td>
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<td>Abyan</td>
<td>Aden – Al’Alam road</td>
<td>Foredune establishment</td>
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<td></td>
<td></td>
<td>Al-Kod nursery</td>
<td>Rehabilitation of forest nursery</td>
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<td>Lahj</td>
<td>Al-Wadi Assaghir (Qaryat Al-Wadi)</td>
<td>Gabion works and afforestation</td>
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<td>Wandi bank tree planting</td>
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<td>Dar Mansour</td>
<td>Sand dune fixation</td>
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<td>Al-Bassateen</td>
<td>Farm protection, tree planting and Sand dune fixation</td>
<td>400 ha</td>
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<td>Taiz</td>
<td>Al-Makha</td>
<td>Tree planting and Sand dune fixation</td>
<td>120 ha</td>
<td>25,000</td>
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<td>Eastern Plateaus and Desert</td>
<td>Hadramout</td>
<td>Yatrarah</td>
<td>Sand dune fixation and gabion works</td>
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<td></td>
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<td>Qaheer</td>
<td>Sand dune fixation and gabion works</td>
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<td>Al-Jawadah</td>
<td>Water control structure</td>
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<td>Marib</td>
<td>Al-Khasha’a – Al-Hani – Athumane</td>
<td>Sand dune fixation</td>
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<td>Al-Saqit, Al-Rakzah, Attaheel</td>
<td>Sand dune fixation</td>
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<td>Al-Jawf</td>
<td>Al-Hazm city</td>
<td>Water control structure</td>
<td>300 ha</td>
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<td>Ma’ain city</td>
<td>Green belt establishment</td>
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<td>Shabwa</td>
<td>Ain Bama'abad</td>
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<td>Arruq’ ha Ba’arram</td>
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<td>Al-Mahara</td>
<td>Hawf forest</td>
<td>Forest management</td>
<td>15,000 ha</td>
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### LIST OF PRIORITY SITES FOR LONG-TERM DESERTIFICATION CONTROL PROGRAMME

**Eastern Plateaus and Desert Region**

<table>
<thead>
<tr>
<th>Governorate</th>
<th>District</th>
<th>Priority Sites</th>
<th>Degradation Type</th>
<th>Proposed Interventions</th>
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<tbody>
<tr>
<td>Al-Jawf</td>
<td>Al-Hazm</td>
<td>Al-Hazm city</td>
<td>Soil erosion</td>
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<td>Al-Khab</td>
<td>Al-Yatamah</td>
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<td>Al-Mahara</td>
<td>Al-Ghaidah</td>
<td>Al-Jaza’a</td>
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<td>Forest protection and management</td>
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<td>Al-A’ayss</td>
<td>Sand dune encroachment</td>
<td>Sand dune stabilization</td>
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## Highland and Mountainous Region

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## Appendix III

### Field Visits Conducted during the Process of Elaborating the NAPCD

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<th>Date of the Visit</th>
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<td>04-15 November 1997</td>
<td>Implementation of FAO consultancy on the “Underlying Causes of Desertification”</td>
<td>Hodeidah, Taiz, Lahj, Abyan, Aden, Hadramout</td>
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<td>19-21 November 1997</td>
<td>Same as above</td>
<td>Marib</td>
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<tr>
<td>06-07 January 1998</td>
<td>Meeting with SP2</td>
<td>Dhamar</td>
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<tr>
<td>13-17 June 1998</td>
<td>Meeting with DG of Regional Agricultural Offices and Focal Points of the National Network to Combat Desertification</td>
<td>Al-Mahwit, Hajjah</td>
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<td>18-24 July 1998</td>
<td>Same as above</td>
<td>Dhamar, Ibb, Taiz</td>
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<td>22-28 August 1998</td>
<td>Same as above</td>
<td>Al-Beida, Shabwa</td>
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<td>13-18 November 1998</td>
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<td>12-15 February 1999</td>
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<td>21-26 February 1999</td>
<td>Same as above</td>
<td>Hadramout</td>
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<tr>
<td>13-21 April 1999</td>
<td>Community consultation in affected areas. Selection of priority sites and appropriate interventions.</td>
<td>Hodeidah</td>
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<tr>
<td>09-23 June 1999</td>
<td>Community consultation in affected areas. Selection of priority sites and appropriate interventions.</td>
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<td>10-12 July 1999</td>
<td>Conduction of regional workshops to present, discuss, and endorse the selected priority sites and corresponding interventions for the Eastern Plateaus and Desert Region</td>
<td>Seiyoun</td>
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<td>Conduction of regional workshops to present, discuss, and endorse the selected priority sites and corresponding interventions for the Coastal Region</td>
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<td>13 October 1999</td>
<td>Presentation of the recommendations of the regional workshops</td>
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<td>13-17 November 1999</td>
<td>Visit to different on-going projects and programmes working in related fields of desertification control activities for better coordination and coordination</td>
<td>Taiz, Lahj, Aden, Abyan</td>
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<td>24-26 October 1999</td>
<td>Follow-up on the elaboration of the desertification map to be provided by SP2</td>
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<tr>
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<td>29 May –02 June 2000</td>
<td>Meetings with Regional Agriculture Offices and Focal Points. Presentation of the NAPCD and Regional Programme. Finalization of cost estimates of intervention</td>
<td>Taiz, Aden, Dalaa, Radaa</td>
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<td>15-22 September 2000</td>
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<td>Hodeidah, Lahj, Aden, Abyan, Taiz, Al-Beida, Dhamar, Dalaa, Al-Mahweet, Hajjah, Hadramout, Shabwa, Marib, Al-Jawf</td>
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# LIST OF FOCAL POINTS OF THE DESERTIFICATION CONTROL NETWORK

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<td>Ahmed Alwahsh</td>
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<td>18</td>
<td>Abdellah Mohamed Assuswah</td>
<td>Responsible of Forestry activities</td>
<td>Amran</td>
</tr>
</tbody>
</table>
Appendix V

MOJOR RECOMMENDATIONS OF THE
NATIONAL WORKSHOP TO REVIEW THE NATIONAL
ACTION PLAN TO COMBAT DESERTIFICATION
(Sana’a, May 30 – June 02, 1999)

1. Upgrading of the General Directorate of Forestry and Desertification Control to a National Authority to adequately fulfill its mandates including range management activities.

2. Establishment of a national committee (at high level) for desertification control. This committee should be composed of all concerned parties (ministries and civil society). A technical team should be identified, under the MAI, to follow up and evaluate national programmes of desertification control.

3. Establishment of a national center for desertification control in order to assess, follow-up, and evaluate the impact of desertification.

4. Capacity building through the establishment of specialized centers in the field of desertification, forestry and range.

5. Necessity of including community participation approaches through the provision of support to NGOs, Cooperative Unions, Community Associations dealing with desertification control activities.

6. Necessity of increasing the environmental awareness among different social groups towards ways of combating desertification.

7. Documentation and revitalization of local and traditional uses related to the protection of land resources.

8. Rationalization of water utilization in all the sectors and necessity of the use of the treated wastewater for establishing green belts around cities.

9. Encouragement of the rehabilitation and maintenance of agricultural terraces, slop lands, and wadis.

10. Provision of support to the establishment of natural reserves to preserve wildlife and genetic resources.

11. Nomination of specialized team to review and update different laws and legislation related to the environment, forestry, water, and desertification control.

12. Classification of the country into four zones (coastal, highland, saharian, and islands zones).

13. Necessity of organizing regional workshops to discuss and finalize regional priority action/programme through community participation.

14. Increase of the GDFDC annual budget in order to widen activities related to desertification control.

15. Creation and establishment of a National Afforestation and Desertification Control Fund.

16. Liaison with donor community, including UN agencies, through the Ministry of Planning and Development in order to seek for funds to support desertification control programmes.
1- General Introduction

The Republic of Yemen is located in the southwest corner of the Arabian Peninsula covering a land area of 555,000 km² (excluding Rub'a Al-Khali and Islands). The five main Agro-ecological zones reflect variations of the elevation from sea level to about 3,700m and give rise to five main Agro-ecological regions: The Coastal Low Lands, the Southern Uplands, the Central Highlands, the Northern Highlands and the Eastern Region.

The highly variable rainfall ranges from 0 -100mm in the eastern region and coastal plains of the South, to 100-200 mm in the hot and humid coastal plains of Tihama and gradually increases with elevation in the watershed mountainous region in the interior reaching an average of 800 mm. The Tihama Plains of Yemen are 30-60 Km. wide running about 400 km. between the Red Sea and the Arabia Sea Coasts and the high mountains in the SouthWestern Corner of the Arabian Peninsula. The Tihama and the eastern desert plains are among the most arid parts of Yemen. The natural vegetation is generally sparse to open, offering little protection of land from wind and rain erosion. The climate varies from hyper-arid (0-100 mm) on the coast to dry (300-400mm) close to the escarpment. The temperatures are topical with monthly averages ranging from 24°C in winter to 35°C in summer. The relative humidity is extremely high, averaging over 60% and often reaching the dew point at night.

The inter-wadi sands occur in at least two major landforms: the sand seas or ergs and the longitudinal draas, both of which are sand bodies with dimensions of 10 Km. or larger. The draas vary from 5-20 Km. in length and 0.5 - 1 Km. in width. The Barachan dunes and transverse dune ridges are the most very common. The Barachans have dimensions of meters to multiples of 10 m, the transverse dune ridges can be hundreds of metros in length. The Barachan dunes are crescent shaped with the concave side facing the winds. The transverse dune ridges are perpendicular to the winds and have barachanoid sections facing away from the wind and interspaced with linguoid crests facing the wind.

Fallow vegetation upon the sands cultivated opportunistically for millet is dominated by a dwarf shrub Dipterygium Galucum and two tuft grasses (Panicum turidium and Odyssea Micronata). The vegetation cover is sparse (less than 5%) and without cropping the cover could probably reach about 30%.

The Tihama region of the Yemen Republic contributes about 40% of the Agricultural production for whole country. This production has largely been based on the provision of irrigation water through substantial investments in the development of both spate and groundwater resources. Over time, the increasing population growth provoked the unbalanced over-exploitation of natural resources and the previous ecological equilibrium was no longer maintained. This has led to the removal of the natural vegetation cover as a result of illicit tree cutting, uprooting of woody vegetation, overgrazing in rangelands and improper cropping practices on marginal lands. This in turn has caused the movement of sand and the formation of sand dunes. Dunes, natural to the environment, have become destabilized and prone to erosion of wind thus developing a continuous process of shifting. This sand dune
movement has threatened villages, roads, irrigated agriculture, and the livelihood of the population in the region. Other regions in the country suffer from this problem but their condition is not as critical and acute as in Tihama.

Although immediate protection measures are required, there is a great need to address the long-term or underlying causes of desertification across a broader perspective.

2- Pre-Project Studies

Assessment of Desertification through the use of Aerial Photography 1976-1987

The following is a summary of the study conducted by FAO in 1989 - 1990.

Objective
To determine the rate at which sand dune environment takes over time in the absence of any specific protection.

The Study Area
Study concentrated on Wadi Zabid, which is bounded on the west by the Red Sea and rises to an elevation of 200 m where it joins the foothills in the east. The area is subject to sand dune encroachment. A set of aerial photographs is available over two discrete time intervals, 1976 and 1987 to allow mapping and measurement of sand dune movement.

Methodology
The aerial photography 1:10,000 from 1987 and a combination of 1:20,000 and 1:60,000 from 1976 were used to observe and estimate the extent of productive land lost during this period of 11 years. A map at 1:20,000 was produced.

A base map was produced using an enlargement of the 1:50,000 topographical map. Villages, roads, and tracks were transferred on a transparent overlay. The 144 Aerial photographs at 1:10,000 were analyzed and an optical pantograph was used to transfer this information to the base map. The analyzed area was represented in a map and a set of six maps were produced to show the extent of sand movement in 1987 as opposed to the agricultural limits imposed by sand dunes in 1976.

Results
A definite reduction in productive agricultural areas was seen across a broad front virtually along the entire southern length of the Wadi from close to the Coastline to the foothills, but basically as a consequence of wind movement, in a southwesterly to a north-easterly direction. Neither the rate of dune movement nor the impact of their movement, however, is uniform. This appears to be largely contingent on specific local circumstances.

Because of the impact of local circumstances, the initial objective to estimate the rate of sand dune encroachment across a linear front was modified to estimate the actual loss of agricultural land over the 11-year period. Areas affected and lost for agriculture were measured in ha. The total productive land in 1976 covered 20,000 ha. The term "Productive Land" is employed since it includes agricultural land and forest plantation. By 1987, approximately 970 ha were lost or affected due to sheet sand movement. This loss amounted to about 4.75% of productive area or at a rate of about 90 ha each year over the last 11 years.

The overall estimate of loss is more important since the losses by specific area varied widely and were dependent on a variety of factors. Thus, for instance on the area of south of Ash Shubayta an area of 90 ha was completely lost for agricultural and approximately 119 ha were,
in 1987, alarmingly affected by dune movement. In this respect about 8.2 ha were lost per year and 11 ha/year were seriously affected.

In the western part of Wadi Zabid, south of the village of As Suwayq and Al Masabiha, approximately 115 ha were seriously damaged due to dune movement. South of the village of Al-Madamman 29 ha were seriously damaged 98 ha were lost, an average of approximately 9 ha/year. The dune movement in the South-West of the village of Al-Madamman was approximately 300 m over 11 years thus reaching 27 m/year.

Sand dune movement was identified in many cases, particularly in the southern part of Wadi Zabid. However, dune limits were difficult to delineate accurately since large zones were covered with sand and were therefore unproductive although not exclusively covered by dunes.

Perhaps most illustrative in the movement of the coastal dunes on an area of unproductive land on the coast of the Red Sea. Between 1976 and 1987, the dunes shifted by 450 m. to 500 m. to the north. This movement, although over an 11 year-period equivalent to a linear movement of nearly 41 m/year, gives an exaggerated estimate of the maximum extent dunes could move in Wadi Zabid area. In the agricultural areas, the movement has been much smaller mainly because of the inherent agro-ecological environment and the efforts of farmers to preserve their environment as best as they can.

3- Tihama Land Cover Change Study

The focus of this study was to map land cover at two discrete points in time, 1973 and 1990, and to subsequently analyze and map differences in the distribution of land cover at these two times.

Up-to-date land use information is essential for sustainable development of agriculture resources in Tihama obtaining information on the type, location and rate of land use change is a priority for effective management and planning of natural resources. A methodology for production of information on the past and present distribution of agricultural resources within the region was proposed and adopted. This methodology was based on a combination of visual interpretation of satellite imagery and archival air-photography, supported by field survey. The objective of the study was to map land cover change in Tihama, with particular emphasis on changes in sand dunes and agricultural lands, with a view to the stabilization of sand dunes and the planning of land use.

Approach to the Study

The methodology was based on the production of detailed maps of land cover for two dates using air photography acquired at 1 : 60,000 scale in 1973, and Landsat Thermotic Mapper (TM) imagery acquired by the satellite in 1989 and 1990.

A Geographical Information System (GIS) was used for digitising; analysing and plotting the land cover data. Maps of land cover for 1973 and 1990 were produced at 1:100,000 Scale. In addition land cover maps which show the changes in land cover between the two dates were also produced at 1:100,000 scale. These change maps are supported by tabulated area statistics, as well as an analysis and discussion. An especially important element of this analysis was to locate and characterize regions of rapid and extensive changes within Tihama and to assess the stability of sand dune regions.
1- RESULTS

CHANGE ANALYSIS OF INDIVIDUAL CLASSES

Dunes: Both dune types have increased in area, however, inland dunes, with an increase of 11 per cent have grown by twice as much as coastal dune (5 percent).

D1 Coastal Dunes: Coastal dunes have increased by 647 ha, the largest part of this being at the expense of Rangeland (R5).

D2 Inland Dunes
The net area of inland dunes is nearly 20,000 ha greater in 1990. Most of this change has come from rainfed Agriculture (A3) and Rangeland (R5). Over 20,000 ha of rainfed agriculture in 1973 has been classified as inland dunes in 1990, with nearly all of this being between Hodeidah and Zabid. This land cover class poses a problem in interpretation, as some areas could be classified both as dunes and as rainfed agriculture. Although 10,024 ha of rangeland become dunes, the net change from rangeland to dunes is only 1,747 ha.

COASTAL CLASSES

C1 Mangrove woodland
There is a small increase (4 per cent) in the area of this class. As mangrove is much easier to interpret using the near infrared waveband of the satellite imagery (displayed in red), than by using black and white air photography, the 1990 estimate of the area of mangrove may be positively biased.

C2 Cultivated date palm
The area of date palm is stable.

C3 Hyphaene woodland
There has been a dramatic loss in the area of this native coastal woodland, which has decreased by 69 per cent. Most of this loss has been to rangeland (R5).

AGRICULTURE

A1 Parkland agriculture
There has been a slight increase.

A2 Wadi agriculture
There has been a very large increase of 46 per cent, reflecting the intensification of irrigation within the wadis. The major source for this increase is from rangeland (R5). Important locations of change are in the Wadi Mawr-particularly at the downstream end, Wadi Zabid, Wadi Siham and in the Midi area (on mapsheet 1642D). Salvadora /Tamarix thicket (R1) is also a significant source for this change.

A3 Rainfed agriculture
The 1990 area is 39 per cent less than the 1973 figure. Nevertheless, this figure is misleading, as this does not represent an actual loss of productive land of this scale. By its opportunist nature, the extent of this class of agriculture will very enormously from year to year, depending on the rainfall. Most of this apparent transition to A3 is at the expense of rangeland
(R5) and inland dunes (D2). The particular years of this study have contrasted a water year, in 1973, when agriculture was widespread, and a drier year in 1990, when agriculture was more limited in extent.

A4 Pump irrigated agriculture
Pump irrigated agriculture has increased by 15 percent, but in addition to this measured change, a large proportion of the increase in wadi agriculture will also be due to the use of pump irrigation. The representation of this class (A4) portrays those isolated areas of pump irrigation away from main agriculture areas. Significant areas of this class appear to have been lost, but have in fact changed category to wadi agriculture. Looking at the gross changes, 8,686 hectares of rangeland outside of the wadi areas have been converted to pump irrigation.

RANGELAND AND WOODLAND

R1 Salvadora/Tamarix Thicket
This has decreased by 29 percent, mainly changing to wadi agriculture and non-wooded rangeland (R5). A good example of both these changes is at the downstream end of wadi Mawr.

R2 Acacia woodland
This has decreased by 17 percent, mainly into agricultural classes and non-wooded rangeland. However this is only a change in total area and does not take into account any changes in the density of tree cover or the volume of wood. It may be the case that the actual loss of trees or wood is greater than this figure suggests.

R3 Acacia woodland and agriculture
This has decreased by 21 percent, largely into non-wooded rangeland and wadi agriculture. The changes between this mosaic and the pure Acacia woodland show a net gain of 640 hectares of pure woodland.

R4 Acacia-Commiphora woodland on gravel plains
There has been no significant change in the area covered by this class, but as with Acacia woodland, this takes no account of any changes in tree density or wood volume.

R5 Rangeland
The area of rangeland has decreased by 3 percent, but this small percentage nevertheless amounts to a significant area of 17,212 hectares. This figure takes no account of the quality of the rangeland, whether for grazing or for environmental protection. Where the rangeland has degraded into bare sandy areas, which have not formed dunes, this change will not be indicated by this study. The greatest loss from rangeland is to wadi agriculture, nearly half of which has occurred in the downstream end of wadi Mawr. Parkland agriculture and inland dunes also account for large losses, but it should be pointed out that there have also been large changes from other and cover types into rangeland.
CHANGE ANALYSIS OF LAND COVER TYPES

Table 2 summarizes changes within appropriate themes or groupings of particular classes.

TABLE 2  THEMATIC CHANGE ANALYSIS

<table>
<thead>
<tr>
<th>THEME</th>
<th>OUT ha</th>
<th>IN ha</th>
<th>CHANGE net ha</th>
<th>CHANGE net %</th>
</tr>
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<tbody>
<tr>
<td>Dunes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D1,D2)</td>
<td>12296</td>
<td>32973</td>
<td>+20677</td>
<td>+10</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All (A1, A2, A3, A4)</td>
<td>54543</td>
<td>74584</td>
<td>+20041</td>
<td>+3</td>
</tr>
<tr>
<td>Permanent (A1, A2, A4)</td>
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<td>82552</td>
<td>+77646</td>
<td>+15</td>
</tr>
<tr>
<td>Irrigated (A2, A4)</td>
<td>4605</td>
<td>67552</td>
<td>+62947</td>
<td>+42</td>
</tr>
<tr>
<td>Rangeland &amp; Woodland</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R1-R5)</td>
<td>83457</td>
<td>51622</td>
<td>-31835</td>
<td>-5</td>
</tr>
<tr>
<td>Woodland classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C1, C2, R2, R4)</td>
<td>13433</td>
<td>2190</td>
<td>-11243</td>
<td>-23</td>
</tr>
</tbody>
</table>

Percentage change is based on the total area in 1973.

DUNES

Here there is a net increase of 20,677 hectares, or 10 per cent. This does not take account of sand sheets, or areas of bare sand, which do not from dunes. Changes have occurred both into and of dunes. The largest increase in dunes comes from rainfed agriculture, mainly in the area between Al Hudaydah and Zabid. This dose not necessarily implies a loss of agricultural land, since most of this opportunistic planting would have been on dunes. However, underlying gains or losses of productive rainfed land will not have been detected.

Only 278hectares of wadi agriculture have been recorded as chang ing to inland dunes, whereas 2,012 hectares of dunes have become wadi agriculture. Similarly, for pump-irrigated agriculture, the changes are negligible. This suggests that rather than threatening agriculture land over large tracts, moving sand in the from of duns is advancing on particular locations; the average size of an area, which has changed from wadi agriculture into duns, is only 21 hectares. In areas at the fringe of agriculture in wadis, the over-expansion of agriculture into areas, which are normally sand duns, may be the root cause of the problem.

AGRICULTURE

There is slight increase of 3 per cent. This includes rainfed agriculture, which, as discussed above, is highly variable from year to year, and two seasons are not sufficient to infer a long-term trend. If this class is excluded from the figures, a different picture emerges.
The increase in agriculture, excluding A3, is 15 per cent, or 77,646 hectares. The main source for these increases is non-wooded rangeland.

A2 and A4 to be generally under command of spate or pump irrigation, even if some areas are not irrigated every season. Parkland (A1), which will include some areas irrigated by pumps, is excluded. This grouping of classes, shows a great include of 42 per cent or 62,947 hectares, which has largely come from rangeland and woodland classes. Approximately 96 per cent of this net-change comes from development within the wadi areas.

In the figures for all agriculture, the large increase in irrigated agriculture has been masked by the changes in rainfed agriculture.

**RANGELAND AND WOODLAND**

As for the rangeland and woodland classes (R1- R5), Overall there is only a decrease 5 per cent, but this hides a marked decrease in Acacia woodland and Salvadora/Tamarix thicket. In addition, the overall figure for rangeland and woodland gives no indication of changes to the quality of the herbaceous and shrub rangeland, which may well have degraded with land use or climatic changes. The available data does not permit the quality of the rangeland to be estimated.

**WOODLAND CLASSES**

Taking the purely woodland classes, both coastal and inland (C1, C3, R2, R4), there is a decrease of 23 per cent or 11,243 hectares. The greatest part of this loss is in Hyphaene woodland, which accounts for 70 per cent of the gross decrease of woodland. Acacia woodland is the other major loss.

**SCALE OF LAND COVER CHANGES**

Table 3 gives the changes greater than 1000 hectares, in order of size. The full list of changes in decreasing area is given in Appendix 5. This show that by far the greatest change is from rangeland (R5) to wadi agriculture (A2), a change, which accounts for 38,186 hectares. Approximately half of this change (18,666 hectares) occurs at the downstream end of wadi mawr.

The second and third largest changes demonstrate the variable nature of rainfed agriculture, and its location on rangeland and inland dunes.

The next largest change is from rangeland (R5) to parkland agriculture (A1). Rangeland to inland dunes (D2) is the fifth largest change at 10,024 hectares, but the net change between these tow classes is only 1747 hectares. The change from (A4) to (A2) indicates that previously isolated areas of pump-irrigated agriculture have been absorbed into more general areas of wadi agriculture, with out really changing the land use. The largest woodland change is the loss of nearly 9,000 hectares of Hyphaene woodland (C3) to rangeland (R5) has been converted ton pump irrigated agriculture (A4). This change, by itself, is larger than the net increase in pump irrigated agriculture. This anomaly is explained by the fact that many areas, which were pump-irrigated agriculture in 1973 had been assimilated into wadi agriculture (A2) by 1990 m thereby reducing the net increase in pump agriculture.
Table 3  
ANALYSIS OF AREAS OF CHANGE GREATER THAN 1000
HECTARES

<table>
<thead>
<tr>
<th>CLASS</th>
<th>1973 CLASS</th>
<th>AREA hectares</th>
<th>POLYGONS number</th>
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<tbody>
<tr>
<td>R5</td>
<td>A2</td>
<td>38186</td>
<td>91</td>
</tr>
<tr>
<td>A3</td>
<td>R5</td>
<td>28159</td>
<td>43</td>
</tr>
<tr>
<td>A3</td>
<td>D2</td>
<td>20932</td>
<td>13</td>
</tr>
<tr>
<td>R5</td>
<td>A1</td>
<td>13453</td>
<td>33</td>
</tr>
<tr>
<td>R5</td>
<td>D2</td>
<td>10024</td>
<td>79</td>
</tr>
<tr>
<td>A4</td>
<td>A2</td>
<td>9069</td>
<td>16</td>
</tr>
<tr>
<td>C3</td>
<td>R5</td>
<td>8997</td>
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</tr>
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</tr>
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</tr>
<tr>
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<tr>
<td>D2</td>
<td>A3</td>
<td>1331</td>
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Appendix VII

GROUNDWATER MONITORING

Groundwater monitoring is critical to water resources sector planning and management in Yemen. It is an integral part of environmental protection and preventive desertification control. Similarly, groundwater monitoring plays an important role in determining the viability and effectiveness of wastewater reuse programmes, a technique that is bound to become an integral component of water conservation in the long-term. The reliability of data needs to be improved and standardization of sample collection and testing methods as well as data recording plus expansion and rationalization of the monitoring network are required.

Groundwater monitoring is a set of processes by which the dynamic situation of groundwater resources are determined in time and space; then the data is treated and made available for use in management of the resource. Monitoring concerns quantity as well as quality and the parameters to be monitored depend on several factors such as the end use of the output, the monitoring capacity, etc.

Prior to 1996, there existed no wide scale and regular programme for groundwater monitoring in Yemen; although certain parameters such as the depth of aquifers were known in regions where wells were exploited. Similarly, on the occasion of groundwater explorations, particularly within the framework of on-going projects, much important information was gathered on certain basins such as that of Sana’a in the seventies. Often these activities ended with the termination of the projects and unfortunately no regular monitoring took place thereafter.

The need for groundwater monitoring was felt during late eighties and early nineties with the alarming decline of water depth in several aquifers and its consequences on drinking supplies, food production, and the environmental balance. Within the framework of the assistance provided to the Water Resources Component of the Land and Water Conservation Project, funded by the World Bank, FAO was requested to provide technical assistance for initiating a programme of water use monitoring and regulation in the agriculture sector, in collaboration with the National Water Resources Authority (NWRA). As a result, a Central Water Monitoring Unit (CWMU) was established and an important programme of water monitoring, focusing in particular on groundwater, was initiated in more than ten governorates participating in the Project.

Through the Technical Assistance provided by FAO, several aquifers were categorized for the first time and appropriate sites for monitoring wells were identified so as to constitute complete networks for every aquifer. In addition, a monitoring programme was elaborated. In the sites where no wells existed, new boreholes were drilled to complete the network. This allowed for 15 new observation boreholes to be drilled within the framework of the Project. The inventory of monitoring wells has then been completed in all governorates covered by the Project.

Field manpower was trained on groundwater monitoring, whereas engineers in the CWMU were trained on groundwater modelling using several computer software programmes.

Groundwater monitoring activities were conducted in all Project Implementation Units (PIUs), under the supervision of the CWMU and its trained technical staff. Where NWRA has already started its own monitoring, such as in Sana’a basin, Taiz and Abyan, monitoring by PIUs has already stopped. Ultimately, at the end of the Project, all monitoring activities will be transferred to NWRA.

The operation of groundwater monitoring, which was initiated under the Project, through FAO Technical Assistance, is supposed to be generalized to all the country as part of the implementation of the National Water Resources Strategy. The road to this end is still very long, tedious and still requires additional assistance and support. However, given its importance as a tool for water resources development and management, environmental protection and desertification control, the urgent need for such generalization can never be emphasized enough.
ROLE OF WOMEN IN ENVIRONMENT PROTECTION ISSUES
(WOMEN NATIONAL COMMITTEE)

Role of Women in the Protection and Improvement of the Environment

Despite the general recognition accorded to women’s work in the countryside, yet the public writings and official statistics often neglect this aspect. Moreover, those studies do not clarify the problems from which women suffer in the sphere of preservation and protection of the environment as well as the maintenance of resources and reinforcing food security. The reasons that lie behind that are at times owed to human activity and climatic conditions that drive women to misuse resources to the utmost rather than exemplary renewable utilization. This is evident in the irrational use of resources of all types, as the soil is subjected to loss of fertility, depletion, aerial and aquatic erosion in most parts of the Republic. Loss of soil fertility also leads to doubled speed of soil erosion owing to many factors, the most important of them being:

The use of chemical fertilizers in an unsound manner, in addition to water salinity in some areas. Water resources also suffer from on-going depletion and excessive pumping of subterranean water, which has resulted in the deterioration of the balance between pumping out rates and replenishment rates of this resource. Then there is the removal of the plant cover, which in turn leads to sand march. As a result of these human practices in respect of environmental resources, the areas of lands that are subjected desertification have increased owing to those reasons, as well as excessive grazing and irrational cutting of wood. The National Plan to Combat Desertification in the Yemen shows that 97% of the Republic’s land is subject in one way or another to desertification. These issues, in their totality, affect the realization of food security in the sphere of agricultural production.

Women’s position in these issues is considered to be a great one especially as 83.14% of the agricultural work force is made up of women. In the presence of illiteracy and absence of extension services being provided to women in this sphere, women’s role in the aggravation of these problems becomes even greater. However, the environmental effects are the most dangerous for women as they are the ones who to a great degree are subjected to these affects under social, economic and cultural conditions, most of which point out that they influence the degree of women’s comprehension of the solutions for the problems related to the environment.

Role of Women in Formulating Environmental/Information Policies

There are many problems that confront the information/environmental institutions concerned with environment issues. Perhaps, the most important of these are:

The clear absence of women’s role in formulating environmental information policies to arouse awareness of the various aspects of women’s participation in environmental work, underlining their official and popular participation in this sphere and the numerous and complementing roles of the existing social and developmental intermediaries and mechanisms existing in society and effecting co-ordination between them. These are directly related to women’s awareness and reinforcement of their roles in development spheres generally and the environment and its protection in particular and in the sphere of decision-making so as to have the roles complemented.
Role of Women in Utilization, Exploitation, and Rational Use of Water

Water is considered to be the most used element and its importance is evident in the sphere of hygiene and environmental health. As such, it is necessary that women be made aware of the returns of rational use of water to meet family needs. Women should also be made aware that water is open to pollution and must be purified and used soundly as water being a natural resource is a right for all.

Role of Women in the Agricultural Sphere

Rural women still work under traditional and backward conditions. Therefore, they have to be guided in a manner that serves the issues of agricultural development and sustainable development. They must be made aware of the dangers that face agriculture through continuing eradication of diseases, excessive use of pesticides and improve the type and quality of agricultural production.

It must be pointed out that the most important negative effects of the world population growth rates on the earth's resources is constructing the share of the individual in land utilized for agricultural production. From this growth, emanate patterns of unsustainable production, which lead to depletion of subterranean water and desertification of farming land. This share has dropped from 20.0% in 1987 to 0.6% in 1995 and has led to the occurring of sharp changes in the composition of crops that primarily rely upon irrigation from subterranean water.

Role of Women in Family Planning

As the problem of family planning is one of the matters that affect women in a vivid manner within the pressing and complex environmental problems, which today have become one of the national population problems, women have a definite role to play in this sphere. Whenever, women are conscious of these matters, their capabilities of confronting these problems at the individual and public levels become clear through their contributions to the formulation of national policies aimed at reducing the unbalanced rate of population increase in relation to the growth of natural resources and the numerous environmental problems that such population increase creates.
### Distribution of Resident Population by Urban, Rural, Governorate and Sex (x1000)

**Projection for 1999**

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Total</th>
<th>Rural</th>
<th>Urban</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
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<tr>
<td>Sana’a City</td>
<td>1,373</td>
<td>618</td>
<td>755</td>
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<tr>
<td>Sana’a</td>
<td>1,242</td>
<td>629</td>
<td>613</td>
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<td>Aden</td>
<td>471</td>
<td>228</td>
<td>243</td>
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<tr>
<td>Taiz</td>
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<td>1,123</td>
<td>1,034</td>
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<tr>
<td>Al-Hodeidah</td>
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<td>993</td>
<td>1,001</td>
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<tr>
<td>Lahj</td>
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<td>318</td>
<td>298</td>
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<tr>
<td>Ibb</td>
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<tr>
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<tr>
<td>Al-Beidah</td>
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<td>278</td>
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<tr>
<td>Hadramout</td>
<td>862</td>
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<td>424</td>
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<tr>
<td>Saadah</td>
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<tr>
<td>Al-Mahweet</td>
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<td>220</td>
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<tr>
<td>Al-Mahara</td>
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<td>Marib</td>
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<td>124</td>
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<tr>
<td>Al-Jawf</td>
<td>499</td>
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<td>261</td>
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<tr>
<td>Amran</td>
<td>886</td>
<td>438</td>
<td>448</td>
</tr>
<tr>
<td>Dalaa</td>
<td>380</td>
<td>195</td>
<td>185</td>
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<tr>
<td><strong>Total</strong></td>
<td>17,676</td>
<td>8,844</td>
<td>8,832</td>
</tr>
<tr>
<td>%</td>
<td>49.97</td>
<td>49.97</td>
<td>100</td>
</tr>
<tr>
<td>% of the total</td>
<td>100</td>
<td>73.95</td>
<td>26.05</td>
</tr>
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Source: Statistical Year-Book 1999. CSO, MPD. June 2000