THE NATIONAL ACTION PROGRAMME FOR ERITREA TO COMBAT DESERTIFICATION AND MITIGATE THE EFFECTS OF DROUGHT (NAP)

Ministry of Agriculture

January 2002
Asmara, Eritrea

THE NATIONAL ACTION PROGRAMME FOR ERITREA TO COMBAT DESERTIFICATION AND MITIGATE THE EFFECTS OF DROUGHT (NAP)

Prepared by Ministry of Agriculture

January 2002
Asmara, Eritrea

This document is published by the Ministry of Agriculture
Asmara, 2002

Draft edition, August 2001

This edition, January 2002

The content of this document were assembled to identify the process involved the development of the National Action Programme to combat Desertification for Eritrea. Much of the information is relevant for dissemination as a learning tool. It is therefore envisaged that the various parts and sections will be freely copied and used in the government departments, bilateral organisations, schools NGOs and interested individuals

Cover photograph: A scene in the western lowlands

TABLE OF CONTENTS

PREFACE

Land degradation is arguably the most critical environmental problem facing Eritrea. It is therefore fitting that a National Action Programme (NAP) be prepared to address this problem. The chapters which follow this Preface describe in greater detail the social, economic, and technical dimensions of land degradation in Eritrea and the policy measures designed to address them. Three fundamental points are made:

> **Firstly,** although land degradation results from complex interactions of natural and human factors, central to all these factors is the role of human action. Land degradation and loss of productivity result from anthropogenic influences: increasing populations of both people and livestock and wrong agricultural practices.
>
> **Secondly,** if we accept the argument that inappropriate and misguided human actions are the leading cause of land degradation and loss of productivity, it follows that appropriate and informed human action is critical to arresting land degradation or even to reversing it.
>
> **Thirdly,** Eritrea is determined to do everything possible to mobilise all of its people to achieve tangible results in stopping further degradation of land and loss of agricultural productivity. This is a national priority of the highest order. But we do not underestimate the enormous challenges that lie ahead. The first international treaty in the environmental field ratified by Eritrea was the 1994 United Nations Convention to Combat Desertification [UNTS 33480] (UNCCD). That action in itself is an indication of the priority we have assigned to land degradation.

The health and productive potential of the land are central to improved agriculture and increased food production. Therefore the preoccupation of the Ministry of Agriculture (MoA) with this question is obvious. As chief custodian of the productive land of Eritrea, the Ministry is deeply aware of its pressing responsibilities to lead the national effort in returning to the land of Eritrea some, if not all, of its productive potentials. This is not an effort exclusively assigned to the Ministry of Agriculture. Meaningful and effective action can only be undertaken through a joint effort of the Government, the people, and external partners. A key goal for NAP is to create synergies with other strategic planning processes. Two critical functions which the NAP process will address include upstream support in policy and institutional development and the mainstreaming of dryland issues in the development efforts of our line ministries.

Effective action will take time and co-ordinated efforts. It will take the widest and most extensive forms of popular participation by all sectors of the population. It will take a combination of many small local activities and some large ones. It will demand skills in mobilisation. It will call for an unusually effective means of co-ordination – means of initiating and sustaining concerted efforts, not isolated ones. It is in this context that the Ministry of Agriculture perceives NAP. NAP was drafted with the view that it become

Eritrea's co-ordinating mechanism for arresting land degradation. Eritrea's vision of sustainable development would be incomplete without addressing the question of land degradation in a co-ordinated manner.

Approximately 80% of Eritrea's population depend on agriculture for their livelihood, and they expect a great number of practical results from NAP. The Government of Eritrea (GoE) perceives NAP as a flexible and dynamic planning process and not simply as the production of another document. The Ministry of Agriculture will be in the forefront of making sure that NAP becomes a framework for preserving Eritrea's most valuable resource – its cultivated and grazing lands.

Arefaine Berhe
Minister of Agriculture

INTRODUCTION

Late in 1992, as the international community was making final preparations for the 1992 United Nations Conference on Environment & Development to be held in Rio de Janeiro, Eritrea was emerging from 30 years of war and destruction. Despite nascent evolution to statehood and lack of familiarity with multilateral negotiations in the environmental field, Eritreans keenly followed the debate in Rio. Far away from the conference halls – indeed, excluded from participating by reason of bureaucratic rules – Eritreans applauded the efforts of the 22 Sudano-sahelian countries that played a significant role in bringing the issue of land degradation to the Conference agenda. Eritreans were aware that the group faced tremendous difficulties in nurturing the idea of an international convention to combat desertification. It was natural for Eritreans to be sensitive to the issue of land degradation because it was arguably the most pernicious and widespread problem facing them as a new nation.

By 1994, it was not coincidental that the first international convention that Eritrea signed and ratified was the 1994 United Nations Convention to Combat Desertification [UNTS 33480] (UNCCD). As outlined in the Convention (Articles 9 & 10), the purpose of NAP is to identify the factors contributing to desertification, and to find practical measures to combat desertification and/or to mitigate the effects of drought. NAP is expected to incorporate long-term strategies to combat desertification and be integrated with national policies for sustainable development. It should also give particular attention to preventive measures. The actions under NAP should therefore entail both policy and institutional measures to facilitate the establishment of an enabling environment at the national level for sustainable resource use, as well as local-level development activities to preserve and/or restore the resource base and improve livelihood security of the affected populations. As conceived by the Convention, NAP is process-oriented, bottom-up, iterative, and decentralised. Through it, a set of integrated measures should be identified. The process itself should continue beyond the identification of those elements in order to provide for implementation and continuous review and adjustment. In formulating and implementing NAP, maximum flexibility is called for to take into account variations in the circumstances of the affected countries.

What follows in this Introduction provides a road map of both the NAP document and the NAP process. The process can be characterised by the deep commitment it has for the consultative process. The views of the people of Eritrea were sought through a series of workshops and seminars held at various regional centres. In addition, a technical committee of 11 experts was established to draft issue papers and to suggest practical measures to address land-degradation issues. A key task of the technical committee was to seek consensus through the regional workshops and to reflect that consensus in NAP.

The NAP document is divided into four parts:

Part A provides an overview of land degradation in Eritrea. It also presents the national vision and philosophy on land degradation and the measures to be taken to combat it.

Part B presents a comprehensive list of factors or issues contributing to desertification and land degradation in general. That list includes both physical and socio-economic factors. Adequate recognition is given here to the underlying socio-economic reasons for land degradation.

Part C presents the National Action Programme (NAP), describing the practical measures proposed to address land degradation. These include policy measures as well as field-oriented measures, projects, and programmes. The particular focus of this Part is on measures that build institutional, financial, and human-resources capacity.

Part D presents the plan for implementing the National Action Programme (NAP) presented in the prior Part. Presented here are the financial, institutional, and human-resources requirements to implement NAP. It also provides information on the sequence envisaged for implementing NAP.

Appendix 1 contains all of the proposed Project Profiles (PPs) to be undertaken within the framework of NAP, 23 in number. **Appendix 2** lists the publications referred to in the text. **Appendix 3** provides four glossaries to define and explain the arcane terms and symbols found in the text: 'Acronyms and other initials'; 'Standard International (SI) units of measure'; 'Eritrean (Tigrigna) terms'; and 'Technical terms'. **Appendix 4** lists the tables, figures, maps, and fact sheets found in the text. **Appendix 5** presents the members of the NAP Technical Committee.

Thus it can be seen that the National Action Programme (NAP), is not a mere document, but rather a process. There is always some difficulty in describing and encapsulating a process in a document, however long and articulate it may be. Some of the flavour of NAP is unlikely to be captured adequately in this document. But hopefully the outlines of NAP will have been clearly delineated and the national consensus on how to address land degradation will have been properly described. The NAP document provides the scaffolding around which is built a coherent set of tactical and strategic instruments to combat desertification.

NAP is an Eritrean product in the traditional sense. It is the people of Eritrea, assisted by a group of national experts, who fashioned and refined NAP into a coherent policy instrument. Having said that, it is important to recognise the valuable contribution external partners made to the process. In particular I wish, on behalf of the Government and people of Eritrea, to thank:

- The **United Nations Development Programme** Office to Combat Desertification & Drought (the United Nations Sudano-Sahelian Organisation) (UNDP-UNSO) for financial support;

- The **Inter-governmental Authority on Development** (IGAD) for its unflagging assistance and partnership in developing the NAP document;

- **Dr Arthur H. Westing** (Westing Associates in Environment, Security, & Education, USA) for his technical advice and editorial assistance; and

- The **Government of Denmark** for its material and substantive support in our efforts to arrest land degradation in general and in developing the NAP process in particular.

Mebrahtu Iyassu
Director General
MoA Department of Land Resources & Crop Production
and UNCCD National Focal Point

PART A: OVERVIEW

Land is the most precious and the most pervasive natural resource Eritrea has. Some 80% of the Eritrean population derives its livelihood from it. The cultivated cropland or arable portion of the landmass, *circa* 3.5% (*circa* 439 thousand ha), is the key resource which needs to be protected from encroaching desertification or land degradation. This is by far the greatest environmental challenge which the people of Eritrea face.

Land areas:
Reliable land areas are not as yet available for Eritrea. In this report, Eritrea's total land area is taken be 124,320 km^2 (12,432,000 ha). The land-use areas being used herein are presented below (see Table A.1), as are the areas of Eritrea's six *Zobas* (see Table B.21).

Population numbers:
As with land areas, reliable population numbers are not as yet available for Eritrea. In this report, Eritrea's 1997 population is taken to have been 3,500,000, and a subsequent growth rate of 2.9%/year is assumed (a rate that leads to a doubling time of 24 years). This makes Eritrea's 2002 population *circa* 4,038,000. Eritrea's 1997 urban population is taken to have been 20% of its total population of that time, *i.e.*, *circa* 700,000, and here a subsequent growth rate of 5.0% is assumed (a rate that leads to a doubling time of 14 years). This makes Eritrea's 2002 urban population *circa* 893,000 (or 22% of total 2002 population). All *per capita* values are calculated on the basis of 2002 values unless otherwise specified.

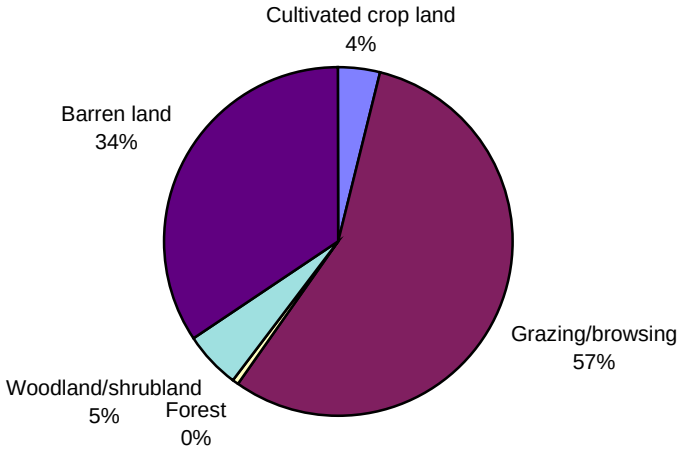
A.1 Land Use

The main forms of land use in Eritrea are agriculture and pastoralism. The major land-use types are shown in the accompanying table and associated chart (see Table A.1).

Table A.1 Land-use Types

Land use	Area (thousand ha)	%
Cropland	439	3.5
(Rain-fed)	(417)	(3.4)
(Irrigated)	(22)	(0.2)
Grazing land	7,000	56.3
Woody vegetation	737	5.9
– Highland forest	(53)	(0.4)
– Plantation	(10)	(0.1)
– Woodland	(674)	(5.4)
– Dry	(664)	(5.3)
– Riverine	(5)	(0.0)
– Coastal	(5)	(0.0)
Urban land	13	0.1
Barren land	4,243	34.1
Total	**12,432**	**100**

Notes: (a) Cropland = arable land = cultivated land.
Grazing land = savanna = grassland = rangeland. (Grazing land generally supports grasses, forbs, and scattered shrubs, thereby offering both grazing and browsing opportunities.)
Woodland = scrubland = shrubland = brushland = bushland. (The dry woodland generally includes various species of *Acacia*.)
Riverine = riparian.
Coastal = littoral = mangrove.
(b) For the areas of Eritrea's six *Zobas*, see Table B.21.
Source: EWFIS (1996), FAO (1996), & NEMP-E (1995).



Much of the landmass of Eritrea, *circa* 56% (*circa* 7 million ha), is better suited for pasture than farming. In these circumstances, it is in a sense appropriate to describe Eritrea as a nation of and for pastoralists. To the pastureland must be added land covered by woody vegetation (highland forest, plantation, and woodland) amounting to *circa* 6% (*circa* 737 thousand ha) of the total landmass. The annual and perennial species, both non-woody and woody, found in the Lowlands Zones are key to the survival of pastoralists. It is this key resource, the biomass produced on the grazing lands, that those shrewd land managers – pastoralists – are so good at optimising. This is the reason why they survive in a landscape that is both harsh and fragile.

A.2 Some Basic Perceptions

A.2.1 Sustainability as a Social Task

However useful the standard international definition of sustainability may be, Eritrea maintains that it can only be defined as a social task, and realised through practical and effective participation of the people. We recognise that sustainability is linked with the future use, and possible abuse, of resources. The future is inherently associated with uncertainty. In these circumstances, we cannot determine sustainability with a uniform set of criteria, but must rather perceive it to be determined by an internal political process.

A.2.2 Soil and Land as Renewable Resources

Contrary to some established definitions, Eritrean policy firmly holds that soil and land are renewable resources. Nature can take more than a century to replenish 1 cm of lost soil, slowly torn apart from solid rock. Juxtapose this fact with the definition of renewable resources: resources that regenerate within a human life span, *i.e.*, 40-80 years. In this framework, soils and land would be classified as non-renewable. However, perceiving Eritrea's most important natural resources – soil and land – as renewable resources provides a logical basis for action to combat land degradation.

A.2.3 Difference between Natural Renewable and Non-renewable Resources

The difference between renewable and non-renewable resources can also be described in another way. Renewable resources, and the ways in which they are used, are inseparably linked to ecological processes. They are therefore in a state of dynamic equilibrium between utilisation and renewal. If this equilibrium is destroyed, degradation occurs, and new and different ecosystems come into existence. On the other hand, non-renewable resources are not an integral part of such ecological processes. They might be thought of as constituting resource pools (mineral deposits etc.). Human beings can tap these pools, but they cannot be replenished. Hence non-renewable resources can be depleted to the point of exhaustion.

A.2.4 Reversing Degradation

Considering the distinction between renewable and non-renewable resources raises a question about the reversibility of processes of degradation. In the case of non-renewable resources, reversibility is clearly not a factor: *e.g.*, once oil is burned, it cannot be recreated from the combustion residue. But when renewable resources are affected by degradation, there is a chance that the process can be reversed: *e.g.*, conservation measures might be implemented to halt soil erosion. Yet once a certain threshold has been exceeded, even the degradation of renewable resources can no longer be reversed.

A.2.5 *Eritrean National Code of Conduct for Sustainable Development*

The *Eritrean National Code of Conduct for Sustainable Development*, adopted in 1995, makes the following point regarding the use of renewable and non-renewable natural resources (NEMP-E, 1995, pp xii & 229):

> '**The Government and peoples of Eritrea...herewith solemnly proclaim...a steadfast resolve to utilise the national renewable natural resources sustainably and the non-renewable ones frugally, and also to dispose of all wastes sustainably: and, in support of this resolve, to achieve a national population level that is in balance with available national resources and sink capacities, so that both present and future generations can live in dignity, and especially so that development can be carried out sustainably and with equity.**'

A.2.6 Participation by the People

Because of the vast expanse of land under threat of degradation and the large percentage of the population affected by this, the Government cannot hope to manage desertification single-handedly. The participation of the people is critically important. In Eritrea, awareness and commitment to participation are deep, practical, and without reservation. Through the NAP process, participation will not only be articulated as a policy measure, but all the practical physical and logistic measures are to be further developed and implemented.

Although the importance of participation has been recognised, it is not always clear what the exact modalities are for making it practical, effective, and result-oriented. The NAP process is to implement the following ways to bolster participation:

- Take all necessary measures to institutionalise consensus-building and decision-making, *inter alia*, by resorting to the traditional mechanisms of frequent *Baito* (Council) and *Megebaaya* (Assembly) sessions at the *Zoba* (Regional) and *Adi* (Village) levels. When we say 'institutionalise' these measures, we mean establishing formal guidelines for the frequency of those meetings, the establishment of their agendas, and the mechanisms for monitoring and assessing the implementation of their decisions.

- When people at the local level are given the opportunity to take active part in the national discourse in combating desertification, they become empowered, and thus able to help determine the course of events.

A.2.7 Perceptions about Pastoralism

Pastoralists are not locked into a destructive land-and-livestock relationship, as many people assume. Nor are they romantic independents living in perfect harmony with nature. They are skilled and knowledgeable herders, with a long tradition of making the best of a tough environment. Many are able to adapt quickly to changing circumstances. And they are not always the adversaries of the farmers – on the contrary, many pastoralists exist in symbiotic harmony with settled farmers.

Risks to pastoralism: alienation of 'rich-patch' areas:
The advance of cultivation poses a severe threat to pastoralism. Both pastoralism and other land uses (*e.g.*, cultivation) hope to expand, and often cultivation is given priority over pastoralism. Some administrative interventions appear to intensify this threat. One of the greatest threats to pastoralism is the taking away of 'rich-patch' areas – fertile areas that pastoralists have traditionally banked on when other grazing areas disappear. The NAP process will develop a strategy for the preservation and exclusive use of 'rich-patch' areas by pastoralists.

Pressure from population increases:
Pastoral populations are increasing, but not as rapidly as agricultural populations. The rate of population growth in pastoral areas is probably in the range of 1%-2%/year. However, the lower pressure from human population increases is offset by an increase in the herd population owing to improved veterinary and water-supply conditions. Moreover the off-take rates have not necessarily kept pace with the increasing in herd sizes. This has placed greater pressures on grazing lands.

Pastoralism and the 'tragedy of the commons':
There is a misperception that individual pastoralist are seen to have little incentive to conserve communal grazing by reducing the size of their herd because they have no guarantee that others will do the same. This is the embodiment of the 'tragedy of the commons' argument. This argument has been criticised from different quarters. Resources are by no means communally owned. They are managed by discrete and definite groups and are far from being open-access resources. Indeed, both restricted use and conservation are actively practised. Hence many pastoral communities have proved viable in spite of the pessimistic 'tragedy of the commons' argument. Clinging to this argument as an excuse to change land-use practices and settle people in ecological conditions that may not be sustainable will not be acceptable in Eritrea.

Rejection of arbitrary sedentarisation:
Pastoralism is not perceived as being too primitive for the modern world. Eritrea will steadfastly avoid converting pastoral areas to commercial or private ranching, taking the control over land-use away from pastoralists, or even driving the pastoralists away altogether, so that a sedentary population can exploit the area. In Eritrea there is the realisation that the pastoralists' own evolving strategies can be the basis for development. However, it must be recognised that pastoralism is at present under extreme pressure from drought, expanding agriculture, and an educational system that generally works against pastoralism.

A.2.8 Factors Contributing to Land Degradation

Land degradation and past colonial domination:
During the period of colonial domination, Eritrea's arable land was under threat. Unrealistic exploitation, excessive removal of vegetation, and heavy extraction of woody biomass resulted in a significant reduction of the land's productivity. This happened despite the avowed policy of the colonial administrations, which expressly stated their preference for the land of Eritrea, rather than for the people of Eritrea. In the end, both land and people suffered.

In 1935 there were fewer than 5 thousand Italian settlers in Eritrea. By 1941 their numbers had grown to 70 thousand. In the 1920s, Italian colonialists had expropriated almost 50% of the land and placed it under state control for the benefit of the Italian settlers.

Failure of traditional conservation measures:
Traditional conservation measures have remained stagnant while socio-economic conditions have changed dramatically. Traditional tenure patterns, particularly *Diessa* (Village ownership) and *Resti* (kinship ownership), have not been conducive to good land husbandry, even though those tenure systems produced a uniquely egalitarian society with a deep spirit of community. Both these systems have prevented landlessness and thus were economically and socially valuable in the context of subsistence agriculture. However, the positive aspect of traditional tenure has been undermined by population pressures. Both the *Diessa* and *Resti* ownership patterns have, in the circumstance, generated fragmentation of holdings.

Whatever traditional conservation measures existed (*e.g.*, prohibition of tree cutting, reduction of over-grazing by preventing cattle – except for milk cows and plough oxen – from grazing in Village lands during certain periods of the year, use of a fallow system to restore the vegetation and fertility of the land) were rendered ineffective as dramatic political, social, and economic changes occurred around the turn of the twentieth century.

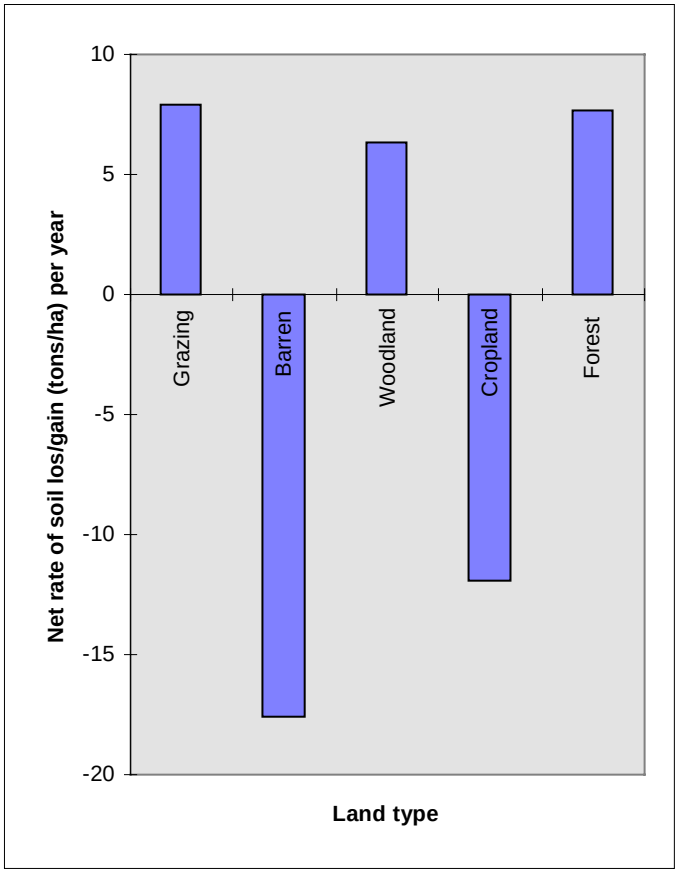
Livestock development concerns:
Livestock population increases, together with improved veterinary services, led to a rapid increase in the numbers of livestock. Between 1905 and 1946 the number of cattle increased by 300% while the number of goats and sheep rose by over 200%. This led to over-cutting of the highland forests. Over-grazing also became a serious problem, especially in the Central Highlands Zone (CHZ). In these areas, since livestock are grazed on communal lands with no user fees, each household attempts to increase the size of its livestock, thus reducing the land's carrying capacity.

Erosion:
Poor, shallow soils are prone to excessive soil erosion. The net rate of soil loss from croplands is estimated at 12 tonnes/ha/year (see Table A.2). Crop yields are declining at the rate of *circa* 0.5%/year owing to soil erosion.

Table A.2 Soil Loss or Gain for the major Land-use Categories

Land use	Area (thousand ha)	%	Gross rate of soil loss (tonnes/ha/year)	Net rate of soil loss or gain (tonnes/ha/year)
Cropland	439	3.5	–21.0	–11.9
Grazing land	7,000	56.3	– 2.5	+ 7.9
Highland forest	53	0.4	– 1.0	+7.7
Woodland	674	5.4	– 2.5	+6.3
Urban land	13	0.1	[na]	[na]
Barren land	4,243	34.1	–35.0	–17.6
Total/Mean	**12,432**	**100**	**–14.2**	**– 1.6**

Note: Cropland = arable land = cultivated land.
Grazing land = savanna = grassland = rangeland. (Grazing land generally supports grasses, forbs, and scattered shrubs, thereby offering both grazing and browsing opportunities.)
Woodland = scrubland = shrubland = brushland = bushland. (Woodland contains primarily dry woodland, but also some riverine and coastal woodlands – see Table A.1. The dry woodland generally includes various species of *Acacia*.)
Source: Bojö (1996).



Nutrient losses:
Eritrea's cropland is being degraded for several reasons:

First, absence of inputs to make up for crop nutrient use. For example, growing sorghum (*Sorghum bicolor*) removes *circa* 30 kg/ha/year of nitrogen (N) and *circa* 12.5 kg/ha/year of phosphorus (P). The use of chemical fertilisers is virtually nil in Eritrea. According to FAO, nitrogen input in Eritrea via chemical fertilisers averages only *circa* 50 g/ha/year of cropped land.

Second, owing to the absence of alternative domestic fuels, somewhat less than 273 thousand tonnes/year of animal dung is used for domestic fuel (see Table B.13). It is estimated that animal dung contains nitrogen in the amount of *circa* 2.77 kg/tonne, and phosphorus in the amount of *circa* 2.57 kg/tonne (Bojö, 1996). Nutrient loss owing to the use of animal dung for fuel is thus *circa* 756 tonnes/year of nitrogen, and *circa* 702 tonnes/year of phosphorus. The resulting cereal output value foregone is estimated at 4.5 thousand tonnes/year (or the equivalent of US$ 1.25 million/year). This loss amounts to 2.2% of Eritrea's 2001 cereal production of *circa* 203 thousand tonnes.

Third, two of the traditional agricultural systems mitigating nutrient loss – the fallow system and crop rotation – are practised with decreasing frequency and regularity because of land scarcity. According to Jan Bojö, more legumes should be planted following good years and fewer during poor years (Bojö, 1996). There are apparently more poor years being experienced than good years. Although more refined data need to be collected and analysed before conclusive views can

be advanced, it can be stated safely that a significant share of nutrient loss will remain even after adjustment for the impact of the fallow system and crop rotation.

Fourth, other factors contributing to land degradation are: rapid modernisation, social breakdown, and possible use of inappropriate machinery, *e.g.*, the disc plough.

Rapid modernisation:
Modernisation is taking place even in remote rural areas. New crop varieties are replacing the traditional varieties. Agricultural extension agents introduce new approaches, which are often imported from abroad. The drive to promote the export of agricultural products is central to rapid modernisation. These are manifestations of different cultures. New resources come into play, whereas others lose the value they previously had. Traditional ecological principles, which conserve land resources in appropriate ways, and which are often rooted in cultural norms, no longer play a decisive role. These developments have the effect of a storm the turbulence of which abruptly terminates processes of local development that have been in progress for decades.

Social breakdown:
Modernisation further marginalises traditional knowledge of appropriate resource use. Modern inputs predominate – indeed, may be given priority as social order and traditional systems of natural resource use break down. The old knowledge becomes worthless in the face of the new. Until understanding of the new production method is clarified and institutionalised, resources are used inappropriately and environmental hazards are increased.

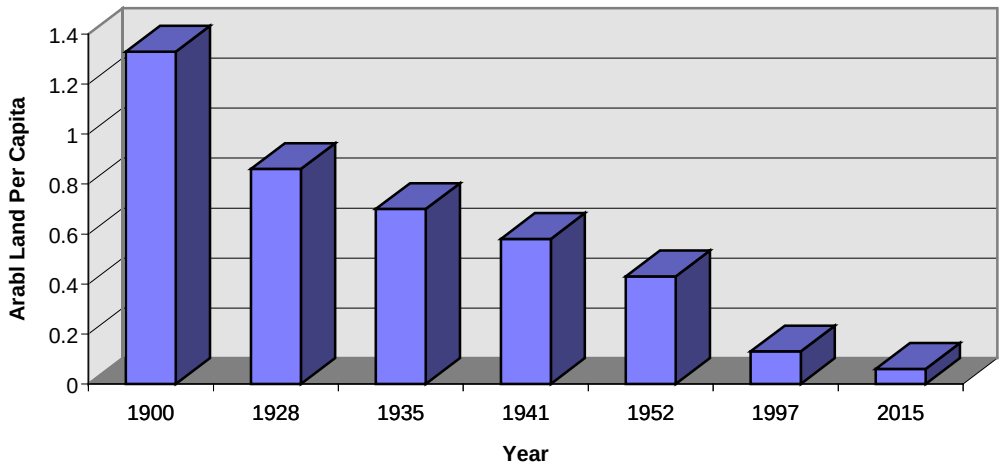
Arable land as a finite resource:
As population increases, *per capita* cultivable land diminishes simply because arable land remains at best constant. At present, *per capita* cultivable land is 0.11 ha (see Table A.3). By 2015, this amount could drop to 0.07 ha. However, the figure may well be even less as land becomes alienated from agriculture to urbanisation and to expand the road network. Moreover, some land will become so degraded that it will be only marginally usable for cultivation. Hence, more and more people will become concentrated on less and less arable land.

Table A.3 Projected Population Growth and Arable Land *per Capita* (1900-2015)

Year	Population	Arable land (*per capita)*
1900	330,000	1.33
1928	510,000	0.86
1935	617,000	0.71
1941	760,000	0.58
1952	1,031,000	0.43
1997	3,500,000	0.13
1998	3,602,000	0.12
1999	3,706,000	0.12
2000	3,813,000	0.12
2001	3,924,000	0.11
2002	4,038,000	0.11
2005	4,399,000	0.10
2010	5,075,000	0.09
2015	5,855,000	0.07

Notes: (a) Based on a population growth rate of 2.9%/year from 1997 on; and on a constant area of arable land of 439 thousand ha.

(b) *Cf.* Table B.1.



Expansion of agriculture into dry woodlands:
As the need to increase production for the market intensifies, both the process of concentration on existing arable land and the pressure to exploit marginal lands have intensified. Therefore the expansion of agriculture into the dry woodlands has become a major concern. Some years ago there was adequate awareness of the need to be cautious about expanding agriculture in the dry woodlands. Because of this policy, the Government had resisted pressures to grant new concessions for commercial farming.

Between January 1992 and December 1995, there were *circa* 4,300 private and commercial applications for new land concessions, totalling *circa* 185 thousand ha. However, during the same period, only *circa* 505 licenses for new commercial farms were granted, covering *circa* 12,400 ha. Many applications are pending, in part because of the requirement that applicants must be able to demonstrate that they have sufficient capital to bring these areas under production. Expansion into these areas would have a number of significant impacts. By way of nearby example, vast areas of the now degraded Sudan, which had been cleared for rain-fed farming over the last 30 years, are apt testament to the destructive impact of this strategy. Not only would the land become degraded following such clearance, but there would additionally be a loss of large areas of dry woodlands.

The caution which the Eritrean Government exercised during 1992-1995 has given way to a liberal expansion of cultivated land. In 1998, the area under cultivation expanded by *circa* 10% (by almost 44 thousand ha). This expansion was the result of extensive mechanised farming. The impact of this expansion, and the extensive use of mechanisation, will both need to be carefully assessed.

Agricultural and food security:
Even in a year of 'adequate' rainfall, Eritrea now produces only about half of its food requirements. Indeed, food assistance to Eritrea amounts to 125 thousand to 236 thousand tonnes/year of cereals. The pursuit of national food security is thus both a legitimate and an urgent national priority.

The extent to which the agricultural sector is strengthened by the objective of food security is a vital issue. Food security is a multi-sectored and multi-faceted issue. Although the agricultural sector plays an important role, it is not the only sector to be concerned. Food security does not imply the complete production by the agricultural sector of the food supply demanded by Eritrea's population. This may not be desirable – indeed, given the fragility of Eritrea's agricultural land, it may not even be possible at present.

A.2.9 Policy Options to Combat Desertification

The following policy orientations are among those to be further developed in the NAP process.

In the land sector:

- Protecting Eritrea's 439 thousand ha of cultivated land from further degradation.
- Exercising caution in expanding agriculture into dry woodlands (*inter alia*, through mechanised farming). The environmental, social, and economic implications of clearing vegetation from marginal lands need careful consideration.
- Implementing the Land Reform Proclamation (No. 58/1994).

In the agricultural sector:

- Addressing food-security objectives in consonance with objectives for arresting land degradation.
- Addressing soil erosion.

In the forestry sector:

- Encouraging social forestry and agro-forestry.
- Encouraging fuelwood plantations.

In the livestock and pastureland sector:

- Encouraging alternative risk-avoidance strategies, as large stocks are not necessarily the best approach to risk avoidance.
- Improving fodder production.
- Avoiding encroachment of farms into pastureland.
- Saving traditional fertile 'rich-patch' areas.
- Avoiding unsubstantiated and unwarranted sedentarisation.
- Removing unwarranted obstacles to the nomadic way of life.

In the water sector:

- Given Eritrea's poor water endowment, expanding and adopting technology for moisture

retention, groundwater conservation, and water recycling.

In the energy sector:

- Given the excessive dependence in Eritrea on fuelwood biomass as an energy source, and the link between land degradation and deforestation, encouraging a shift from using traditional non-commercial biomass energy to using conventional commercial energy.

- Introducing fuel-efficient stoves. Substantial improvement can be achieved in the efficiency of using traditional biomass for cooking (currently operating at less than 12% efficiency) with fuel-efficient stoves. A major challenge in this will be to provide affordable commercial energy without incurring large-scale subsidies. Initially only those in the upper income brackets are likely to benefit from energy that can be referred to as affordable. Eventually, as the economic situation in Eritrea improves, the larger segment of the society with modest income has to be included in the affordable-energy scheme.

In the socio-economic sector:

- Mobilising and empowering civil society to address land degradation effectively.

- Devolving decision-making to the lowest (grassroots) levels, and encouraging localisation and decentralisation.

- Seeking consensus and giving communities a voice in determining priorities.

- Supporting stake-holder dialogue through the National Forum on Land Degradation (see Section D.2). The Forum is not an institution *per se,* but rather an institutional process.

- Developing community-based local land management plans.

In the education, research, and training sectors:

- Expanding research, education, and training in appropriate technologies to arrest land degradation.

In the information and data-management sector:

- Creating national capacity to monitor, assess, and evaluate land degradation.

In the drought-prediction sector:

- Creating capacity for the early warning of drought, and for devising mitigation measures.

- Developing Eritrea's capacity to evaluate climate variability and its implications for land degradation.

As regards gender issues:

- Mainstreaming gender issues in all policy dialogues on combating desertification.

As regards civil society, NGOs, and community-based organisations:

- Empowering civil society, NGOs, and community-based organisations to be active partners of Government in combating land degradation.

As regards financial arrangements:

- Developing an appropriate financial mechanism – *e.g.*, the Eritrean National Desertification Fund (ENDF) – to catalyse action at the grassroots level.

As regards institutional arrangements:

- Developing appropriate institutional modalities for the office unit responsible for co-ordinating the implementation of NAP, giving consideration, *inter alia*, to the role of the Ministry of Agriculture, and the role of the reorganised Technical or Steering Committee.

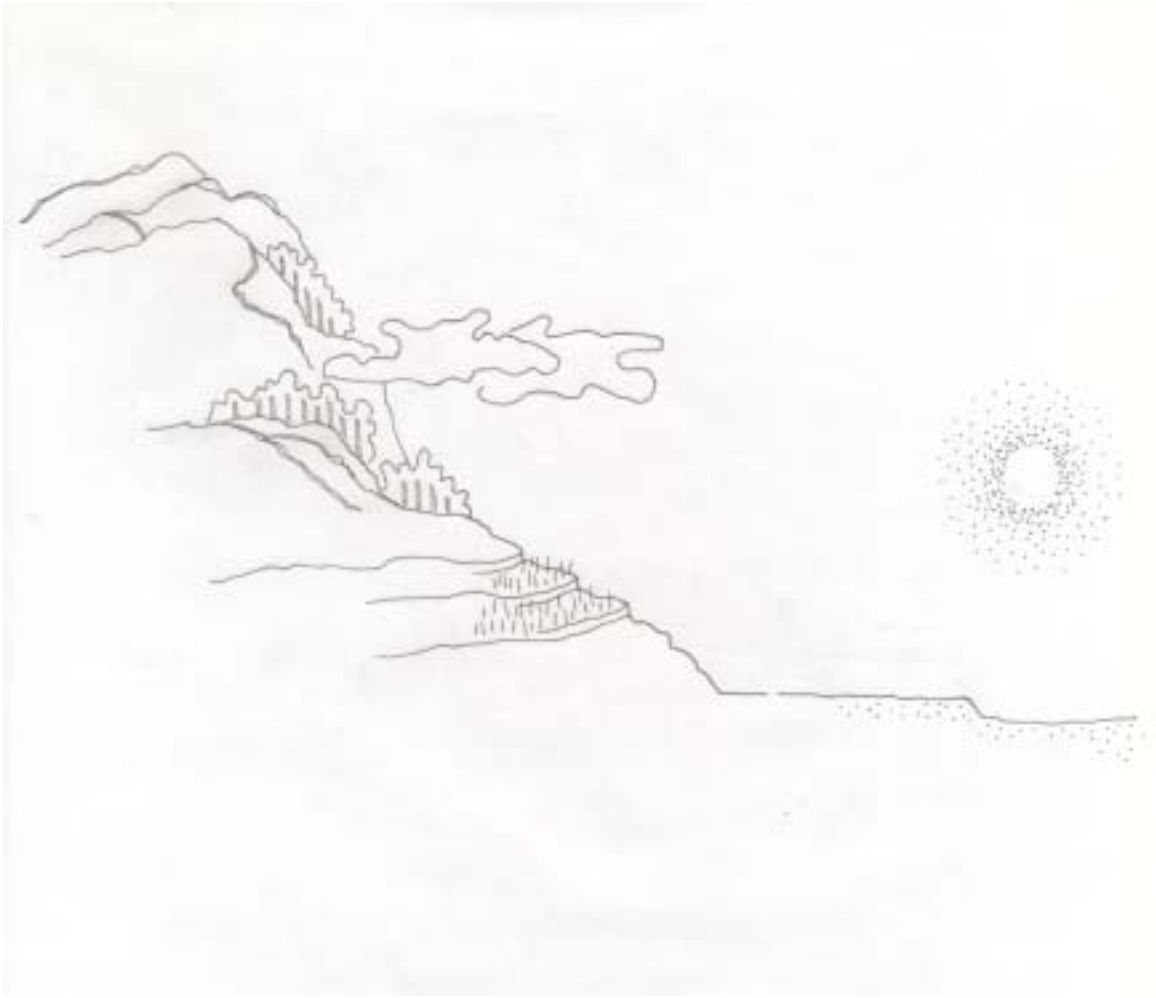
As regards international co-operation:

- Fostering bilateral partnerships with countries that have had successful experiences in combating land degradation.

PART B FACTORS CONTRIBUTING TO DESERTIFICATION

In this Part B of the report, the factors contributing to desertification are presented in some detail within the framework of 12 major sectors: Land issues; Agricultural issues, Water issues; Energy issues; Biodiversity issues; Forestry issues; Livestock and rangeland issues; Human-settlement issues; Drought-preparedness issues; Awareness, education, & training issues; Socio-economic issues; and Public-participation issues.

B.1 Land Issues



B.1.1 Overview

Eritrea has a complex series of landscape and climatic features characterised by vertical zonation, which go from semi-desert to high-mountain environments, and with a wide range of land uses.

Though no reliable current land-use data exist grazing land and barren land dominant land use in Eritrea, which together add up to *circa* 90% of the total area (see Table A.1). Land currently under cultivation (rain-fed and irrigated) constitutes only *circa* 3.5%).

Roughly 80% of the people of Eritrea earn their living from economic activities related to the exploitation of land. The demands for arable land and lands for grazing, forestry, wildlife, tourism, and urban

development are becoming more pressing every year.

The cropland of Eritrea is under heavy pressure owing to increasing population densities and soil erosion. The overall average population density today is 9.2 persons/ha of cropland, or 0.11 ha/*capita* of cropland (see Table A.3). Taking only the rural population into consideration, these values become 7.2 persons/ha of cropland, or 0.14 ha/*capita* of cropland (see Table B.1). Assuming that the extent of cropland will remain constant in size in the coming years, these values will become ever less favourable.

Table B.1 Projected Rural Population Densities on Cropland (1997-2015)

Year	Rural population (thousand)	Rural population per ha of cropland	Cropland hectares per rural person
1997	2,800	6.4	0.16
1998	2,867	6.5	0.15
1999	2,934	6.7	0.15
2000	3,003	6.8	0.15
2001	3,073	7.0	0.14
2002	3,144	7.2	0.14
2005	3,365	7.7	0.13
2010	3,755	8.6	0.12
2015	4,171	9.5	0.11

Notes: (a) Rural population based on a total 1997 population of 3,500 thousand that has since then been growing at 2.9%/year, less its urban fraction that was in 1997 20% of total population, but that has since then been growing at 5.0%/year. Density values based on a cropland area of 439,000 ha.

(b) *Cf.* Table A.3.

To satisfy the demand of the growing population for agricultural land, additional agricultural land is needed each year. This results in expansion into fragile or otherwise unsuitable areas. On the other hand, the landscape of Eritrea is mainly mountainous, characterised by steep slopes. This, together with the torrential nature of the rain and paucity of vegetational cover accelerates the washing away of soil. For example, net soil loss from cropland is 11.9 tonnes/ha/year, while that for barren land is fully 17.6 tonnes/ha/year (see Table A.3). Assuming an average rate of decline in productivity of 0.3–0.6%/year, the gross discounted cumulative loss (GDCL) over 100 years is estimated to be *circa* US$ 18–US$ 36 million (Bojö, 1996).

In addition, the traditional Eritrean land-holding system and the neglect of the colonial powers have both contributed to the deteriorating state of the land of Eritrea. The Government of Eritrea (GoE) has therefore given priority to land issues and has promulgated the Land Reform Proclamation (No. 58/1994). This Proclamation is aimed at reforming the system of land tenure; determining land use, determining the manner of expropriating land utilised for development and national reconstruction; and determining the power and responsibility of institutions which will implement the Proclamation. Implementation of the Proclamation should be a core issue in the fight to combat desertification (see Fact Sheet B.1).

B.1.2 Land Issues

B.1.2.1 Legal and Institutional Issues

Promulgation of the Land Reform Proclamation (No. 58/1994) is one step forward in the fight against land degradation and towards the introduction of wise land husbandry in Eritrea. This Proclamation will change existing tenure systems and introduce a new and uniform system throughout the country.

The Land Reform Proclamation (No. 58/1994) guarantees all Eritreans above 18 years of age the right to land based on the usufruct principle. The Government owns all land in Eritrea, and will allocate land fairly and equitably without discrimination on the basis of race, religion, gender, or national origin. The new system of land allocation and tenure is expected to confirm and reinforce the security of tenure and thus improve the incentives for better husbandry of land resources.

However, the Land Reform Proclamation (No. 58/1994) gives only a general framework, and detailed work is needed in drawing up the necessary policies, rules, regulations, and guidelines of implementation. A land-use policy is needed to balance the competing demands for land amongst different sectors of economy – food production, export crops, tourism, wildlife conservation, housing, public amenities, and other infrastructure.

Article 46 (Sub-articles 1 & 2) of the Land Reform Proclamation (No. 58/1994) states that the Government shall have supreme authority in formulating the country's land-use policy. It further states that the power provided shall include the authority to determine the classification of land and its usage and to limit the amount of land to be distributed amongst the usufructuaries.

The institutions necessary for the implementation of the Land Reform Proclamation (No. 86/1994) are in their infancy. Responsibility mainly lies with the MoLWE Department of Land. At this time, that Department is focused mainly on building its human and institutional capacities. A great effort will be needed to upgrade the existing labour situation, both in quantity and quality. The establishment of functional land-administration bodies at a lower level is another ongoing task.

B.1.2.2 Assessment of Land Resources

The land resources of Eritrea have not yet been studied in detail. The existing data are mostly interpolations of Ethiopian data that lack field verification because of the inaccessibility of many areas during our protracted War of Liberation of 1961-1991 and our subsequent Ethiopian War of 1999-2000.

Natural-resource and socio-economic surveys and land evaluations would provide the baseline information needed for effective and rational land-use planning, and to make decisions on investment in natural-resource conservation and protection.

Assessment of the natural resources will require the following steps:

1. Production of satellite images and aerial photos;
2. Collection of existing data relevant to natural resources, such as socio-economic, agro-climatic, and soil data; and
3. Presentation of results in the form of different maps, such as maps of land use, land cover, land capability, soil group, and geology.

One of the steps taken towards fulfilling the assessment of natural resources will be the preparation of maps of agro-ecological zones for Eritrea. Several such maps do already exist, but they have been based on Ethiopian maps and other sources. The Ethiopian maps had lacked ground verification and thus none based on them provide reliable information.

With the need for an accurate agro-ecological map for Eritrea in mind, the Ministry of Land, Water, & Environment (MoLWE) has recently prepared a new one. However, it is not detailed, having been compiled on the basis of existing data and with only limited field checking. Accurate and reliable data on soils, climate, and other natural resources will be needed to prepare a more detailed map.

B.1.2.3 Land Tenure

Land tenure is the ownership or leasing system of land or the right to use it. Eritrea now has a number of different systems of land tenure. The extended-family system and Village systems of land ownership are dominant in the Central Highlands Zone, whereas tribal systems and Government ownership are dominant in the Eastern and Western Lowlands Zones.

The old systems of land tenure have through time become the cause of land conflicts and social inequity, as the question of women and landlessness remains unsolved. The *Diessa* system (where land is in Village ownership) is dominant in the Central Highlands Zone, which comprise 65% of the population and 16% of the land. The periodic redistribution of land under this system (every 5-7 years) has led to fragmentation of land, and has discouraged farmers from long-term investment in improvements.

The Land Reform Proclamation (No. 58/1994) introduces a new and uniform land tenure system. According to this Proclamation, the Government owns the land and every Eritrean above the age of 18 has a right of usufruct. Hence the new land tenure is expected to:

- Give incentives to farmers to invest in land improvement owing to secured tenure rights;
- Promote social and economic equity;
- Promote wise land use through the introduction of land-use planning; and
- Decrease land conflicts by introducing system of clear land ownership.

Therefore, the new land-tenure system is expected to contribute greatly to the reduction and/or control of land degradation. However, the contribution of land tenure to combating desertification will not be significant if it is not supplemented by systems of resource tenure such as tree-tenure and water-tenure systems. Therefore, the MoLWE Department of Land will need to work closely with the MoLWE Department of Water Resources and the Ministry of Agriculture to solve this problem.

With the existing capacity, implementation of the new land-tenure system should be started in selected pilot areas. This would help the MoLWE Department of Land to explore practical problems in the field. The experience gained from this process would help facilitate the implantation of the new land-tenure system in wider areas of Eritrea.

B.1.2.4 Land-use Planning

Land-use planning is a new practice in Eritrea. The mishandling of land by the colonial powers and the different tenure systems in Eritrea were the main obstacles to its introduction. The Land Reform

Proclamation (No. 58/1994) has established the basis for a new and systematic way of planning. A land-use planning unit has been formed under the MoLWE Department of Land. This unit is in its infancy and is focused mainly on urban and peri-urban areas owing to the high demand for land for urban expansion and the need to protect agricultural land loss in those areas. Since mid 1997, land classification and partial land-use planning have been accomplished for 117 Villages and Towns. Additionally approved for land use have been 42 areas of investment and social services. Beyond this, *Tiesa* land (land traditionally given by a Village to its inhabitants for residential purposes) has been given out in 240 Villages in southern Eritrea.

However, land-use planning is also needed in rural areas where there is an urgent need for wise use of the scarce land resources, especially in the Central Highlands Zones. The wise use of land through land-use planning will help to control land degradation. Since land-use planning takes the ecosystem and its carrying capacity into consideration, it would help communities in achieving the sustainable use of their resources. It will also help to identify and delineate the highland-forest areas, economic trees, and the wildlife as means of helping to preserve the biodiversity of Eritrea. Moreover, careful planning can deal with infrastructure expansion with due environmental consideration. Hence, given the existing limited capacity, introduction of land-use planning is needed to be carried out in prioritised areas of environmental and economic significance.

The land-use unit dealing with planning will need to upgrade its human and material resources both in quantity and quality in order to meet this demand. The development of a land-use policy and associated guidelines and standards for planning are also prerequisites.

B.1.3 Recommendations

The following recommendations are in order regarding land issues *vis-à-vis* desertification:

1. An integrated national land-use policy is required which integrates the various sectoral policies based upon the principles of efficiency, equity, and environmental soundness.

2. A systematic and user-oriented assessment of the land resources of Eritrea should be a priority.

3. Guidelines, directives, and standards for implementing the new land-tenure system and the introduction of land-use planning are required.

4. Strengthening the institutional and professional capacities of land use are needed.

5. Land-use planning should precede every development activity on land.

Fact Sheet B.1 The Land Reform Proclamation (No. 58/1994)

Objective: To reform the system of land tenure in Eritrea .

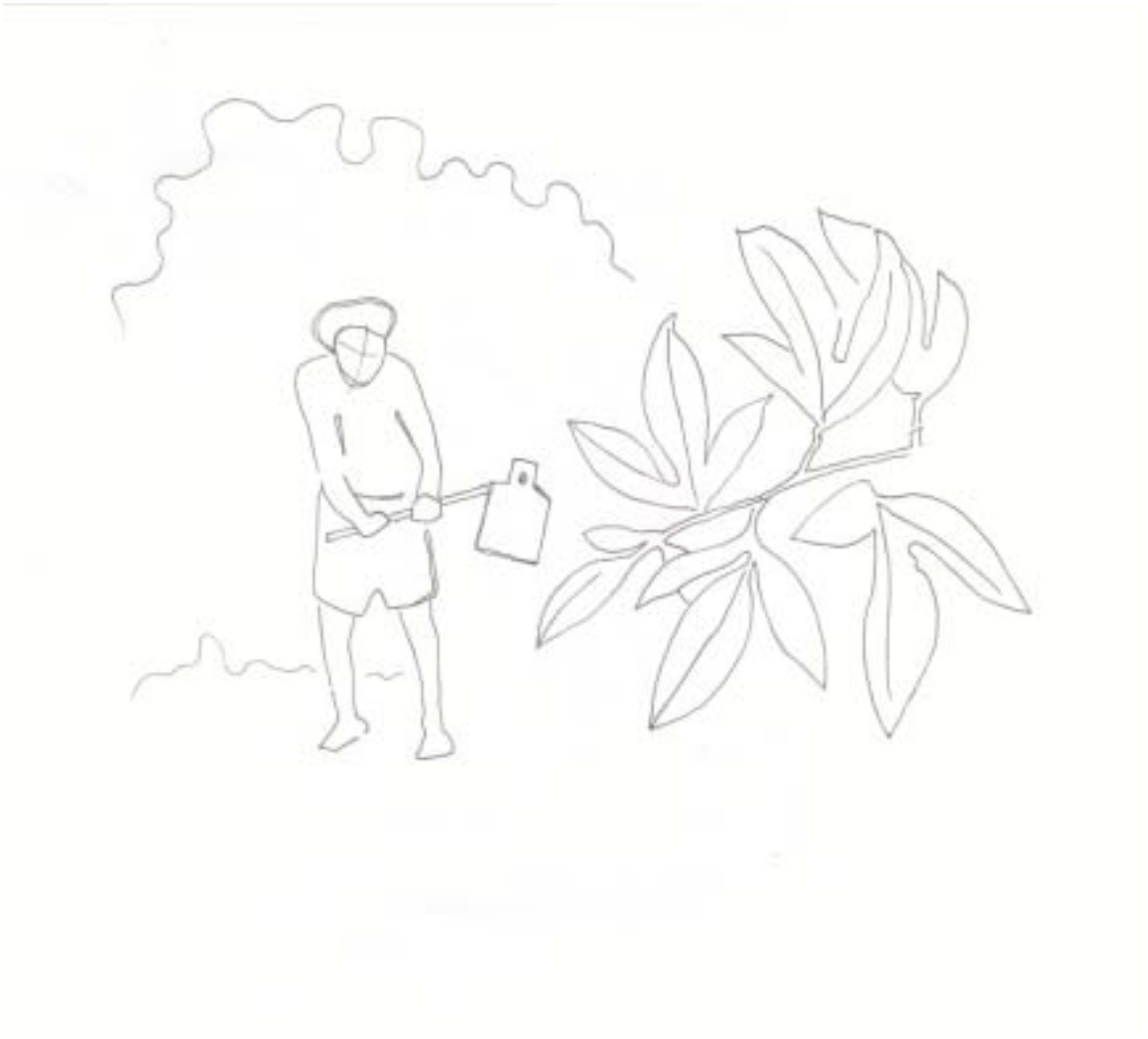
- To determine the manner of expropriating land for purposes of national development.
- To determine the powers and duties of the Land Commission.

General content:

The Government of Eritrea (GoE) promulgated this Proclamation on 24 August 1994. It contains 5 sections and 59 articles. Its general content can be summarised as:

- Land in Eritrea is owned by the State.
- Every Eritrean citizen above the age of 18 shall enjoy usufruct rights over land, with no discrimination on the grounds of sex, belief, race, or clan.
- The usufructuary can use the allotted land for his or her lifetime; may lease his or her usufruct right over the land in whole or in part; or may transfer it to his or her children.
- The Land Administrative body is responsible for classifying and distributing land according to its use, and for keeping a proper registry.
- The Government, with the approval of the Office of the President, has the right to appropriate land to be used for development purposes and national construction by paying the necessary compensation.
- Generally speaking, this Proclamation changes all the land-holding systems in Eritrea into one uniform system covering the entire nation.

B.2 AGRICULTURAL ISSUES



B.2.1 Overview

Eritrea has potentially arable land of *circa* 1,176 thousand ha (existing cropland plus land now covered by woody vegetation – see Table A.1). Of the *circa* 439 thousand ha now under cultivation, *circa* 417 thousand ha is cultivated under rain-fed conditions and the remaining 22 thousand ha under irrigation.

There are six agro-ecological zones in Eritrea. The most important Zones for agriculture are the Central Highlands Zone (CHZ) and South-western Lowlands Zone (SWLZ). Pastoral and agro-pastoral systems predominate in the North-western Lowlands Zone (NWLZ) and Coastal Plains Zone (CPZ), although irrigation agriculture is important along major river valleys and from spates in areas adjacent to escarpments. The Green Belt Zone (eastern escarpment) supports mainly disturbed highland forest, but includes some localised areas of intensive cropping.

Production is primarily subsistence in nature, and the major crops grown are sorghum (*Sorghum bicolor*),

pearl-millet (*Pennisetum glaucum*), finger-millet (*Eleusine coracana*), barley (*Hordeum vulgare*), wheat (*Triticum* spp), and teff (*Taf*) (*Eragrostis tef*). A wide range of other pulses and cereals is also grown. Small-scale irrigation is practised for high-value crops, fruits, and vegetables in limited portions of the Highlands and Lowlands Zones, using dug wells and micro-dams.

Generally, crop yields are very low, and the crop season is short, covering 2-3 months. The returns on these activities are low and often inadequate to cover household subsistence needs. Hence, the current food-security situation, though improving, is still of major concern. Farming households face food insecurity as evidenced by *per capita* food production well below current requirements. The main reasons for low production are recurrent droughts, severe land degradation, low soil fertility, improper farming systems, insect pests and diseases, and low agricultural inputs (fertilisers, pesticides, etc.).

Eritrea has been subjected to land degradation because of many natural and human causes. These include climatic conditions, deforestation, over-grazing, over-cultivation, soil erosion, and decline of soil fertility. Eritrea is in the Sahelian Zone of East Africa where the land is mostly arid or semi-arid and is characterised by erratic rainfall – usually unevenly distributed and also frequently failing. Hence, Eritrea is vulnerable to all of the problems associated with low rainfall.

The main causes of deforestation are consumption of fuelwood, construction of traditional houses (*Hidmos*), and land clearing for cultivation without replanting. Over-grazing is a common phenomenon all over Eritrea, with resulting soil degradation. Livestock ownership is still an indication of wealth and social standing that tempts farmers or pastoralists to hoard more animals than they require.

Over-cultivation is aggravated by the existing conditions. Generations of intensive farming, especially in the Central Highlands Zone, have decreased the productive capacity of the soil there. Practically, no soil enrichment measures are as yet being taken, and as a consequence the decrease in soil fertility leads to increased crop failure.

Another debilitating factor is soil erosion, which is one of the most serious environmental problems in the Central Highlands Zone (NEMP-E, 1995, p. 52). Eritrean soil is subjected to continuous erosion because of the rugged nature of its landscape. In some cases, this may have been exacerbated the neglect of land and soil conservation practices by the colonial governments.

Owing to these and other related factors, the soils are vulnerable to massive erosion. They have lost their fertility and they are very shallow, with limited water- and nutrient-retention capacities.

B.2.2 Agriculture and Desertification

The accepted UNCCD definition of desertification is ‘land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities’ (Article 1.a). However, for Eritrea, the following definition is more appropriate:

> **Desertification is the continuous and sustained decline in the amount and quality of the biological productivity of arid and semi-arid lands caused by inappropriate land-use practices, whether or not in conjunction with extreme natural event. Such stress, if continued over the long term, leads to ecological degradation and ultimately to desert-like conditions.**

Biological productivity of a given area refers to the productivity of its naturally occurring plant and animal life as well as to that of its agricultural plants and animals (Sabadell *et al.*, 1982).

B.2.3 Factors Contributing to Desertification

B.2.3.1 Climatic Conditions

It is clear that physical environmental factors, especially climate, play a fundamental role in desertification. Climate, more especially rainfall, is particularly important in the process of crop and livestock production.

Eritrea is one of the countries in the Sahelian Zone of East Africa. The climatological data available for Eritrea (Asmara, 1905-1995; other stations, 1949-1975) indicate that the country's annual rainfall is insufficient and erratic. Moreover, the duration of rainfall during *Kremti* (the June-September long rainy season) is becoming shorter. During 1914-1923 the rainfall extended over as much as 5 months, whereas since that time its duration has dropped to 2½ months with the exception of an occasional very good season.

Generally, the rainfall in Eritrea is unreliable in quantity and distribution. The problem of inadequate total rainfall over much of Eritrea is compounded by the high variability of both total annual rainfall and its intra-annual distribution. In the history of Eritrea, several years are recorded where low rains have led to the near total loss of crop production and the near total loss of fodder for livestock (see Section B.9.2.2).

B.2.3.2 Population Pressures

The population of Eritrea is now *circa* 4.0 million (see Table A.3). It is estimated to be growing at *circa* 2.9%/year, which leads to a doubling time of 24 years. Of the population, *circa* 78% reside in rural areas (see Table B.20) and depend primarily upon agriculture and livestock production for their livelihood. Crops and livestock account for *circa* 60% of their income, the remainder coming from wages, self-employment, and trade activities.

The population increases and the associated demand for land have led to an extension of rain-fed cropping into marginal lands and a shortening of fallow cycles. This pressure, in combination with various other factors, have caused social and ecological imbalances, leading to a reduction in land productivity. As fertility declines, crop yields become lower and negative feedback becomes important. Thus, to compensate for lower yields, the land is worked ever more intensively, resulting in severe land degradation.

B.2.3.3 Improper Systems of Cultivation

Traditional agriculture in Eritrea, the rapidly increasing population, and the consequences of this for agricultural, industrial, and urban development, present profound challenges to environmental sustainability. The ecological and social consequences of the mounting human pressures, and the self-defeating attempts to cultivate ever steeper slopes, become more apparent with time as Eritrea approaches the terminal phase of human-induced environmental denudation.

The farming system is overwhelmingly traditional. A wide range of crops is grown with poor crop management. All rain-fed crops are local varieties established by farmer selection over generations,

adapted to the short growing season. Land preparation is carried out with the traditional plough drawn by a pair of oxen or camels. Seed is broadcast by hand. Chemical fertilisers and other chemical treatments are used only rarely. Farmyard manure is also used only rarely as fertiliser, now largely being used instead for fuel. Weeding is done by hand. Pest attacks are a major constraint in all crops. Soil erosion on arable land is high. There is no detailed land-use study.

There are several types of land-holding systems in Eritrea. The *Diessa* landowner system is the dominant one in the Central Highlands Zone, whereby every 5-7 years there is a redistribution of land within the Village.

Even if the *Baito* system has some benefits in the sense that each family gets an equal share of land in terms of area and fertility, the disadvantages outweigh the benefits. This system results in a strong disincentive to proper land management, especially to conservation and soil-fertility measures, because an individual farmer is not going to use the land for a long period. Today, farmers are waiting for changes in land distribution, either to the *Diessa* system or by going to another land-tenure system. They do not want to invest in conservation measures or to fertilise their land. Moreover, the land fragmentation created by increases in Village population numbers represents a problem for the development of mechanised agricultural farming.

B.2.3.4 Improper Irrigation Systems

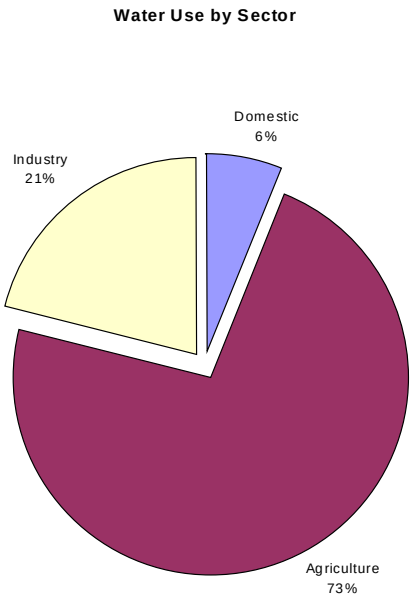
Eritrea has both perennial and seasonal irrigation systems. Of Eritrea's *circa* 22 thousand ha of irrigated cropland (see Table A.1), *circa* 4 thousand ha is under perennial irrigation, and the remaining *circa* 18 thousand ha under seasonal irrigation (FAO, 1994). The seasonal irrigation is mostly spate irrigation in the Eastern Lowlands Zone (ELZ), but also includes the 1,840 ha Alighider Agricultural Estate on the lower Gash River. Under spate irrigation, rivers are diverted by temporary brush-wood and earth structures into a series of large bunded fields.

Spate irrigation is low cost, but labour-intensive. Only minimal water control is possible, and frequent repairs are necessary to the diversions and field bunds because of flood damage. The lack of permanent water-control structures also means that some farmers will suffer flood damage while others will have inadequate water.

Perennial irrigation systems are mainly dependent upon surface water or groundwater. However, the capacity of both the surface water and groundwater may be greatly depleted owing to over-exploitation, as happens in areas such as the Alla and Tselima Plains.

Generally speaking, irrigated agriculture does not contribute much to desertification because of the limited areas under irrigated agriculture. However, if not properly designed and managed, irrigated land is extremely susceptible to flood damage in the case of spate irrigation, and to depletion of groundwater resources in the case of areas such as the Alla and Tselima Plains.

The following diagram shows that most water in Eritrea is used for agricultural purposes. Therefore, proper water utilisation is of paramount importance for sustainable agricultural development. It takes *circa* 1000 tonnes of water to grow 1 tonne of grain, and all too often 70-80% of the water never reaches the crop.



B.2.3.5 Soil Erosion

Soil erosion is the detachment and transport of soil particles by water or wind. Erosion by water is the dominant one in Eritrea. It is common in the Central Highlands Zone. Erosion by wind is more common in the Coastal Plains Zone, where the soils are sandy, the area is flat, and the vegetational cover is sparse.

Both the natural (geological) and human-induced types of erosion are serious in the Central Highlands Zone, Green Belt Zone (eastern escarpment), and western escarpment. Soil erosion is becoming the most serious environmental problem threatening Eritrean agriculture. Natural factors such as abnormally intense if erratic rainfall and rugged topography (especially in the Central Highlands Zone), combined with over-grazing and the massive destruction of the highland forests in the last few decades, have led to high rates of soil erosion.

Owing to these and other related factors, an estimated 2.4 million ha of the Central Highlands Zone (including especially its northern portion) had by 1984 been degraded through water erosion. The soil loss from sheet and rill erosion in this Zone is in the range of 5-100 tonnes/ha/year (NEMP-E, 1995, p. 52).

According to Jan Bojö, the loss of topsoil causes an accelerating decline in crop productivity. Hence the gross annual immediate crop loss (GAIL) is in the range of 0.3-0.6%/year, which corresponds to US$ 0.1–US$ 0.4 million/year (Bojö, 1996). FAO (1994) states that soil erosion is a serious problem throughout Eritrea, but does not give any quantitative estimates of its extent. On the other hand, the World Bank (1994) argues that in terms of the impact on income, productivity, and human welfare, land degradation and the associated problem of deforestation are the two areas of greatest concern in Eritrea. Halting or reversing land degradation and ensuring food security are the two major objectives of the Ministry of Agriculture (MoA, 1993). Land which can become severely degraded within a short period of time may take several hundred years to return to its former condition. According to research on soil formation, it takes from 300 to 1000 years to replace 2.5 cm of lost topsoil (FAO, 1994).

According to the World Bank (1994), between 1979 and 1992 *circa* US$ 116 million of 'food-for-work' (FFW) assistance was allocated to soil- and water-conservation work in Eritrea. Massive terraces were constructed in the Central Highlands Zone. However, most of the practices designed to address the problem have fallen short of expectations. Often farmers failed to adopt the recommended interventions or abandoned them when the project ended.

B.2.3.6 Nutrient Losses

In most cultivated soils in Eritrea, fertility has been depleted because nutrients are being lost through soil erosion and crop removal without replenishment by addition of natural or chemical fertilisers. Farmers rarely use chemical fertilisers, and animal dung and agri-residues (crop residues) are now mainly used for fuel and livestock feed. As noted earlier, it is estimated that animal dung contains nitrogen in the amount of *circa* 2.77 kg/tonne, and phosphorus in the amount of *circa* 2.57 kg/tonne (see Section A.2.8). Such use thus leads to reduced grain production.

A number of field surveys have been conducted on the soils of Eritrea. The majority of these are exploratory or reconnaissance surveys, so do not provide sufficiently detailed data. However, recent soil analyses indicate that in the Hamassien area, 88% of the soils are low in organic matter. Phosphorus is very low and potassium is low to very low. In Halhale, the phosphorus content is very low, in the range of 1.01-1.08 ppm. In Merhano, 24 out of 30 soil samples analysed were found to have low phosphorus content. Some soils could also be deficient in sulphur (Mohogho, 1997).

Therefore, with hardly any agri-residues or other organic matter applied to the soil, it is almost certain that, left as it is, soil fertility will decrease further, crop yields will decline, and susceptibility to erosion will increase.

B.2.4 Recommendations

The land of Eritrea is characterised by a diversity in agro-ecological conditions which permit the production of a large variety of crops adapted to different climatic conditions. Eritrea also has potentially exploitable surface-water resources, notably: the Mereb River, Gash River, Setit River , the rivers of the Green Belt Zone (eastern escarpment), the Barka River, and the south-eastern rivers in the Danakil Depression (see Table B.7).

In addition to that, Eritrea has potentially arable land in the Western Lowlands Zone (WLZ) which is still unexploited, rich, and fertile. This Zone has the ability to produce surplus grain, fruit, and vegetables for domestic and export purposes. Therefore, the productivity of these resources could be raised significantly under the following proper technologies and management practices:

1. Intensive mechanised farming;
2. Enlightened soil and crop management;
3. Soil- and water-conservation practices; and
4. Supplementary irrigation activities.

B.2.5 Programme of Action and Priorities

B.2.5.1 Intensive Mechanised Farming

Intensive farming by concentrating agricultural inputs in a specific area permits production without adversely affecting the natural resources. This could be achieved through the following:

i. Improvement and expansion of agricultural research, extension, and training. Those efforts should cover all agricultural sub-sectors: crop and horticultural production, rain-fed and irrigation farming, livestock husbandry and health, land resources, soils, soil- and water-conservation practices, and forestry. The research should be focused sharply on the needs of Eritrea's farmers, be adaptive in nature, and wherever possible be carried out on the fields of producers.

ii. Strengthening plant-protection activities. Pest infestations – *e.g.*, by desert locusts (*Schistocerca gregaria*) and army worms (*Spodoptera exempta*) – are common and are mentioned by many farmers as being equal to drought in their negative impacts.

iii. An accelerated programme of importing and testing improved crop varieties with potential for use under different agro-ecological conditions, together with an extensive fertiliser trial and demonstration programme. Adoption of improved varieties from neighbouring countries may be especially useful.

iv. A fertiliser import and distribution programme under a fertiliser-credit scheme and insurance programme.

v. Expansion of mechanised farming in areas of high potential, especially in the Lowlands Zones, that can be irrigated or rain-fed with supplementary water, with the use of appropriate soil- and water-conservation measures.

Integrated farming was introduced in 1998. In that initial operation, 349 tractors were used to cultivate 42,504 ha of farmland. The total yield obtained was *circa* 70 thousand tonnes. According to the MoA, yields obtained from integrated farming are double those from traditional farming. However, in the long run, problems associated with mechanised farming include the deterioration of soil structure owing to excessive cultivation and soil compaction. Such undesirable effects can be minimised by minimum-tillage practices because with fewer cultivation operations, the soil is less disturbed, less compacted, and less vulnerable to erosion. Therefore, detailed studies and surveys should be done in association with introducing mechanised agriculture on soil type, soil depth, slope of the land, soil-moisture content, vegetational cover, soil erosion, and types of machinery used.

B.2.5.2 Soil and Crop Management

Soil management:
The aim of soil management is to create optimal conditions for plant growth through improved soil fertility and structure. Improved soil-management practices also increase rates of water infiltration, improve soil water-holding capacity, and reduce runoff and erosion. Improved soil-management practices include appropriate tillage practices, application of fertilisers and manures, mulching, and the incorporation into

the soil of agri-residues and other organic material.

The objective of appropriate tillage is to optimise the physical and biological conditions of the soil for increased crop production and to ensure timely seedbed preparation and weed control.

Additions of manure and fertilisers to the soil provide the required plant nutrients for vigorous crop growth. Fast growth leads to quicker ground cover and better yields. Organic matter plays a vital role in improving soil structure, thereby encouraging water infiltration and increasing soil resistance to erosion and its ability to hold nutrients. Mulch protects the soil from surface sealing, holds water, and allows it to infiltrate slowly. Besides helping to control erosion, mulches also reduce evaporative water loss, improve water retention, increase the number and activity of microörganisms in the topsoil, and suppress weeds.

Crop management:
Several principles of crop management and a number of agronomic techniques have been developed to reduce erosion by ensuring adequate ground cover and to improve fertility. Therefore, consideration should be given to how an optimal ground cover can be established. This could be achieved through crop selection, early planting, crop rotation, intercropping, mixed-cropping, etc.

Some crops are much more effective than others for conservation purposes. For example, perennial crops are generally much more effective as ground cover than annual crops. Moreover, legumes such as beans provide better ground cover and erosion control than does maize.

Timely land preparation permits the early planting of a crop. This ensures that the crop emerges 1-2 weeks after the onset of the rains and protects the ground quickly against the impact of raindrops.

Good crop rotations facilitate the conservation and incorporation of organic matter, the restoration of soil structure and fertility, the control of erosion, and a reduction in pests and diseases.

Intercropping and mixed-cropping with leguminous and non-leguminous crops, and with early- and late-maturing crops, have the advantage of providing continuous ground cover. At the same time, such practices provide some level of food security in the event that one of the crops fails. They can also improve the diet of the farm family.

B.2.5.3 Soil- and Water-conservation Practices

Soil- and water-conservation practices have been carried out in Eritrea for a long time on a large scale, both on and off farmland, together with afforestation programmes on hillsides and enclosures (see Table B.2). However, much more will have to be done especially in renovating the structures.

Table B.2 Soil-conservation Structures Constructed on Cultivated land (1992-1998)

	Activity	Achievements (km)
	Stone bund	29,572
	Soil bund	19,802
	Bench terrace	87
	Fanya juu (contour terrace)	3,943
	Check dam	806
	Sown terrace	19

Soil- and water-conservation practices include biological (agronomic and vegetational) and physical (structural) practice of the following sorts:

i. *Agronomic measures:* Cultural or biological practices such as mixed-cropping, contour cultivation, mulching, and manuring that promote soil- and water-conservation practices. They are usually associated with annual crops, and are repeated routinely.

ii. *Vegetational measures:* Use of perennial crops, grasses, shrubs, or trees. These are usually of long duration, such as some agro-forestry technologies. They sometimes lead to changes in slope profile, as, *e.g.*, the terraces that develop from establishing narrow strips of vetiver (*Vetiveria*), elephant, or other native grasses on the contour.

iii. *Structural measures:* Permanent features formed from earth, stone, or masonry that are designed to protect the soil from uncontrolled runoff and erosion and to retain water for when it is needed. The most common conservation structures used on cropland are contour (level) bunds of stone or soil, level *Fanya juu* hillside terraces, check-dams, micro-basins, waterways, cut-off drains, and double ditches – all chosen according to the ecological zone, soil type, soil depth, and available material. The development of integrated watershed-management practices in drainage areas is also vital for conserving the soil and for recharging the groundwater to the full capacity of the soil.

B.2.5.4 Development of Irrigation Schemes

Eritrea has six agro-ecological zones. Four of these zones support rain-fed crops, but are drought-prone. The two Zones with favourable rainfall are the Green Belt Zone (eastern escarpment), which obtains the highest rainfall (*circa* 700 mm or more), and the South-western Lowlands Zone.

In view of the inadequacy and unreliability of rainfall in much of Eritrea, irrigation will have to play an important role in improving the security of crop production. In fact, some perennial and seasonal irrigation activities have already been implemented in both the Highlands and Lowlands Zones. However, much remains to be done to use the available water resources sustainably.

B.2.5.4.1 Perennial Irrigation from Groundwater

The main sources of groundwater for irrigation are the alluvial aquifers along riverbeds such as those of the lower Gash, Barka, and Mereb Rivers (see Maps B.3 & B.4). Irrigation from shallow groundwater could be practised extensively in the valleys of the Central Highlands Zone.

B.2.5.4.2 Perennial Irrigation from Dams

Many dams have been constructed in the past 10-15 years in the Central Highlands Zone, although these are not as yet being fully utilised (see Table B.3)

Table B.3 Existing Micro-dams (Built both Before and After Independence in 1991)

Zoba	Quantity	Area rainfall (mm)	Irrigable area (ha)	
			Actual	Potential
Maekel	23	500-700	64	1,087
Debub	54	300-900	174	2,023
Anseba	17	200-600	2	302
Semenawi Keyih Bahri	4	<200->900	0	83
Gash-Barka	4	200-700	4	7
Total	**102**		**244**	**3,569**

B.2.5.4.3 Seasonal Irrigation by Diversion

The use of spate diversion in the Eastern Lowlands Zone (ELZ) is of long standing, *e.g.*, on the Sheeb, Forro, and Alighider Agricultural Estate projects. However, this is a very small and traditional system of irrigation. By constructing permanent structures such as those in *Wadi* Labka and Bada, spate irrigation could be extended to large areas.

B.2.6 Institutional Issues

B.2.6.1 General Policy

The general policy with respect to agricultural factors contributing to desertification must include:

- The creation of a modern, technologically advanced, and competitive agricultural sector;
- The production of high-value agricultural commodities through the development of irrigated agriculture;
- The better utilisation of water for irrigated agriculture and new irrigation schemes; and
- The promotion of research and extension.

The main institution involved in the agricultural sector is the Ministry of Agriculture (MoA). Other relevant institutions are the Ministry of Local Government (MoLG), Ministry of Land, Water, & Environment (MoLWE), Eritrean Relief & Refugee Commission (ERREC), University of Asmara (UoA), Eritrean Grain Board (EGB), and credit institutions.

MoA has three main technical departments, of which the MoA Department of Land Resources & Crop Production is directly involved in agricultural activities. The structure of the technical departments in the *Zobas* and *Sub-zobas* is the same as at the central Government level. The extension functions of MoA are carried out through the *Zoba* and *Sub-zoba* offices. Those functions are as yet barely adequate to service the needs of farmers.

The land-holding system dominant in the Central Highlands Zone is called *Diessa*. Under this system, land is the common property of all Village residents. The land is periodically redistributed by the Village *Baito* (Council) to the eligible members of the Village in accordance with rules and regulations unique to

each Village. Therefore, many communities currently have their own local by-laws for enclosure management, water use, cropping patterns, and fallow periods.

Several international organisations co-operate with Eritrea on various agricultural projects, including integrated watershed management, irrigation schemes, horticultural development, and food security. Among those organisations are especially DANIDA, FAO, Norwegian Church Aid, the World Bank, and the African Development Bank (AfDB).

B.2.6.2 Disaster-preparedness in Agriculture

Agriculture is a major component of the economy, and is vulnerable to various calamities or disasters. Eritrea is located in the Sahelian Zone of East Africa, characterised by a low and erratic rainfall pattern. Drought has a major impact on Eritrea's human as well as livestock populations. Pest infestations – *e.g.*, by desert locusts (*Schistocerca gregaria*) and army worms (*Spodoptera exempta*) – are also common, recurring repeatedly in Eritrea.

A number of famine records owing to failures in crop production because of rainfall shortages exist for Eritrea. Indeed, compilations by the former Eritrean Relief Agency (now ERREC) indicate that droughts have occurred almost every year (ERA, 1989). Thus, 12 droughts were recorded during the period 1970-1989: in 1970, 1973, 1974, 1977, 1980, 1981, 1982, 1983, 1984, 1985, 1987, and 1989. During 1984-1985, there was a mass displacement of *circa* 650 thousand people.

Eritrea is prone to outbreaks of the desert locust, in large part because the humid sandy soils of the Coastal Plains Zone (CPZ) along the Red Sea provide a good breeding environment for those pests. In fact, desert locust plagues have caused regional famines from time to time. To illustrate the magnitude of the problem from neighbouring Ethiopia, crop damage in 1957 owing to desert locusts amounted to *circa* 167 thousand million tonnes of grain (DLCOEA, 1993). This was followed by further depredations in 1967-1969 and 1978-1979.

Desert locust outbreaks have long occurred at intervals of *circa* 10 years, but since 1976 they have started recurring at shorter intervals. Yearly occurrences were recorded during 1984-1988 (ERA, 1988). In 1987, severe desert locust outbreaks were experienced because our War of Liberation of 1961-1991 had prevented control operations. Since 1993, there have been two heavy outbreaks, in 1995 and 1997 (see Table B.4).

Table B.4 Desert Locust (*Schistocerca gregaria*) Control Operations (1993-1997)

Year	Area infested (ha)	Area controlled			Pesticide amount			
		Ground	Aerial		Ground	Aerial		Person-days
		(ha)	(ha)	Flying hours	(L)	(kg)	(L)	
1993	-	9,078	18,300	-	11,630	0	9,100	1,468
1995	103,584	26,317	25,580	67.05	13.438	664	12,805	12,085
1996	45.25	45.25	0	0	35.25	0	0	
1997	-	27,050	8,400	39.0	22,838	0	8,400	
Total	**103,629.25**	**62,490.25**	**52,280**	**106.05**	**47,941.25**	**664**	**30,305**	**13,553**

Army worm infestations are becoming more prevalent in Eritrea. However, the degree of infestation has not reached disaster levels on a nationwide basis. But in some localised areas devastating results have been observed (see Table B.5).

Table B.5 Army Worm (*Spodoptera exempta*) Control Operations (1993-1998)

Year	Area infested (ha)	Area controlled			Amount of organo-phosphorus pesticides applied			Person-days
		Ground	Aerial		Ground	Aerial		
		(ha)	(ha)	(Flying hours)	(L)	(kg)	(L)	
1994	122,479.45	23,020.20	62,246	-	17,425	42,182.75	26,316	-
1995	-	-	-	-	-	-	-	-
1996	1,045.	591.	-	-	544	-	-	784
1997	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-
Total	**123,524.45**	**23,611.20**	**62,246**	**-**	**17,969**	**42,182.75**	**26,316**	**784**

The use of chemical pesticides for the control of desert locusts and army worms might be harmful for the non-targeted beneficial organisms found in the infested area and also in the Red Sea owing to the polluted runoff entering it. However, no survey or study has been carried out to regarding the extent of harmful effects from such spraying.

Drought, famine, and pest (*e.g.*, desert locust) infestations can strike at any time, and in such cases we must be prepared to mitigate their effects through such activities as afforestation programmes, highland-forest protection policies, soil- and water-conservation practices, and water-management techniques. These measures would go a long way toward preventing land degradation, strengthening a food-security programme, and supporting plant-protection activities.

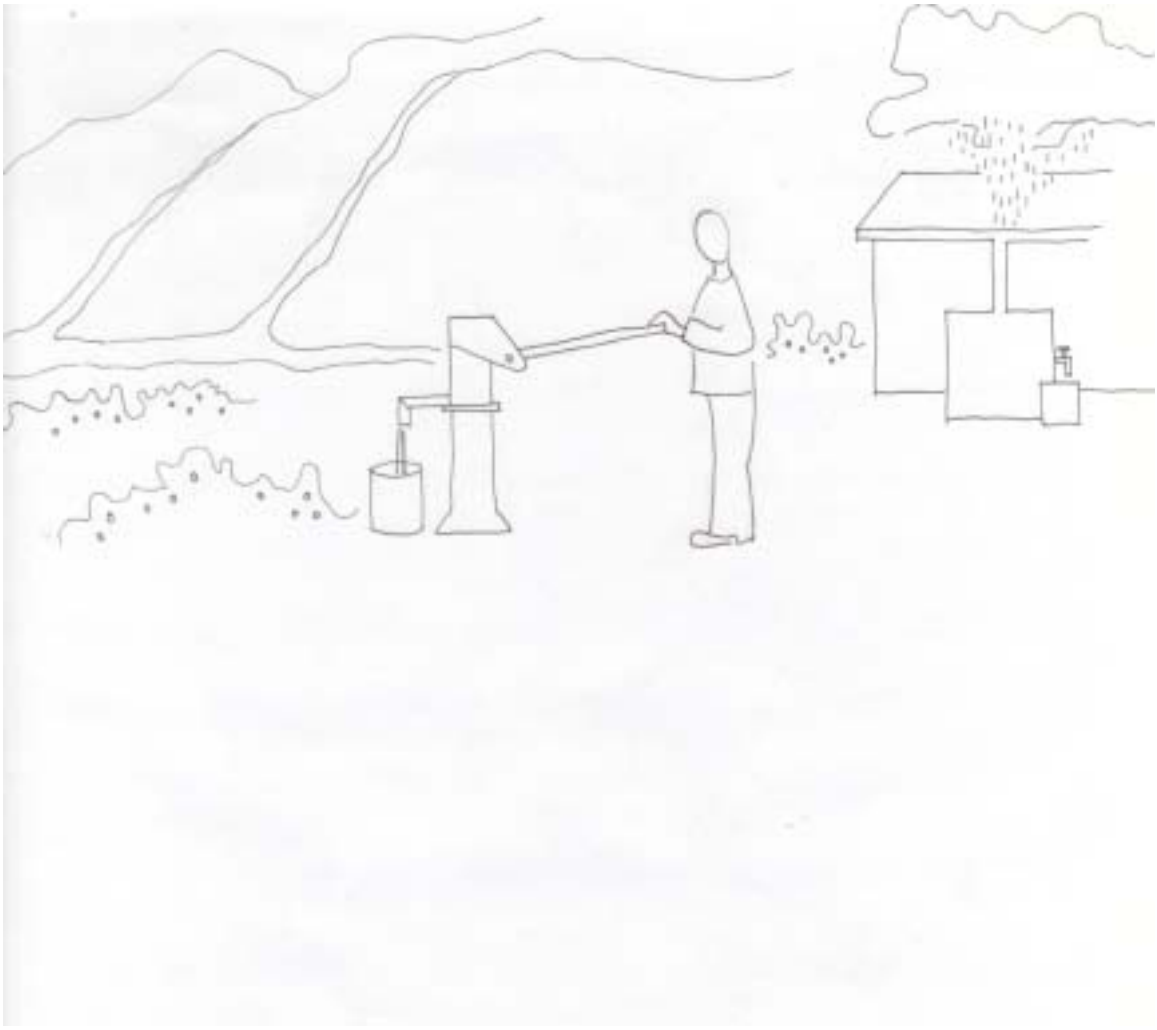
In Eritrea, preparedness is available through certain organisations and Government bodies to combat disasters at the national level. These include the Desert Locust Control Organisation for Eastern Africa (DLCOEA), the MoA Early Warning & Food Information System (EWFIS), and the Eritrean Grain Board (EGB).

Role of DLCOEA:
The mandate of the Desert Locust Control Organisation for Eastern Africa (DOLCEA) is to monitor and bring about effective control of the migratory pests in the East Africa region. By and large, DLCOEA is credited with controlling infestations of desert locusts and army worms so they do not reach disaster levels. This has been accomplished through its early-warning system, based on several studies that have helped it to predict infestations. The Ministry of Agriculture (MoA) has been working closely with DLCOEA.

Role of EWFIS:
The specific importance of the MoA Early Warning & Food Information System (EWFIS) is to facilitate timely recognition of the problem and to carry out timely transfer of valuable information to the appropriate decision-makers among affected groups. As part of an overall information system for Eritrea, EWFIS will provide the basis for more rapid assessments of need and faster recognition of appropriate responses before people and livestock start to starve and migrate.

Role of the EGB:
The primary role of the Eritrean Grain Board (EGB) is to hold emergency stocks of food for the prevention of food insecurity in times of drought, flood, pest infestation, and emergencies caused by human actions (see Fact Sheet B.2). The EGB also develops strategies for disaster preparedness, prevention, and mitigation. It reviews current indicators of food shortages and other types of disaster, and suggests new indicators. An emergency food shortage might also be encountered owing to the effects of drought until such times as other sources of supply can be mobilised from abroad. The EGB also collects early-warning data from regional, provincial, and district offices. And it conducts national food assessments and identifies areas of immediate or potential risk, at the same time identifying surplus and deficit areas.

B.3 WATER ISSUES



B.3.1 Overview

B.3.1.1 Climate

Eritrea lies in the Sahelian Zone of East Africa, which is characterised by frequent and prolonged droughts. Eritrea suffered from three major prolonged droughts during the period 1965-1978 (UNESCO & WMO, 1985). Since then, drought has been recurring on a 5-6 year cycle, with the latest failure in rainfall having occurred in 1993 (DoWR, 1995).

The climate in Eritrea is arid to semi-arid, with average rainfall varying from 100 mm to 900 mm, and average annual ranging temperature from 10^{o}C to 36^{o}C (see Table B.6). Rainfall is extremely variable in space and time. The spatial rainfall variation depends basically on the local relief. The rains associated with high-intensity, short-duration storms result in heavy floods.

Table B.6 Zonal Climatic and Topographic Characteristics of Eritrea

Physiographic zone	Elevation (m)	Climate	Mean annual temperature (^{o}C)	Mean annual rainfall (mm)	Potential evapo-transpiration (mm)
Central Highlands	1500-2400	Sub-humid	17.5	500-700	1700
Western Lowlands	300-1500	Semi-arid	29	350	1800
North-eastern Lowlands	0-600	Semi-arid	29	200	2000
E & SE Lowlands (Danakil Depression)	100-600	Desert	33	≤100	>2000
Spatial average		**Arid to semi-arid**	**27.125**	**337.5**	**1900**

B.3.1.2 Physiography

Eritrea can be divided into three major and several minor physiographic zones based on a combination primarily of topography, geology, and climate:

1. **Central Highlands Zone** (CHZ).
2. **Western Lowlands Zone** (WLZ).
   – with subdivisions **North-western** (NWLZ) and **South-western** (SWLZ).
3. **Eastern Lowlands Zone** (ELZ) plus **Coastal Plains Zone** (CPZ).

The Central Highlands Zone is separated from the Western and Eastern Lowlands Zones by steep slopes and escarpments. The area between the Central Highlands Zone and the Eastern Lowlands Zone is known as the **Green Belt Zone** (eastern escarpment).

B.3.1.3 Surface-water Resources

Eritrea has five or six major drainage systems of varying sizes (see Table B.7).

Table B.7 Major Drainage Basins of Eritrea and their Catchment Areas

No.	Basin	Catchment area (km^2)
1	Setit River	7,300
2	Mereb – Gash River	17,400
3	Barka – Anseba River	41,200
4	Red Sea	44,689.53
5	Danakil Depression	10,532.43
6	Several small rivers flowing to the Sudan	3,730.47

B.3.1.4 Sediment Transport

Most of the rivers and streams of Eritrea are seasonal, with very high intermittent flash flows during the rainy season. Owing to the steep slopes in the Central Highlands Zone, together with poor vegetational cover and torrential rains, all of the rivers and streams flood seasonally, carrying with them very high sediment loads. The average sediment yield from the seven monitored basins is *circa* 7.8 tonnes/ha/year (see Table B.8).

Table B.8 Annual Sediment Yield from Important Eritrean Rivers

River	Site code	Catchment area (km^2)	Annual sediment yield (tonnes/km^2/year)
Anseba	3002	1,136	598
Barka	3001	5,083	1,571
Gash (at Tesseney)	2001	22,036	466
Mereb (at Dbarwa)	2003	199	714
Galla	2004	203	1,374
Mereb (at Kisad-Ika)	2005	5,906	977
Wadi Labka	4001	638	3,757
Total/Mean		**35,201 (total)**	**782 (mean)**

Source: Modified from MoLWE (1998).

B.3.1.5 Groundwater Resources

The water-resources potential of Eritrea is not well known since no comprehensive water-resources assessment has as yet been prepared. The present working assumptions are based on the climatic zones, drainage patterns, geological and hydro-geological characteristics, assumed recharge patterns, and water quality. A Geological and Water Resources Regions map of Eritrea is available. Eritrea may be divided provisionally into three main types of aquifer and a number of broad groundwater regions

a. *Inter-granular aquifers:* In the Western and Eastern Lowlands Zones (associated with river valleys and floodplains) and in the Coastal Plains Zone (associated with seasonal and ephemeral streams and hot springs) (see Map B.3);

b. *Fractured and jointed volcanic aquifers:* In the Central Highlands Zone, mainly in the southern plateau (associated with seasonal streams and springs); and

c. *Fissured and karstic aquifers; aquitards; aquacludes; and groundwater barriers:* In the Western Lowlands Zone and Green Belt Zone (eastern escarpment) (associated with ephemeral and seasonal streams and rivers).

B.3.2 Water Demand and Consumption

B.3.2.1 Domestic and Urban Water Supplies

Present average countrywide domestic water consumption is estimated to be 13 L/*capita*/day, for a domestic-use total of 52 thousand m^3/day (see Tables B.9 & A.3). This *per capita* amount is less than the requirement considered necessary for health. Such low average consumption results from the lack of an adequate water-supply infrastructure, long walking distances to water, and, in many places, from an insufficient supply from rivers, streams, and bore holes. Domestic water in the rural areas is not chemically treated. Consequently households dependent upon surface water are exposed to a serious health hazard. On the basis of population figures and water-use estimates, present national total water consumption (including domestic, commercial, industrial, and agricultural) is estimated to be 32 L/*capita*/day, for a total consumption of 129 thousand m^3/day (see Table B.9). Both domestic and total water demands are projected to grow substantially in the coming years. Therefore, 'Let not a single drop of water that falls on the land, go into the sea without serving the people'.

Table B.9 Projected Human Water Demand in Eritrea (1998-2015)

Year	Population (thousand)	Domestic demand (L/*capita*/day)	Total demand (L/*capita*/day)	Total demand (10^3 m^3/day)	Total seasonal peak demand (10^3 m^3/day)
1998	3,602	9	25	90	108
2002	4,038	13	32	129	155
2005	4,399	17	39	172	206
2010	5,075	22	48	244	293
2015	5,855	27	55	322	386

Notes: (a) For domestic demand it is assumed that the time to and from the water source will decrease from a maximum of ½ hour to a maximum of ¼ hour during 1998-2015.
(b) Total demand includes domestic, commercial, industrial, and agricultural demands.
(c) Total seasonal peak demand is estimated to be 120% of Total demand.
Source: Modified from MoLWE (1998).

B.3.2.2 Livestock Water Demand and Supply

The drinking-water demand for livestock can be calculated based on the daily requirements of the several major types of livestock (see Table B.10). Projections have been made of future demand based upon estimates of the expected increases in herd size, such increases assumed to now be tapering off (see Table B.11). Thus, the present estimated total livestock requirement is estimated to be 43.1 million m^3, increasing to 47.5 million m^3 by 2015.

Table B.10 Livestock Drinking-water Requirements

Type of livestock	Water demand (L/day)	Water demand (m^3/year)
Cattle	27	9.9
Goats & sheep	5	1.8
Donkeys, mules, & horses	16	5.8
Camels	50	18.3

Source: Modified from MoLWE (1998).

Table B.11 Projected Livestock Drinking-water Demand (1997-2015)

Type of livestock	Drinking-water demand (million m^3)					
	1997	**2002**	**2005**	**2010**	**2015**	
Cattle	19.1	20.5	21.3	22.1	22.6	
Goats & sheep	12.2	13.1	13.6	14.0	14.3	
Donkeys, mules, & horses	3.0	3.3	3.4	3.6	3.7	
Camels	5.8	6.2	6.5	6.7	6.9	
Total	40.1	43.1	44.8	46.4	47.5	

Note: Based on numbers of livestock as presented in Table B.19; and livestock drinking-water requirements as presented in Table B.10.

B.3.2.3 Irrigation Water Demand

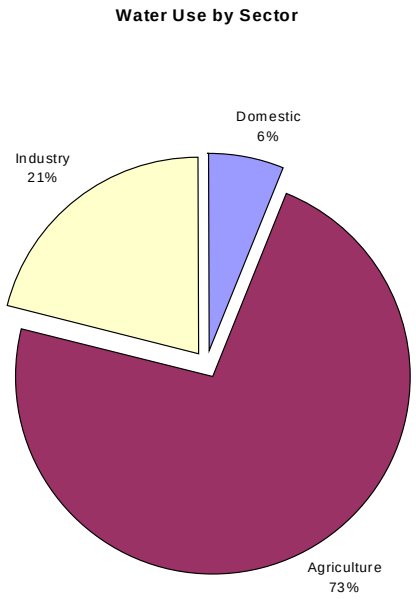
Estimates have been made of gross irrigation requirements for typical cropping patterns, calendars, and intensities for the various agro-ecological zones (see Table B.12).

Table B.12 Irrigation Demand for Various Cropping Patterns and Intensities

Zone	Cropping pattern	Cropping intensity (%)	Gross irrigation demand (1000 m^3/ha/year)			
			Gravity	**Sprinkler**	**Drip**	**Total**
Highlands	Grain crops + vegetables	150	13.4	10.3	7.6	**31.3**
W. Lowlands	Grain-oil + *Kremti* vegetables	130	11.6	8.9	6.6	**27.1**
W. Lowlands	Cotton + sorghum + alfalfa + vegetables	120	18.5	14.2	10.5	**43.2**
W. Lowlands	Banana + citrus + vegetables	120	32.2	25.4	18.7	**76.3**
E. Lowlands	Grain-oil crops	100	11.7	0	0	**11.7**

Notes: (a) Cropping intensity here refers to the increase in cereal production (including from newly possible multiple cropping) as a result of irrigation.

(b) Gravity irrigation includes basin, border, and furrow irrigation, with wild flooding excluded (MoLWE, 1998).



B.3.3 Water Resources and Desertification

An increase in temperature results in an increase in evapo-transpiration , leading in turn to increased aridity. In arid and semi-arid regions this leads to increases in desertification and decreases in woody-vegetation cover. Dust storms from wind erosion of bare soils enhance warming and hence lead to additional moisture losses. There are indications that the regional climate is warming, so that drought conditions are worsening in the Sahara and Sahel regions. In the Sahel, the period of 1970-1990 experienced a water deficit of 43% over the previous 20-year period. The number of days of rainfall has decreased during the rainy seasons, and the rainy seasons themselves have become shorter. These changes in rainfall pattern and increased periods of drought are expected to have negative effect on the water resources of Eritrea. These reductions of moisture have a direct impact on soil degradation and pastoral production. The rich biodiversity of Eritrea is also under threat.

B.3.4 Factors Contributing to Desertification

B.3.4.1 Unfavourable Climatic Conditions

The main impacts of reduced rainfall in the Sahelian Zone of East Africa are soil degradation, reduction of pastoral production, and food shortages. These have already caused significant population movements. Such movements lead to disruption of families, expansion of slums, inadequate supplies of clean water, poor sanitation, pollution of surface waters, and reductions in groundwater resources. Increased drought intensifies desertification and leads to floods in the Coastal Plains Zone. Reductions in rainfall and soil moisture have adverse consequences on hydrological systems. Runoff, water storage, groundwater, and potable water would be depleted, all leading to adverse consequences.

B.3.4.2 Low Moisture-retention Capacity of the Terrain

The Eritrean terrain is characterised by low moisture-retention capacity. The following terrain differences are noteworthy:

- *Steep slopes:* The Central Highlands Zone is characterised by steep slopes which are clearly not moisture retentive.

- *Thin soil cover:* When topsoil is lost in Eritrea's generally thin soil cover, soil-moisture-retention capability is reduced, resulting in a decline in soil fertility.

- *Poor vegetational cover:* Eritrea's widespread over-grazing leads to an inadequate ground cover, leading to a high erosion hazard.

- *Small, discontinuous aquifers in fractured rocks:* The rock basement which underlies most of Eritrea is complex. It contains only small, discontinuous aquifers. Recharge rates are usually too slow and the watertable is low. The renewable groundwater resources are dependent on recharge from annual rainfall to retain long-term sustainability. Groundwater reservoirs often have greater buffering capacity for rainfall variations than rivers, as the latter respond more directly to seasonal variations. Lack of an effective water-resources-management strategy and of relevant regulations are further constraints.

- *Lack of water-conservation measures:* Rainfall is torrential and the runoff is very high. As a result, the water travels down slope very rapidly. During *Kremti* (the June-September long rainy season) most of the rivers flow to the Sudan and others to the Red Sea Most of the rivers in Eritrea are not perennial, being without water during *Hagay* (the October-February dry season). Promotion of rain-harvesting mechanisms during the rainy seasons could serve as a water source for food production and for maintaining the environment during *Hagay*.

B.3.4.3 Unwise Irrigation Practices and Unregulated Use of Available Resources

In Eritrea, irrigation to grow seasonal crops is traditionally practised mainly through diversion of flood flows and construction of large-diameter wells in river valleys. Irrigation is traditionally practised in the floodplains of western and eastern Eritrea by constructing diversion canals. Such construction of canals has destroyed very large numbers of trees. The other type of irrigation practised is by extracting water from wells. This type of irrigation has created its own form of damage, the deterioration of groundwater resources. The Alla and Tselima Plains are good examples. Deterioration of groundwater also has an impact on Eritrea's biodiversity. Degradation of soils from salinity is primarily a problem of irrigated areas. Soil erosion and sediment transport are rapidly increasing problems, affecting both water quality and aquatic ecology. Despite the major problems associated with insufficient amounts of water, the deleterious effects of increasing discharges of untreated sewage into surface waters and groundwaters are the main current threats to Eritrea's water bodies and watercourses.

Rapid urbanisation and industrialisation in many areas are creating stress to Eritrea's water bodies. Some of those threats derive from the discharge of untreated water from industries such tanneries, textile mills, and chemical industries, and from the discharge of untreated domestic sewage. The solid wastes deposited around cities is another source of surface-water and groundwater pollution, especially when they are leached out during the rainy seasons. These various toxic chemical wastes are continuously polluting the water bodies that directly affect riverine (riparian) woodlands, livestock, and the entire Eritrean biodiversity.

The availability of insufficient amounts of water is a recognised phenomenon in Eritrea in particular and in the Sahelian Zone of East Africa generally. The basic problem in Eritrea is the lack of an efficient water law. The absence of establishing a system of water rights, allocation of available water resources for different uses and amongst various sectors, and the regulation of water augmentation, discharge of untreated wastewater, and proper waste-disposal mechanisms are creating stress and deterioration of the water resources of Eritrea.

B.3.5 Programme of Action and Priorities

Each country has a unique set of hydrological, geographic, and economic characteristics, and must thus develop its own strategy of water-resources management. These several parameters can only be taken into consideration in developing one's strategy based on information derived from a long-term monitoring programme. The enrichment of knowledge about the existing water-resources potential creates the best basis for efficient water management by Eritrea.

B.3.5.1 Developing an Effective Water-resources Development and Management Strategy

There is a need to expand the existing hydrological and hydro-geological database through long-term monitoring and assessment of the water resources, and to develop relevant regulations.

❖ **Monitoring and assessment of the water resources**

- *Monitoring surface water:* Monitoring of flow, water quality, and sediment load. Monitoring of river basins in selected catchments, to include flow and sedimentation-load measurements. The calculation of annual sediment loads will help in determining the amount of soil being eroded from the selected catchment. To deal with the increasing numbers of proposals for water-storage facilities on the main rivers will require estimates of likely reservoir sedimentation levels.

- *Monitoring groundwater:* Monitoring of watertable fluctuations and water quality. As groundwater becomes more heavily utilised, the need for groundwater monitoring, both in terms of quality and quantity, becomes essential. Therefore, the approach to improving the hydro-geological database should focus on resources of special importance, such as aquifers at risk of saline intrusion and sites where the water demand is high or predicted to rise substantially.

- *Monitoring water quality:* Monitoring of river pollution in places where increasing urbanisation, development of industry, and use of agro-chemicals that may affect water

users and ecosystems. Neither surface-water nor groundwater quality is now being routinely monitored.

- *Assessing the water resources:* There is an urgent need to establish means for the data-processing and analysis of the information gathered from the monitoring programmes just outlined.

❖ **Regulating the use of the water resources**

- Establish a system of water rights.
- Promulgate and enforce a comprehensive water law.
- Allocate available water resources to different uses and amongst various sectors, in line with the social and economic programmes of Eritrea.
- Ensure equity in the allocation of water resources
- Ensure that all water users pay appropriately regulated prices for the water used.
- Ensure integrated water-resources development and management
- Promote the role of information in water-resources development and management. Such information is needed by decision-making at all levels of the community, for the education of the public about the role of water in its day-to-day activities, for monitoring water-law compliance, for supporting water-related research, and for disaster management.
- Improve the management of supply and demand, efficiency analysis, and overall performance of the water-distribution system to all sectors.

B.3.5.2 Promoting Water-conservation Practices

A programme of action promoting water-conservation practices must:

- Devise catchment-treatment programmes to prevent or minimise siltation of surface-water reservoirs.
- Design and construct water-impoundment structures to increase water supply and induce groundwater recharge.
- Promote and advocate water-harvesting, and conservation methods and strategies with regard to the use of available water.

B.3.5.3 Developing a Water-resources Information System

In order to develop a soil- and water-management strategy, a well-established information system is a key requirement. The main physical components of an information system are data collection, transmission, storage, analysis, and transformation into ‘user-friendly’ information. This should be supported with

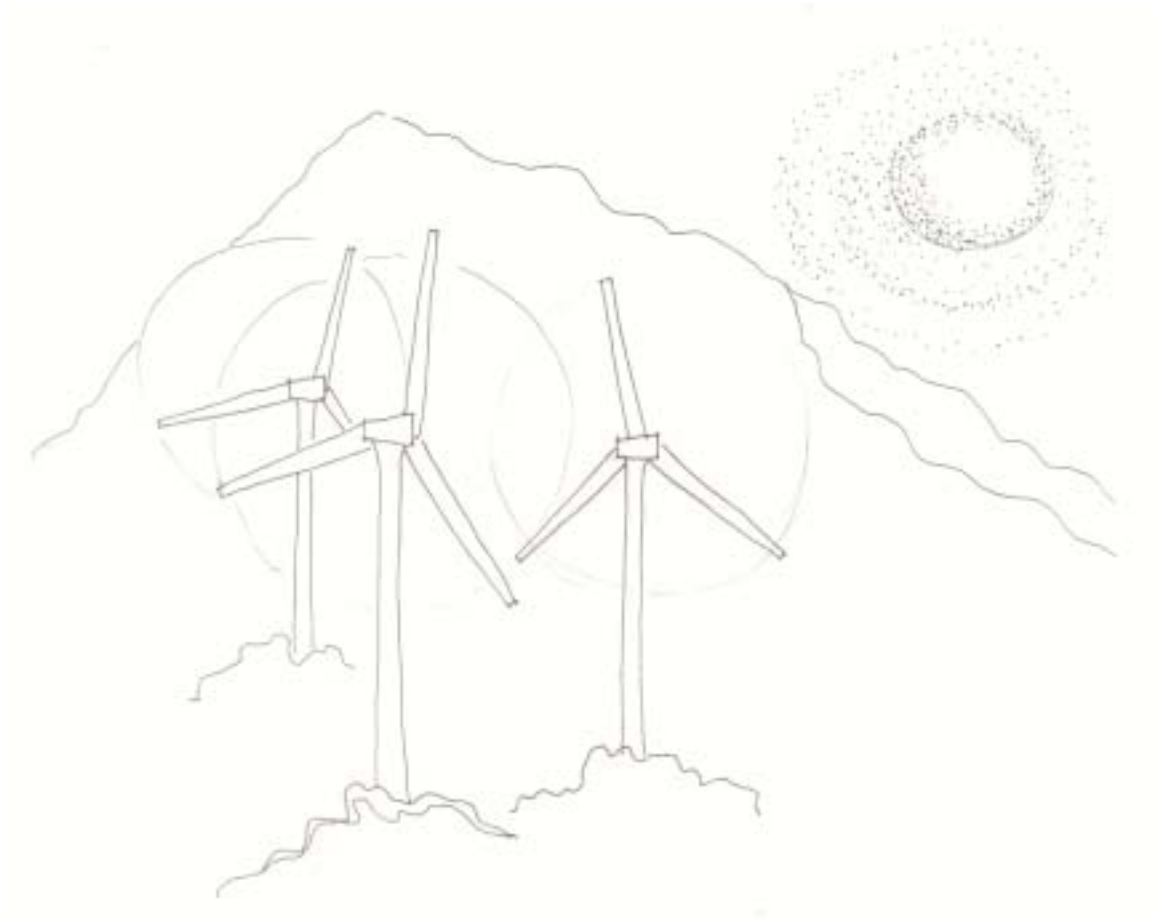
information transmission, dissemination, and an interactive system to aid in decision-making. Also essential are river and catchment mapping for establishing links between the environmental pressures from human activities on water resources and soil degradation, as well as a database of rivers, groundwater, and soil degradation in the upper catchment. The watershed is a natural geographic unit for the study of hydrology, of river-basin and hydrometric sub-zone boundaries, of watershed topography and terrestrial data, of land-use, and of watertable levels and rainfall patterns.

B.3.6 Institutional issues

The main institutions involved in the water sector include especially the MoLWE Department of Water Resources, the Ministry of Local Government (MoLG), and the Ministry of Agriculture (MoA). The MoLWE Department of Water Resources, in collaboration with MoA, are working on a project entitled 'Sector Study on National Water Resources and Irrigation Potential'. The MoLG is implementing various projects for rural and urban water supplies.

Key institutional issues with respect to water resources include: (a) Economically and environmentally sound and sustainable water-resources development, according to a prioritised schedule; and (b) Encouragement of community awareness, of empowerment (particularly of women), and of ownership.

B.4 ENERGY ISSUES



B.4.1 Introduction

For the large majority of people in Eritrea, as for most of the other Sub-saharan African peoples, ‘energy’ refers to fuelwood, charcoal, cow dung, candles, agri-residues, and kerosene. In most rural areas, energy for agricultural and transportational needs is still derived from human and other animal power. Without access to the services that modern commercial energy provides, these rural communities will continue to be unable to generate a surplus, to participate in markets, or to develop beyond subsistence activities. Moreover, Eritrea lies within the vulnerable and already affected area of the Sahelian Zone of East Africa where the threat of desertification is of the highest concern and where the energy picture is obviously implicated to be one of the causes of environmental degradation resulting from the poor management of traditional fuels.

The 1994 United Nations Convention to Combat Desertification [UNTS 33480] (UNCCD) is mindful that desertification and drought affect sustainable development through their inter-relationships with important

social problems such as poverty, poor health and malnutrition, and lack of food security – as well as those arising from migration, displacement of persons, and other demographic dynamics. The approach of UNCCD is to create an enabling environment for sustainable development by combating desertification and/or mitigating the effects of drought in which the provision of commercial energy plays an important role. Our rural communities have the urgent needs both for access to the services that commercial energy provides and for the better management of traditional fuels.

UNCCD states that 'development and efficient use of various energy sources' should be a priority field for national action programmes in those countries experiencing serious drought and/or desertification (Article 10.4), of which Eritrea is one. In addition, UNCCD calls for the promotion of capacity building 'by providing appropriate training and technology in the use of alternative energy sources, particularly renewable energy resources, aimed particularly at reducing dependence on wood for fuel' (Article 19.1.f). UNCCD states further that national action programmes for African countries should include amongst their measures to conserve natural resources, 'ensuring the development and efficient use of diverse energy sources, the promotion of alternative sources of energy, particularly solar energy, wind energy and bio-gas, and specific arrangements for the transfer, acquisition and adaptation of relevant technology to alleviate the pressure on fragile natural resources' (Annex 1, Article 8.3.b.iii).

Another link between energy and desertification is through climate change. Since climate change is an important factor in desertification, activities that mitigate climate change will also help to combat desertification. Efficient utilisation of indigenous energy resources, promotion of renewable energy technologies, and measures of energy conservation in all consumption sectors are ideal methods for mitigating the effects of climate change and thus in combating desertification as well.

To formulate the energy-sector component of the National Action Programme (NAP), a dialogue will be required among the Government (including its experts), our development partners (including the UNCCD Secretariat), and the benefiting communities. This dialogue will have to take into consideration: (a) the Government's existing social, economic, and energy policies; (b) the availability of conventional and renewable indigenous energy resources; and (c), above all, the energy demands of the urban and rural populations and the commercial and industrial sectors. Such a dialogue will help design the implementation strategies, facilitate the transfer of appropriate technologies, and generate local and international technical and financial resources (including from the private sector).

B.4.2 Sustainable Energy Policies and Strategies

B.4.2.1 Introduction

Energy is central to current concerns about sustainable human development, affecting: (a) economic and social development; (b) economic growth; (c) the local, national, regional, and global environments; (d) the global climate; (e) a host of social concerns, including poverty, population, health, and gender-related issues; (f) the balance of payments; and (g) the prospects for peace. Energy is ***not*** an end in itself, but rather the ***means*** to achieve the goal of sustainable human development.

Sustainable development needs to be looked at from different angles – the economic, social, and environmental perspectives. The levels of economic and social development differ from nation to nation as well as among different locations within a single country. This requires a variety of strategies. For the energy sector, this means that a strategy has to be developed that ensures a desired energy service which

can be maintained for an indefinite time at all levels of society.

It must be understood that criteria for sustainability should include more than resource conservation and environmental impacts. The economic, financial, and social implications must also be taken into account. In particular for a poor nation like Eritrea, where investments in future energy sustainability must compete with spending for daily survival, short-term affordability will always be an issue.

B.4.2.2 Policy Objectives

The sufficient, reliable, and sustainable production and supply of affordable energy throughout Eritrea is the main objective of the Government's policy in the energy sector. The general policy is to provide the energy services based on a diversified supply of energy sources. The specific objectives of this policy are twofold. *Firstly,* it must facilitate economic growth through the provision of adequate, reliable, and sustainable refined energy at an economic price and at appropriate locations. *Secondly,* it must improve the living standards of the population through the provision of affordable energy.

The energy policy must incorporate the management of energy production, distribution, and utilisation as well as promotional and regulatory activities for energy-conservation measures. The implementation of the policy must be mindful of the desire to halt, and in some cases reverse, the recent trend in environmental degradation, and of the need to make the most effective use of limited resources, particularly in the initial stages of development.

To achieve the above-mentioned objectives, the Ministry of Energy & Mines (MoEM) is entrusted with the task of designing and refining policies, strategies, and regulatory issues in the energy sector, approving the corresponding plans and programmes formulated in the sector, and supervising their implementation.

B.4.2.3 Policies and Development Strategies

Sustainable energy policies and strategies must:

- Promote economically and environmentally sound energy-sector development through the application of the appropriate technology of energy production, conservation, and optimisation of use.

- Implement a policy of appropriate energy pricing structures that avoid all forms of subsidy.

- Diversify sources of energy in order to minimise strategic dependence on Eritrea's dwindling biomass energy resources and on imported oil, by way of promoting private capital participation in hydrocarbon exploration and of developing the potential for renewable energy resources.

- Modernise and expand Eritrea's power-generation and distribution systems, and create a situation conducive to private participation in energy development and marketing.

- Develop capacity through training and establishment of the necessary institutional and legal frameworks, in order to manage the energy sector competently.

B.4.3 Energy Sector Background

The 1997 energy balance for Eritrea indicates that:

- 77.3% of the total final energy supply (TFES) is met from biomass. Total biomass consumed was 31.1 PJ (*circa* 740 thousand tonnes of oil equivalent). Actual consumption of biomass for energy in 1997 was *circa* 1,989 thousand tonnes, of which fuelwood accounted for 71%, charcoal 6%, animal dung 20%, and agri-residues 3% (see Table B.13).

- 21.3% of the TFES is accounted for by oil products.

- 1.4% of the TFES is met from electricity.

The total TFES in 1997 was 40.3 PJ (*circa* 960 thousand tonnes of oil equivalent), of which 77.8% was consumed by the household sector, 13.8% by the transportation sector, 6.0% by the public and commercial sectors, and 2.4% by industry. TFES per capita was 309kgoe and the commercial energy's share for the per capita being 80kgoe.

Biomass as the main energy source:
Biomass fuels consist of fuelwood, charcoal, animal dung, and agri-residues (crop residues). In 1999, Eritrea consumed *circa* 1.3 million tonnes of such fuels, or *circa* 350 kg/*capita* (see Table B.13).

Table B.13 Biomass Energy Consumption (1994-1999)

Type of Fuel	1994 (thousand tonnes)	1995 (thousand tonnes)	1996 (thousand tonnes)	1997 (thousand tonnes)	1998 (thousand tonnes)	1999 (thousand tonnes)	1999 Consumption *per capita* (kg)
Fuelwood	1,292	1,334	1,375	1,418	831	856	250
Charcoal	114	117	121	125	73	75	20
Animal dung	360	371	383	394	265	273	74
Agri-residues	47	49	50	52	91	94	25
Total	**1,813**	**1,871**	**1,929**	**1,989**	**1,260**	**1,298**	**369**

Notes: (a) The 1995 data were established by the comprehensive energy survey conducted jointly by the MoEM Department of Energy and Lahmayer International for that year. The entries for the remaining years have been extrapolated using a 3% growth rate for household energy consumption and a 7% growth rate for other consumer sectors. Anothr survey was conducted in 1998 forming the basis for the years 1999/2000.

(b) The 1999 *per capita* consumption based on a 1999 population of 3,706 million (see Table A.3).
Source: Modified from Habtetsion & Tsighe (2000) & DoE (2000).

Eritrea now consumes *circa* 250 kg/*capita*/year of fuelwood (see Table B.13). In Asmara it is now *circa* 176 kg/*capita*/year. But in remote areas with better availability of highland-forest resources it may go as high as 970 kg/*capita*/year. Animal dung and agri-residue consumption occurs almost entirely in the Central Highlands Zone (especially in its southern portion) where scarcity of fuelwood is prevalent. As the charcoal-consumption figures are arguable, the MoEM Department of Energy in 1998 launched a programme to update the energy database that had been created for the base year of 1995. We hope that a clearer picture will soon be obtained of charcoal (including recycled charcoal) consumption.

All rural communities in Eritrea, estimated to now account for *circa* 78% of the total population (see Tables B.20 & A.3), as well as most households in the urban areas and some commercial enterprises such as bakeries and brick manufacturers, depend largely on biomass fuel for energy.

The extensive use of fuelwood is believed to contribute significantly to the drastic loss in vegetational cover and degradation of the environment. The traditional use of the highland-forest resources for energy is obviously under-managed and unsustainable inasmuch as only *circa* 0.4% of Eritrea is now under highland-forest cover (see Table A.1), as against perhaps 15% in the 1940s. In fact, there are indications that Eritrea's highland-forest cover may now be approaching 1% owing to the recent Government actions to prohibit the cutting of live trees for energy purposes and by designating potential highland-forest areas (over 100 thousand ha) as enclosures (FAO, 1997).

Traditional cooking practices in Eritrea are estimated to have 10% or less heat-utilisation efficiency. This results from the prevalence of 'three-stone' open hearths in the Lowlands Zones. The efficiency of the partially enclosed stoves common in the Central Highlands Zone may reach up to 12%. Moreover, the generated smoke and particulate matter pose serious health hazards for women and the children they carry on their backs when cooking. Moreover, the non-renewable use of biomass for fuel increases the greenhouse-gas load in the atmosphere, thereby contributing to the current worrisome rise in global temperatures.

The rural population, which in the past enriched the soil for cultivation with animal wastes and agri-residues, is now being forced to use these important soil nutrients for cooking their food. This is obviously at the cost of agricultural productivity as chemical fertilisers are still beyond the reach of most of our rural communities.

Petroleum products:
Petroleum (oil) products are the second major source of energy in Eritrea and the only fossil fuel used in the country at present. Petroleum consumption has been increasing at an average rate of 8.6%/year during the period 1994-1997 (see Table B.14). However, it is clear that the rate of increase in consumption has been dropping off: the increase from 1994 to 1995 was 15.2%, that from 1995 to 1996 9.4%, and that from 1996 to 1997 only 2.6%. The high growth rates of the household fuels (liquified petroleum gas [LPG] and kerosene) are the result of switching away from biomass fuels to these petroleum products.

66% of the oil products have been consumed in the transportation sector, 16% in the public and commercial sectors, 11% in the household sector, and 8% in the industrial sector.

Table B.14 Consumption of Petroleum (Oil) Products (1992-1997)

PRODUCT	1992 (tonnes)	1993 (tonnes)	1994 (tonnes)	1995 (tonnes)	1996 (tonnes)	1997 (tonnes)	Growth rate 1994-1997 (%/year)
Liquified petroleum gas	300	430	847	1,255	1,631	1,504	19.8
Motor gasoline (regular)	6,096	10,228	11,613	12,596	14,035	14,733	8.2
Kerosene	8,146	12,263	14,181	17,237	19,721	21,086	13.2
Jet fuel (A-1)	3,525	3,889	4,211	5,411	9,612	9,859	31.3
Diesel oil (automotive)	55,685	103,028	114,369	128,792	134,147	137,730	6.0
Fuel oil (inland)	11,722	23,657	26,396	34,829	45,064	43,160	17.3
Fuel oil (bunkers)	3,642	11,903	9,723	10,793	6,460	7,972	–11.1
Bitumen	-	3,265	2,158	220	213	483	–45.2
Lubricants	-	-	1,301	1,795	1,961	2,475	20.2
Total/Mean	**89,116**	**168,663**	**184,799**	**212,928**	**232,844**	**239,002**	**8.6**

Electricity:
It is estimated that there were close to 100 MW of installed power throughout Eritrea by the end of 1996, 70% of which is directly under the Eritrean Electric Authority (EEA). The generating capacity of EEA has approximately tripled since the end of our War of Liberation of 1961-1991, in part owing to a major power expansion project near Massawa and the construction of 132 kV and 66 kV transmission lines connecting large cities. *Per capita* electrical consumption tripled during the period 1991-1997, from 16 kWh to 48 kWh, and the number of customers grew from 55 thousand to 91 thousand. Total generation was *circa* 203 GWh in 1997, that of EEA alone being 170 GWh.

Electrical generation is all via thermal means, and the average generating efficiency is *circa* 37%. Technical losses are commonly *circa* 15% in both the integrated and self-contained systems. In 1997, industry accounted for 46.4% of electrical consumption, domestic usage 34.0%, general and commercial usage 18.0%, and street lighting 1.6%. During that year, electricity tariffs for the systems operated by EEA averaged US$ 0.112/kWh (or 0.84 Nakfa/kWh). It is estimated that up to 20% of all Eritreans are getting electricity at least for lighting. Of the electricity generated in 1997, 80.0% was sold, 4.2% was used by EEA for its own consumption, and the balance of 15.8% was lost in transmission and distribution.

The MoEM Energy Research & Training Centre has so far installed photo-voltaic (PV) systems with a combined capacity of over 180 kW for such applications as health centres, Village water pumps, schools, and general communication systems. It is also estimated that over 120 kW has been installed by other Government organisations and NGOs. This brings the total installed PV capacity to over 300 kW by 1998, which is *circa* 0.4% of the capacity under the EEA system.

B.4.4 Potential for Indigenous Energy Resources

The primary energy supply is highly dependent on imports and the already depleted highland-forest resources. Therefore, an increase in energy supplies and services from available and sustainable indigenous energy resources is desirable and must be vigorously pursued. An increased and sustainable use of local energy resources will have beneficial effects on energy-supply situations, on the balance of payments, and on the environment.

All geological, geophysical, geochemical, and seismic tests have pointed to the fact that significant oil and gas reserves might exist in the off-shore areas of the Eritrean side of the Red Sea. Two concession areas for oil prospecting have been awarded to a consortium of three foreign private companies and drilling has been initiated. No significant coal reserves have as yet been identified.

Eritrea is especially rich in 'renewable' solar and wind energy resources. It enjoys high solar radiation for over nine months of the year. Thus the potential for utilising solar energy is substantial. In the future, solar energy will certainly play an important role in the energy supply of Eritrea, especially in the remote rural areas. Eritrea also has considerable wind-energy potential. The use of wind turbines for producing electricity or pumping water is very promising. An extensive assessment of wind and solar energy resources is in progress throughout Eritrea.

Geothermal energy is another 'renewable' source of energy with very good opportunities in Eritrea. The Eritrean part of the East African Rift Valley, offers favourable conditions for geothermal energy applications. The potential of large hydropower generation is very small in Eritrea. However, a large potential for small hydro-systems may exist in inland water basins. Modern biomass energy, such as energy crops or biogas from organic wastes, may have good potential as well.

A study of the potential for energy recovery from the municipal solid wastes generated by Asmara is in progress. Preliminary results indicate that three times the energy equivalent of the 1997 consumption of LPG could have been recovered from the Asmara landfill if it had been fitted out with a methane-recovery facility.

The Ministry of Agriculture is largely responsible for developing the huge amount of biomass-based energy resources. To protect Eritrea's fragile and degraded highland forests and allow for natural regeneration, *circa* 192 thousand ha are now protected (see Table B.17). In these areas the cutting of trees, grazing, farming, and other agricultural practices are prohibited. In addition to this, rural communities and students are planting millions of trees yearly during their school vacations (30 thousand having participated in 1998). So far, *circa* 70 million trees have been planted (see Table B.18), and the success rate is estimated to be almost 100% along roadsides and between 30% and 70% elsewhere. Cutting of live trees for the purpose of obtaining fuelwood is now completely banned in Eritrea. The same is true for charcoal-making as the conversion from wood to charcoal requires a ratio of up to 6:1. It is amazing that the population is to a large extent respecting these Government regulations.

A cotton-stock briquetting pilot plant started operation in January 1998 at the Alighider Agricultural Estate. Its production capacity is 4000 tonnes/year. The current facility could accommodate a second production line, and plans exist to install it if the pilot project is deemed successful. Commercial enterprises using fuelwood – *e.g.*, brick and lime manufacturers, hotels, and bakeries – are expected to be

the briquette customers.

B.4.5 Demand-side Implications of Energy-source Switches

Cooking:
A large reduction will be necessary in the use of biomass for cooking, for both *Injera* and other foods, for hot water, and for brewing of *Suwa*. Possible energy-source switches are from biomass to kerosene, LPG, solar energy (for hot water), and electricity. The introduction of other energy sources is seen as a major contributor to the recovery of natural vegetation and to the regrowth of sources of biomass energy through intensive planting schemes in and around local communities. Still, biomass will for a long time to come remain the main cooking fuel for the remote rural areas that have no direct access to the kerosene, LPG, or electricity distribution networks. Furthermore, the cooking for *Injera* is predominantly done by making use of biomass as a matter of tradition. It is estimated that at least 50% of all biomass energy consumption in Eritrea is for the making of *Injera*. Urban Eritrea is shifting towards more modern energy carriers and energy technologies to cook *Injera*, *e.g.*, converting to LPG *Mogogos* or electricity *Mogogos*.

Water pumping:
An increase is necessary in the use of solar photo-voltaic (PV) electricity, electrical and mechanical wind pumps, diesel-oil pumps, hand pumps, and electricity via grid extensions. Provision of safe and sufficient water is one of the highest Government priorities throughout Eritrea.

Hot water (urban Eritrea):
A decrease is desirable in urban Eritrea in the use of electricity for electric boilers. This can be achieved by an increase in the use of solar water heaters.

Refrigeration:
An increase is desirable in the use of wind or solar photo-voltaic electricity, or electricity from the local grid for refrigerators, in place of kerosene for kerosene-operated refrigerators. For a long time, most refrigeration in rural Eritrea will be in connection with vaccines for health centres and livestock. The Government of Eritrea considers health one of its highest priorities.

Lighting:
A decrease is desirable in the use of wood, candles, and kerosene for lighting. This can be achieved through an increase in wind or solar photo-voltaic electricity and electricity from the local grid.

Construction:
A decrease is necessary in the use of wood for construction in both urban and rural areas. Construction of a typical rural house (*Hidmo*) in the Central Highlands Zone used to require the cutting of *circa* 100 trees. This is no longer possible, so alternatives must be found. Additional energy consumption can be expected in construction work with the increasing use of devices that require diesel oil or electricity.

Agriculture:
The use of diesel oil will increase for tractor ploughing, irrigation, grain milling, and other agro-industrial machinery. This will lead to a decrease in the human and animal power input into land preparation, harvesting, and agro-processing. In general, this shift of energy towards the commercial sources can be expected to boost productivity, as manifested by the recent integrated farming schemes introduced by the Government.

Small-scale industrial production:
A decrease is necessary in the use of biomass by various small-scale industrial activities in brick and lime making, the food sector, and clay-based products (pottery). Such decreases are expected to lead to an increase in the use of petroleum fuels and electricity.

Medium- and large-scale industrial production:
A large increase can be expected in the use of electricity for electric motors, lighting, and communication facilities. A large increase is also expected for diesel or fuel oils for stationary motive power and process heat since it is Government policy to promote the industrialisation of Eritrea.

Electronic services:
An increase can be expected in the use of electricity for communication facilities, office machines, radios, and television sets in both the institutional and household sectors.

Space heating and cooling (urban Eritrea):
An increase can be expected in the use of electricity for electric heaters and air conditioning. Promotion of solar-based heating and cooling is desirable here.

Transportation:
A large increase can be expected in the use of diesel oil for trucks, buses, and rail locomotives, as well as an increase in the use of gasoline for cars and motorcycles. Human and animal power should decrease, except for the use of bicycles for personnel transport.

B.4.6 Supply-side Implications of Energy-source Switches

Biomass:
A large reduction is in some cases necessary in the use of biomass for cooking, water heating, lighting, industrial applications, and space heating. Possible fuel switches are from biomass to kerosene (for cooking), LPG (for cooking), solar energy (for water heating), electricity (for cooking, lighting, and industrial uses), and diesel oil and other fossil fuels (for industrial uses). Concrete blocks, bricks, and corrugated iron sheets should replace construction wood.

The combination of biomass currently being the major energy source for rural Eritrea and the ability to re-grow biomass when land, favourable climate, water, and human resources are available makes the regeneration of biomass an important activity to be pursued. The development of modern energy crops such as salicorn (*Salicornea*) and briquetting of agri-residues should be vigorously pursued, using cotton and sorghum stalks, industrial sisal wastes, banana stems and leaves, wild grasses, etc.

Kerosene:
An increase is to be expected in the use of kerosene for cooking and refrigeration (primarily at health centres). A reduction in the use of kerosene for lighting will follow rural electrification. Possible fuel switches for lighting are from kerosene to solar electricity, diesel-oil generators, and electricity from extensions of the grid into rural areas.

Liquified petroleum gas (LPG):
An increase is to be expected in the use of LPG for both cooking and industrial furnaces. One of the constraints of LPG supply has been removed by the construction of a storage facility have a capacity of

2000 m^3.

Solar energy:
An increase is highly desirable in the use of solar energy – both solar photo-voltaic electricity and solar thermal electricity – for water pumping (PV), refrigeration (PV), community lighting (PV), and hot water (thermal), and should thus be extensively promoted.

Wind energy:
Introducing wind energy is highly desirable for generating electricity and for pumping water mechanically.

Geothermal energy:
Introducing geothermal energy is highly desirable for generating electricity, assuming that geothermal exploration indicates sufficient potential for feasible exploitation of the resource.

Diesel oil:
A large increase can be expected in the use of diesel oil and other fuel oils for motive power, both stationary (in industry) and mobile (in transportation), for irrigation (in agriculture), for process heat (in industry), and for generating electricity (small-, medium-, and large-scale).

Electricity:
A large increase is desirable in the use of electricity for cooking, pumping water (in rural areas), lighting, refrigeration, electric motors (for industry), space heating and cooling, office machines, and communication. The Hirgigo project should be supplemented by an extensive rural electrification programme.

Human and animal power:
A reduction in the rural uses of human and animal power for transportation (except for the use of bicycles) over large distances will follow increased availability of motor transport. Possible fuel switches are from human or animal power to diesel-oil-based means of transportation (buses, trucks). Agricultural activities should be conducted using commercial energy in order to increase productivity and contribute to the goal of food security.

B.4.7 Energy-conservation Measures

In industrialised countries, where availability of commercial energy is seldom a constraint, there is growing recognition that some of the greatest and most cost-effective opportunities for sustainable energy development involve the improvement of end-use efficiency. This is accomplished by providing the same energy service with less energy input or by obtaining more energy services for the same energy input. The same also applies to developing countries, even if the total savings can be expected to be much smaller.

There are two types of energy-efficiency measures to be considered: (a) more efficient end-use of energy in existing installations (efficiency retrofits) through improved operation and maintenance and/or replacement of some components; and (b) more efficient end-use of energy by the use of new processes or new equipment.

Any strategy for sustainable-energy development must consider the possibility for improved energy end-use efficiency. This is clearly the case for Eritrea's industrial, commercial, transportation, and

household sectors. Possible energy-conservation measures for the various energy services presented earlier follow.

Cooking:
We need to abandoned the 3-stone fire for cooking as soon as possible because of its low energy efficiency (*circa* 10%). Instead, energy-efficient biomass stoves should be introduced for the household sector, especially in those rural areas where the dependency on biomass fuels will remain for many years to come. Further, energy-efficient cooking practices need to be stimulated, *e.g.*, pre-soaking grains, cooking with a lid, and using solar energy for pre-heating. An improved energy efficiency also needs to be worked on for other cooking stoves (those using kerosene, LPG, or electricity). Special attention needs to be given to disseminating energy-efficient stoves in order to ensure that what has been developed is also going to be put to use. Preliminary research at the MoEM Energy Research & Training Centre has shown that efficiency of wood *Mogogo* stoves could be doubled. Dissemination of such stoves will certainly help reduce fuelwood consumption.

Water pumping, lighting, and refrigeration:
The use of energy efficient devices (for lighting, refrigerators, and water pumps) can reduce the total investment as well as the operating costs of an energy-service system. It will often be cost-effective even if an energy-efficient light bulb should cost 3-5 times as much as a conventional one, since its energy consumption is at least that much lower. Especially when electricity supply is expensive, which is true for photo-voltaic (PV) systems and also for diesel-oil generators, energy-efficient lights are expected to significantly reduce the overall lighting-system costs. These opportunities need to be carefully studied and implemented. The use of energy-efficient devices in a grid-connected electricity system has the same effect, except for the scale of operation, and is therefore no longer readily visible to the individual consumers who ultimately invest in the energy-efficient devices. To stimulate the investment in energy-efficient devices, the individual consumer should be able to share in part of the benefits of generating less electricity.

Large-scale industrial production:
Significant potential exists to improve energy efficiency in all industries, but particularly in the most energy-intensive ones – steel, glass, ceramic, cement, and petroleum refining. Energy typically accounts for a large proportion of the production costs in those industries. The introduction of advanced technology to reduce production costs, improve product quality, and/or facilitate environmental protection will reduce energy requirements as well. Thus, the promotion of technological innovation will typically lead to gains in energy efficiency. These opportunities are especially important because of the large amount of current infrastructure-building activities in Eritrea, which gives rise to a rapidly growing demand for basic materials.

Small- and medium-scale industrial production:
What has been noted for large-scale industrial production is also true for smaller scales of production. Especially the massive use of energy in brewing and other food production at cottage level – as well as in lime, brick, and pottery making – have a substantial potential for reducing the predominantly biomass energy now being used. Improved designs of stoves and furnaces, in combination with an improvement in the manner in which these devices are used, have a large potential for energy-efficiency improvements that should be exploited.

Transportation:
The energy used in transportation should be optimised through stimulating the development of mass

transportation systems rather than transportation systems based on individual motorised transport. Development of bicycle transport in urban and semi-urban areas, with suitable infrastructure and landscaping (*e.g.*, in Asmara) should be stimulated in favour of motorised transport. Improvement in the quality of the transportation infrastructure (*e.g.*, of roads, railways) also helps reduce energy consumption.

Construction:
The design of buildings should be stimulated that are energy-efficient in terms of space heating, cooling, and lighting. Constructed buildings that have been designed to make use of passive solar energy and natural lighting will reduce energy use for the lifetime of the building.

B.4.8 The Way Forward

Following are some concrete interventions that could contribute to the aim of creating an enabling environment for local community development in the energy sector:

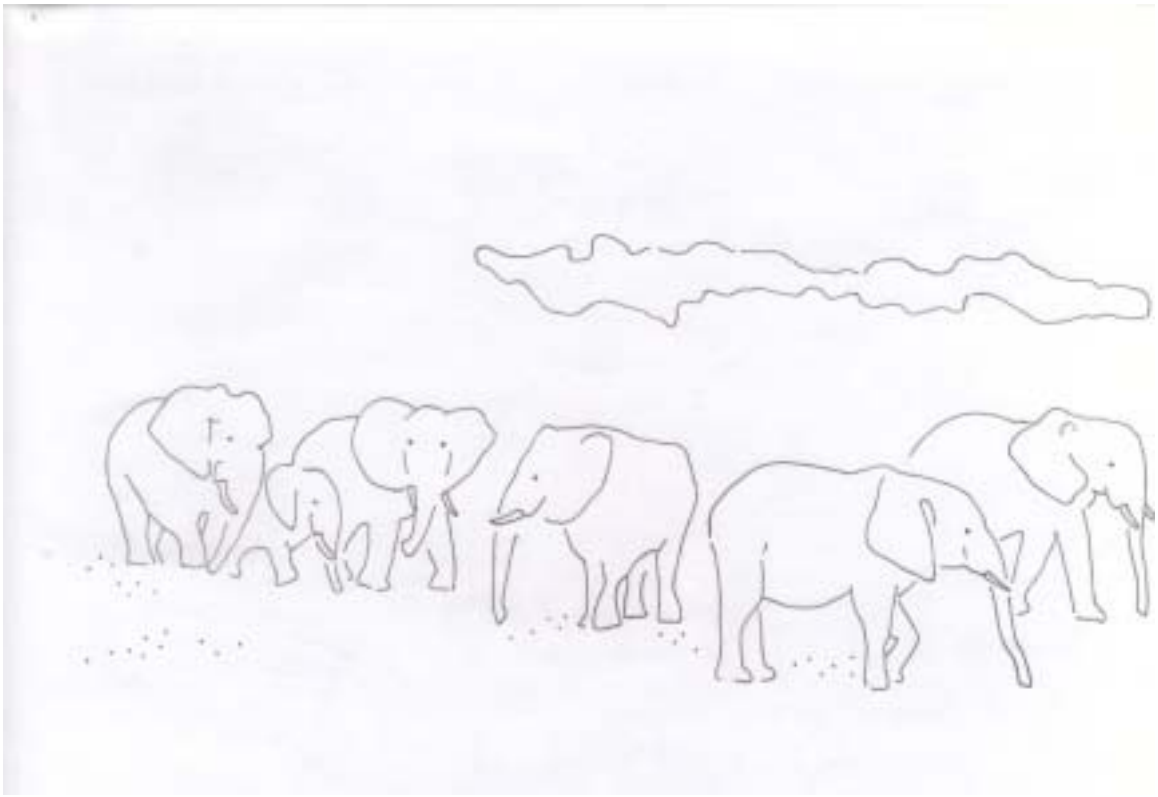
- *Policy interventions:* A whole range of policy interventions is required at national and international levels to reduce the cost of basic services (education, health care, water, sanitation, energy, etc.) and to increase local productivity, purchasing power, and business opportunities.

- *Training of local technicians and entrepreneurs:* If alternative and renewable energy systems are to serve the energy needs of rural communities, then the need is obvious for resident technicians operating local businesses that are able to supply, install, operate, and maintain those systems. To achieve this strengthening, the MoEM Energy Research & Training Centre and other training centres will be needed to train the necessary technicians.
- *Research, development, testing, production, and supply of products targeted to local consumers:* There is a need to support national and regional energy research centres to provide the theoretical framework and data required for the development of indigenous energy resources. There is a need to build up local design and manufacturing capacities. There is the additional need to standardise components, to build up in-country stocking, and to establish reliable supply lines for local and foreign components so that rural technicians can access the equipment they need to maintain a client's systems.

- *Financing and credit schemes:* Buying a solar photo-voltaic electricity system is like buying 20 years of power up front. Most families cannot afford to do this. Moreover, they could not afford the capital investment costs involved in hooking up their homes to an electricity grid system. Some sort of credit system as well as a 'rural electrification fund' should be established to help realise these schemes.

- *Awareness, education, and demonstration programmes:* Public-awareness campaigns should be organised, using the media and other fora to inform the people of the great potentials for renewable energy technologies and for energy conservation measures.

B.5 BIODIVERSITY ISSUES



B.5.1 Background

Historically, Eritrea hosted a wide range of wildlife, including elephant (*Loxodonta africana*), buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), lion (*Panthera leo*), leopard (*Panthera pardus*), roan antelope (*Hippotragus equinus*), greater kudu (*Tragelaphus strepsiceros*), warthog (*Phacochoerus aethiopicus*), wild ass (*Equus africanus*) nubian ibex (*Capra ibex nubiana*), dorcas gazelle (*Gazella dorcas*), soemmerring's gazelle (*Gazella soemmerringii*), ostrich (*Struthio camelus*), and cheetah (*Acinonyx jubatus*). Today, the species richness of wildlife is considerably depleted owing to the decades of our War of Liberation of 1961-1991, persistent drought, and neglect by the past colonial administrations. For instance, there are no recent records of buffalo, cheetah, giraffe, roan antelope, or lion. Nevertheless, Eritrea exhibits a wide variety of natural ecosystems, which are well distributed across Eritrea. The dominant ecosystem is characterised by an extensive grassland system in the Western and South-western Lowlands Zones, punctuated by riverine woodlands and dry *Acacia* woodlands. The vegetation of the mountainous North is primarily steppe with patches of semi-desert and riverine woodland. The south-central area hosts woody-vegetation systems including dry *Acacia* woodland, African pencil cedar (*Juniperus procera*) highland forest, and the last remnants of mixed evergreen tropical highland forest. Likewise, a mixture of semi-desert and halophytic vegetation with small patches of mangrove (*Avicennia marina*, etc.) woodland characterises Eritrea's lengthy coastline.

Although the long-term trend of biodiversity status in Eritrea over this century has been negative, there are encouraging signs of improvement over the past decade. During the period 1991-2001, the status of Eritrea's flora and fauna has improved, though from a rather poor initial condition. This improvement has resulted from the cessation of our War of Liberation of 1961-1991, better management by the Government,

and a sequence of relatively good years of rainfall. This period of stability allowed both natural habitat and agricultural systems to recover somewhat from their degraded states.

The biodiversity of flora and fauna in Eritrea is poorly documented and there exist as yet no complete checklists of plants or animals at the national level. Species-level diversity has been reviewed for a number of major taxa. In all cases, the long time gap between information collected prior to 1960 and that collected since 1991 has created a major problem of distinguishing between what had been recorded as historically present and what may actually be present today. To contribute to the minimising of this problem, the MoLWE Department of Environment recently prepared a preliminary assessment of Eritrea's biodiversity (DoE, 1998). In preparing that assessment, efforts were made to collect, review, and compile biodiversity information at the ecosystem, species, and genetic levels. The checklists that were prepared as part of that assessment for plants, mammals, birds, reptiles, and amphibians should now be used as a resource for expanding and updating the range of taxa for which information has been collected. Likewise, those checklists could be used as a basis for the detailed surveying and documenting all of Eritrea's flora and fauna. Moreover, they could provide a starting point for any study of the status of Eritrea's biodiversity or of its biological resources, for designing programmes of action in conservation and the sustainable use of natural resources, as well as for the rehabilitation of degraded land and combating desertification in general.

Eritrea has been recognised by Nicholas I. Vavilov, the great Russian plant geographer who travelled extensively in the Horn of Africa, as a 'Centre of origin' for a number of crop species and as a 'Centre of diversity' for others (Vavilov, 1997, pp 108-111). Thus, Vavilov concluded this area to be the centre of origin for chick pea (*Cicer arietinum*), teff (*Taf*) (*Eragrostis tef*), sorghum (*Sorghum bicolor*), sesame (*Sesamum indicum*), and finger-millet (*Eleusine coracana*). He concluded that these species were first domesticated in this area because their wild ancestors and relatives can still be found here. Likewise, he concluded this area to be a centre of diversity for barley (*Hordeum vulgare*) and wheat (*Triticum* spp), as those crops have a wide range of diversity in Eritrea, although they do not have wild relatives in the area.

Conservation of the varied and unique ecosystems and of the diverse flora and fauna presents a challenge to the people of Eritrea. Efforts to promote conservation must take into account the need for complete protection for certain species and habitats and hence, for the formation of a system of protected areas. At the same time, it must be recognised the vast majority of Eritrea's biological resources and biological diversity will have to continue to exist outside those protected areas. Therefore, protection of these resources cannot stop with the establishment of conservation areas. Effective land-use planning is recommended as necessary across the entire country not only to conserve biological diversity, but also to promote the sustainable use of the resources.

The MoLWE Department of Environment – in collaboration with other relevant Government institutions such as the Ministry of Local Government, Ministry of Agriculture, Ministry of Fisheries (MoF), and University of Asmara (UoA) – has completed a National Biodiversity Strategy & Action Plan (NBSAP) in August 2000. One of the objectives of the NBSAP is the rehabilitation of degraded terrestrial ecosystems and their components through the establishment of protected areas; a related objective is the management and sustainable use of all of Eritrea's natural resources. These objectives are to be implemented through activities that have a direct relationship with combating desertification in Eritrea. Some of the activities are to be:

- Identification, surveying, and border demarcation of representative protected areas;

- Collection of information on invasive exotic species and on methods of their control; and
- Combating drought as an agent of genetic erosion through the selection and development of drought-resistant crop cultivars from local landraces.

B.5.2 Key Concerns and Threats to Flora and Fauna

As noted above, Eritrea was once host to a wide variety of wildlife species. However, after decades of war, drought, and neglect, populations of many species have decreased dramatically, and in some areas have even disappeared. Surprisingly, preliminary observations indicate that wildlife persists in some areas. For example, a small elephant population is known to occur in south-eastern *Zoba* Gash-Barka. Soemmerring's gazelle, dorcas gazelle, and ostrich occur on the Buri Peninsula of *Zoba* Semenawi Keyih Bahri, and the wild ass is also present in this area. However, amongst others, animals such as the giraffe, lion, cheetah, and buffalo that were historically present in Eritrea are extinct at present. There is no recent evidence of the presence of these wild animals.

Most of these observations pertain to high-profile species. Little is known about the current status of invertebrates, reptiles, amphibians, and other less prominent organisms. A general survey of the flora and fauna of Eritrea to determine the populations and distributions of a wide range of species is thus highly needed. It will be important to include these as yet overlooked groups of species in scientific research as well as in conservation programmes, as each species has an important role to play in the ecosystem as a whole.

Undoubtedly, the single most important factor adversely affecting species abundance is loss of natural habitat, *e.g.*, owing to the conversion of highland forests into cropland or grazing land. Other threats include depletion caused by over-exploitation, either for local use or for commercial harvesting and trade.

A complete checklist of plants with quantitative information on their distribution and abundance does not exist at present, although such a list would be indispensable for planning actions to restore them. There does at present exist a compilation of 22 presumably endangered tree species of Eritrea, produced by the MoA Department of Forestry & Wildlife in conjunction with the National Environmental Management Plan for Eritrea (NEMP-E, 1995, p. 64). However, qualification for this list was probably based on the intensity of human use, rather than on plant population density or changes in abundance (see Table B.15).

Table B.15 'Endangered' Tree species of Eritrea and their Uses

No.	Tree species	Common name (English/Tigrigna)	Common uses
1	*Adansonia digitata*	Baobab/*Duma*	Source of food, fuelwood, a medicinal
2	*Balanites aegyptiaca*	Desert date/*Kog*	Fuelwood, food, fodder, timber, a medicinal
3	*Boscia angustifolia*	—-/*Kermed*	Fodder, timber, farm implements, a medicinal
4	*Boscia salicifolia*	—-/*Oba*	Fuelwood, food, fodder, timber
5	*Boswellia papyrifera*	Bitter frankincense/ *Meker*	Incense, fodder, a medicinal
6	*Buddleja polystachya*	Butterfly bush/ *Metere*	Fuelwood, fodder, timber, a medicinal, a detergent
7	*Commiphora africana*	Myrrh/*Anqua*	Fuelwood, food, fodder, timber, medicinal
8	*Cordia africana*	—-/*Awhi*	Fuelwood, food, fodder, timber, bee forage, beehive, a medicinal, shade
9	*Croton macrostachys*	Croton/*Tambuck*	Fuelwood, building, tools, vats, forage, drums, beehives, mulch, soil conservation
10	*Diospyros mespiliformis*	Persimmon/*Tselimo*	Fuelwood, food, timber, shade
11	*Dobera glabra*	—-/*Gharsai*	Fuelwood, food, fodder, timber, toothbrushes, shade
12	*Erythrina abyssinica*	Flame tree, Lucky bean/*Zuwawue*	Fuelwood, tools, bee forage, a veterinary medicinal
13	*Ficus sycomorus*	Sycamore fig/ *Saghla*	Fuelwood, food, gum, beehives, a medicinal, riverbank stabilisation, shade
14	*Ficus vasta*	—-/*Daro*	Fuelwood, food, timber, gum, shade
15	*Juniperus procera*	African pencil cedar/*Tsihdi*	Fuelwood, poles, timber, ornamental, windbreak, shade
16	*Mimusops kummel*	—-/*Kummel*	Fuelwood, food, timber, tool handles
17	*Prunus africana*	African prune/—-	Fuelwood, charcoal, timber, a medicinal
18	*Rhus abyssinica*	Abyssinian sumac/ *Amus*	Fuelwood, food, construction timber, bee forage, toothbrushes
19	*Rhus natalensis*	Natal sumac/*Tetale*	Fuelwood, charcoal, food, construction timber, hand tools, a medicinal
20	*Syzygium guineense*	Waterberry/ *Liham*	Fuelwood, charcoal, food, bee forage, poles, timber
21	*Tamarindus indica*	Tamarind/*Humer*	Fuelwood, charcoal, food, fodder, poles, timber, a medicinal, riverbank stabilisation, tannin (bark), windbreak, shade
22	*Ximenia americana*	Hog-plum or Tallowwood/*Mullo*	Fuelwood, charcoal, food, bee forage, oil (seed), timber, a medicinal

Source: NEMP-E (1995, p. 64).

The introduction of alien species can also have devastating effects on indigenous plant species and ecosystems. Obviously, Eritrea is in danger of being over-run by alien invasive species. The fragile and degraded ecology of much of the landscape provides great opportunity for alien invasive plant species to establish themselves and spread. At present, three alien species can be identified as being of major concern as regards the loss of natural habitat. These are the prickly-pear cactus (*Beles*) (*Opuntia ficus-indica*), white tobacco (*Asha gereb*) (*Nicotiana glauca*), and one or more species of mesquite (*Mosquit* or *Temr musa*) (*Prosopis chilensis* and, according to Bein *et al.* [1996], also *P. juliflora*). All three of these invasives have demonstrated an enormous ability to spread into the natural habitats of Eritrea and suppress indigenous species.

To date, little action has been taken to study or control the spread of these three alien plant species. Although, especially prickly-pear cactus (*Opuntia ficus-indica*) and mesquite (*Prosopis chilensis*) have economic importance to local communities (as sources of both food and fodder), they are a potential threat to Eritrea's native biodiversity. Thus a survey of the distribution and rate of spread of all major alien invasive species, as well as of their negative impacts, merits major attention.

Drought, insect pests and diseases, war, and the introduction of high-yielding exotic crop varieties have been the major causes in Eritrea of loss of indigenous crops and landraces. The rainfall data registered in recent decades show a decline in magnitude and increase in irregularity in their distribution. This has decreased the frequency of those landraces of plant species that need more precipitation to mature. Likewise, the outbreak of migratory pests (desert locust and army worm), other common insect pests (stalk borer, grasshoppers, aphids, cutworms, beetles, etc.), and diseases (rusts, root rots, etc.) are other factors that lead to the loss of those landraces not specifically adapted to those insults.

To control the introduction of alien pests, diseases, and invasive species, the Ministry of Agriculture is in the process of preparing draft legislation on plant quarantine. Once this legislation is in place, the introduction of those damaging aliens could be effectively excluded from entering Eritrea, or at least their entry could be kept to a minimum. Quarantine regulations would help in the conservation of crop and livestock species that could have been endangered through the spread of alien pests and diseases.

In general, local crop landraces are low-yielding, and in the past as well as at present actions have been taken to introduce high-yielding exotic varieties of different crops to increase crop production (*e.g.*, of sorghum [*Dinkmash* varieties] and of wheat [*Bahooi* and other varieties]). Until now, no assessment or survey has been conducted to study the loss incurred in local landraces owing to the introduction of exotic ones. However, it is likely that little loss has taken place. Nonetheless, a decrease in abundance of local landraces is occurring, which places them under threat of future extinction. Modernisation of agriculture increases crop production and food security, but conservation of our landraces for their genetic diversity needs to be considered as well. In short, although the introduction of exotic high-yielding varieties is desirable to attain food security for Eritrea, it ought to be carefully monitored for its negative impacts on overall crop diversity, so as to minimise genetic erosion.

B.5.3 Natural Resources and Creation of a Protected-area System

Several wildlife reserves were established during the Italian colonial period (the 'Gash-Setit', the 'Yob', and the 'Nakfa'). However, neither effective nor visible development efforts were undertaken to translate into reality what existed on paper. The present situation offers the opportunity for the establishment of a comprehensive system to provide protection to Eritrea's unique and varied natural habitats and wildlife

species.

Despite the long years of war, drought, and neglect, there are some areas of Eritrea that have largely resisted human influence and remain essentially intact. These places offer possible options for the establishment of conservation areas in Eritrea. There are many other parts of Eritrea that are unique, diverse, or otherwise worthy of protection. For this reason, it will be critical for a survey to be carried out to assess Eritrea's habitats and to prioritise those areas for conservation action. Of particular importance is the need to include in a protected-area system a variety of habitats that take into consideration a range of ecosystems, *e.g.*, highland tropical forestland, woodland, grassland, and semi-desert woodland (scrubland). Areas now considered to be a priority for conservation of biodiversity are summarised below:

i. The Semenawi Bahri: Situated in the Green Belt Zone (eastern escarpment) between 900 m and 2,400 m with a north-south range of *circa* 20 km, this area contains Eritrea's remnants of mixed evergreen tropical highland forest. The area is typified by fertile soils and abundant rainfall, yet at the same time the ecology of the highland forest is very fragile and will need more attention to be conserved and appropriately developed. At present, at least the following wildlife occurs in the Semenawi Bahri, although in low densities: leopard (*Panthera pardus*), greater kudu (*Tragelaphus strepsiceros*), duiker (*Cephalophus* sp), and warthog (*Phacochoeros ethiopicus*). It is likely that prior to human intervention wildlife was abundant and diverse as this Zone was known to feature luxuriant vegetation.

ii. North of the Setit River on the south-eastern edge of *Zoba* Gash-Barka: Characterised by thick woodlands dominated by doum palm (*Hyphaene thebaica*) in the south-east and undulating grasslands (savannas) and dry *Acacia* woodland in the north and west, this area harbours Eritrea's only population of elephants (*Loxodonta africana*), which is estimated to comprise not more than 100 individuals. Other species occurring in the area include warthog (*Phacochoeros ethiopicus*), greater kudu (*Tragelaphus strepsiceros*), leopard (*Panthera pardus*), baboon (*Papio hamadryas*), vervet monkey (*Cercopithecus pygerythrus*), and many different species of birds. This area has experienced minimal human pressures compared with other parts of Eritrea. However, pastoralists graze livestock in the area and could cause degradation in the absence of regulation. Likewise, fire outbreaks are reported to occur on the hilly grasslands and, if not adequately controlled, could play a negative role. The vegetation in general shows signs of deterioration. Regeneration of the baobab tree (*Adansonia digitata*) is poor, and for several other species the adult trees do not appear healthy. Because of the diversity of wildlife present and the relative absence of human pressures, this area should be viewed as a priority area for conservation.

iii. Riverine habitat along the Gash and Barka Rivers: The riverine (riparian) vegetation along both of these rivers is dominated by the doum palm (*Hyphaene thebaica*), which protects the banks of the rivers from erosion. The doum palm is also valued locally as it is used to make mats, ropes, and brooms, as well as being a good source of food and fodder for domestic consumption. However, clearing of the doum palm for agriculture is seriously threatening the stability of these riverine ecosystems. Riverine woodland is an uncommon vegetational type in Eritrea, and efforts should be made to conserve the few remaining sites. Loss of the riverine woodland will not only lead to a reduction in biodiversity, but may have other adverse consequences, such as desertification along riverbanks and siltation of waterways.

iv. The Buri Peninsula: This area is located in the south-eastern part of *Zoba* Semenawi Keyih Bahri, opposite the Dahlak Islands. The area is semi-desert and is home to ostrich (*Struthio*

camelus), soemmerring's gazelle (*Gazella soemmerringii*), and dorcas gazelle (*Gazella dorcas*). Wild asses (*Equus africanus*) have also been observed around Thio and Bada, but populations are thought to be small. Likewise, patches of relatively undisturbed mangrove (*Avicennia* etc.) woodland occur along the coast of the Red Sea in *Zobas* Semenawi Keyih Bahri and Debubawi Keyih Bahri. These areas provide critical habitat for bird and marine life.

Protected areas and reserves are created for various reasons, especially the protection of wildlife and the preservation of areas of outstanding natural or cultural significance – the latter of national or even international significance. Loosely defined, protected areas are natural areas where human activity is limited and extraction is not allowed.

Creation of a protected or conservation area should follow a set of procedures, but foremost, it is essential that local people participate fully in the entire process. Protected-area establishment often involves the acquisition of a certain area of land that has been traditionally used by local people. Therefore, local participation is crucial if there is to be mutual understanding and a positive atmosphere between the local people and protected-area authorities. Local people must understand the value of a protected area and why ecosystems should be safeguarded from over-exploitation. Once that message is accepted and co-operation has been assured, then implementing establishment of the protected-area system can proceed properly.

B.5.4 Traditional Practices and Customary Law

For centuries, the natural flora and fauna of Eritrea have been economically very important to the local communities as they have been a major source of fuelwood, wood for house construction, fruits and other foods, medicines, etc. However, those biological resources have become dramatically depleted owing to mismanagement during the successive periods of colonial rule, our prolonged War of Liberation of 1961-1991, our Ethiopian War of 1999-2000, recurrent droughts, and, more recently, over-exploitation by the local people. The local communities have traditional practices and customary laws that were used over the years to manage and conserve the resources. Some of those common practices and customary laws are presented here:

- Cutting down indigenous fruit trees such as jujube (Christ's crown of thorns) (*Ziziphus spira-cristi), Ficus vasta,* desert date (*Balanites aegyptiaca*), *Cordia africana,* hog-plum (*Ximenia americana*), and doum palm (*Hyphaene thebaica*) was traditionally forbidden.

- Enclosures were traditionally established, either temporary or permanent. Temporary enclosure, as the term implies, is an area prohibited from human and livestock interference for perhaps few months, until the grass and other vegetational cover matures. The community leaders determine a date when livestock would again be allowed to graze and browse. Permanent enclosure, on the other hand, is an area closed to human and livestock interference for a longer period, say for five or more years, in order to permit the vegetational cover to fully recover. In such areas, tree planting may supplement the existing vegetation. Guards are hired and paid by the communities to look after traditional enclosures. Cutting down of trees from enclosures was traditionally prohibited unless permission was obtained from a Village forestry administering committee. In some areas, as in *Sub-zoba* Haikota, a person who cut down trees without permission had to pay one goat or sheep as a penalty.

- The hunting of wild animals during their breeding season was traditionally forbidden (*e.g.*, in

the Shambuko area);

- In some areas, such as *Sub-zoba* Elabered, killing female and especially pregnant wild animals, was traditionally prohibited.

As can be seen from the present status of the biological resources and biological diversity, apart from the other factors stated above, it is evident that the traditional practices and customary laws used by the local people were not effective enough to protect the natural resources. This is mainly owing to the lack of public awareness. The issue of public awareness needs to be addressed in order to improve the attitudes of society on the matter of how to reasonably conserve and sustainably use the above-specified resources.

B.5.5 *In situ* Conservation

At present, Eritrea does not have a formal gazetted protected-area system for *in situ* conservation of forests and wildlife. However, the establishment of such a system is a national imperative, and the NEMP-E proposed four locations as priority areas for the establishment of the above-specified system (NEMP-E, 1995, pp 72-73):

- **Semenawi Bahri:** to protect Eritrea's last remnant of mixed evergreen tropical highland forest.

- **Gash-Setit:** an area north of the Setit River at the eastern edge of *Zoba* Gash-Barka, to protect the remaining elephant (*Loxodonta africana*) population.

- **Riverine habitat along the Gash and Barka Rivers:** to protect the stability of these riverine (riparian) ecosystems.

- **Buri peninsula:** the south-eastern edge of *Zoba S*emenawi Keyih Bahri, to protect the wild ass (*Equus africanus*).

Until a formal system of protected areas is established in Eritrea, any conservation of forests and wildlife will be achieved only as a secondary benefit of other activities. The most significant activity would be the creation of permanent or temporary enclosures, undertaken by the Ministry of Agriculture in collaboration with local communities.

At present, the *in situ* conservation of crop landraces is taking place spontaneously on individual farms throughout Eritrea. Landrace conservation in this uncoordinated fashion carries a risk that local landraces will be lost as a result of some genetic erosion such as drought, pests, diseases, and low market values. Thus, there is a need for co-ordination here to create awareness and to provide technical assistance to the farmers for on-farm conservation. Special attention should be given to the threatened crop landraces by multiplying them on Government research farms.

B.5.6 *Ex situ* Conservation

At present, there are no *ex situ* facilities for wildlife conservation in Eritrea. There is no botanical garden, no herbarium, and the Asmara zoo is not up to desired standards. Currently, there exists no complete checklist of plant and animal species and their distribution and abundance. This lack prevents the identification of those species of major concern for *ex situ* conservation. It is nonetheless clear that there is

a growing need for *ex situ* conservation of some locally threatened plants and animals – and thus for the establishment of adequate botanical and zoological gardens.

Currently, the *ex situ* conservation of crop landraces is undertaken at the MoA Plant Genetic Research Unit for Eritrea (PGRU-ER) within the MoA Department of Agricultural Research & Human Resources Development. The PGRU-ER has only limited capacity to accomplish all the necessary activities for *ex situ* conservation, including the needed full inventory of Eritrean genetic resources. Thus, there is a need to increase and strengthen both the human and physical-equipment capacities of the PGRU-ER.

B.5.7 Legislation

In order to set the stage for a sound national conservation programme, wildlife-conservation laws must be proclaimed soon as part of the broader legislation on the protection of biological diversity. Specific legislation should be designed and passed to regulate international trade in flora and fauna, to establish and maintain national protected areas, and to regulate hunting and other natural-resources harvesting. Co-operation amongst ministries is essential here to ensure that key issues are not left out. Also, it is extremely important to include in this legislation species that are often forgotten: reptiles, amphibians, and invertebrates. Eritrea needs comprehensive legislation that leaves little in doubt. It is better to be more careful at the start than to try to implement additional legislation once a problem has arisen.

B.5.8 International Co-operation

Owing to the past decades of isolation, Eritrea has not had the benefit of significant co-operation and co-ordination with individuals and institutions in forest and wildlife conservation. Eritrea now has the opportunity to attain what it has only been able to dream about in the past – namely, to become part of the international conservation family. Eritrea acceded to the 1973 Convention on International Trade in Endangered Species of Wild Fauna & Flora [UNTS 14537] (CITES) on 22 January 1995 and approved the 1992 Convention on Biological Diversity [UNTS 30619] (CBD) in March 1996. It also hopes to establish relations with other nature conservation agencies. With Eritrea's wildlife situation being as it is, that is to say, desperate, international co-operation with respect to technical assistance, scientific research, and financial support is essential.

B.6 FORESTRY ISSUES

B.6.1 Status of Forest Resources

B.6.1.1 Historical Background

The status of highland-forest cover about a century ago was estimated to be 30% of the total landmass of Eritrea. With the coming of the Italian colonialists, highland-forest destruction became rampant for agricultural concessions. In recognition of this, the then Governor-general of the Italian colonial government in Eritrea had enacted legislation totally banning tree cutting anywhere in Eritrea. The ban was intended to serve as a measure of preserving the highland-forest resource. However, while that ban was in place, contrary to the legislation, land concessions of *circa* 90 ha/*capita* were given out to Italian nationals, with a green light to clear-fell highland forests for the purpose of converting them to productive agricultural land. In reality, the concessionaires' true motive was cash returns from the sale of trees rather than from the output of cash crops. Aside from those 'agricultural' concessions, additional concessions were granted to establish sawmills, especially in the 1930s.

Following Italian control, the granting of agricultural concessions in highland forests continued during the period of the British Protectorate. All told, *circa* 55 sawmills and wood-processing factories were established in Eritrea up to 1947 (MoA, 1994). These certainly contributed to highland-forest destruction. The Ethiopian occupiers also continued the same policy of neglect, although no clear data exist to show how much destruction was done to the environment during that period. However, it is no secret that the degree of devastation was tremendous. The traditional system of cutting large numbers of trees for constructing houses (*Hidmos*) in the Central Highlands Zone has also contributed a lot to highland-forest destruction.

With the end of our War of Liberation of 1961-1991, the Eritrean Government found a nation totally degraded and in need of a huge reforestation effort. Encouraging activities related to afforestation and highland-forest conservation have been taking place since independence in order to reverse the effects of deforestation.

B.6.1.2 Current Status of Woody Vegetation

Three major forest/woodland types are distinguished in Eritrea: highland forests, Acacia woodlands and Riverine forests. Originally the highland forests of *Juniperus procera* and *Olea africana* would have extended over much of the plateau, but have been largely destroyed or degraded; only remnants now survive. On the lowlands and lower escarpments, *Acacia* woodlands occupy about a quarter of the surface of the country. Riverine fringe river systems of the Gash/Mereb, Setit and Barka in the lowlands, where Doum palm (*Hyphaene thebaica*) is an important constituent. These forests are under threat as they occupy fertile, well-watered and level sites suited to development for commercial agriculture. But, they are also vital to the lives of the local populations. On the coastal plains tree cover becomes increasingly sparse towards the sea. In places mangroves border the coast, the main species being *Avicennia marina*.
Natural forest cover has been classified according to six major vegetation types following international methodology.

I) Highland forest, composed of a mixture of coniferous species (*Juniper*) and broad-Leafed species (African olive and associated species)

ii) Mixed woodlands of *Acacia* and associated species, occurring mainly in the south western lowlands, but also in restricted areas elsewhere in the country;

iii) Bush or shrub vegetation, which is the dominant cover in Eritrea;

iv) Grasslands to wooded grasslands, which occur in many parts of the country;

v) Riverine forest, composed essentially of Doum palm, which is common in the western lowlands and is frequent in the eastern lowlands; and

vi) Mangrove occurring in many spots along the coast and concentrated mainly around Assab and between Tio and Massawa.

The natural vegetation of the country constitutes 0.8% high land forest. Forest and woodlands, including riverine forest and mangroves cover 13.7% of the total area. The category “bush” is the dominant vegetation in Eritrea covering at 63.8% of the total area. The riverine forests and mangroves play important

ecological and economic roles for rural communities, and occupy 1.5% and less than 0.1%, respectively

B.6.2 Major Issues

B.6.2.1 Shortages of Fuelwood and Construction Wood

Fuelwood consumption produces one of the seriously detrimental demands on the ecology of Eritrea. The rural communities, most urban households, and some commercial enterprises depend on biomass fuel for energy, but the available supply has dwindled sharply. Hence, the rural people who used to enrich farmlands with animal manure and agri-residues have minimised that valuable traditional practice, not out of choice, but of need. Instead, they are using those farming by-products for fuel owing to the scarcity of fuelwood. This is causing environmental deterioration and the debilitation of soil resources.

Fuelwood is one of the most important forest products in Eritrea. According to a recent study conducted by the MoLWE Department of Environment (DoE, 2000), total fuelwood consumption at the national level is estimated to be *circa* 856 thousand tonnes/year – and all biomass energy consumption *circa* 1.3 million tonnes/year (see Table B.13). That study also showed that shortage of fuelwood has pushed many households into using animal dung and agri-residues.

It is very evident then many more trees will have to be cut down on a continuing basis from the limited remaining natural resources in order to meet the relentless demand of fuelwood by the population. A Government directive banning the cutting of live trees has been in effect since 1994, but the compelling demand for this energy source makes it hard to hold people to this, because they would be left with virtually no energy alternative at hand – many are now simply forced to continue cutting. The largest present share of highland-forest destruction lies with tree cutting for fuelwood, followed by timber cutting for construction poles.

A typical traditional highlands home (*Hidmo*) takes *circa* 100 poles for its construction, that is to say, the felling of 100 live trees – a staggering number. Currently in Eritrea, it can be said that there are virtually no timber trees left for construction except for those poles obtained from eucalyptus (*Eucalyptus*) plantations, which are estimated to cover only 10 thousand ha. All sawn timber is imported. It is estimated that *circa* 60 thousand m^3/year of sawn timber and semi-finished wood is imported. The cost of the imported timber is currently *circa* US$ 332/m^3 (FAO, 1997). Transmission poles and scaffolding must now also be imported. Matches are produced in Asmara from imported splints. Undoubtedly Eritrea has an expanding need for construction-grade softwood timber, spurred by an expanding population and expectations of rapid development.

B.6.2.2 Soil Erosion and Sedimentation

Deforestation has an adverse impact on the fertility of an area through soil erosion and runoff. The cost to downstream areas can be sizeable, indeed, because forests have a twofold buffering activity: first the tree canopy intercepts the rainfall; and, second, the water that trickles down through the canopy is absorbed by the humus, permitting local recycling of the rainfall. The loss of those functions results in rivers coming from deforested lands to flood excessively after a downpour, but quickly running dry thereafter (Jepma, 1995).

Soil erosion induced by rain and wind is most serious on barren land and cropland (see Table A.2). It is an

especially serious environmental problem in portions of the Central Highlands Zone, where it can account for the loss of 15-100 tonnes/ha/year of soil. The soils of those areas are now shallow, poorly resistant to erosion, and of low fertility owing to inadequate vegetational cover. Because of erosion, the structure and texture of the soil are highly disturbed and its water-holding capacity decreased. As a result, this has contributed to a reduction in crop yield during recent years (NEMP-E, 1995, p. 52).

Jan Bojö has tried to calculate the gross annual soil erosion and the net loss or gain through redeposition under different land-use regimes in Eritrea (Bojö, 1996). His report indicated that gross soil loss on barren land is by far greater than for the other land-use categories (see Table A.2). On the other hand, the net rate of soil loss from cropland is less than the gross rate of loss.

Soil erosion is mostly manifested in the Central Highlands Zone (especially in its northern portion) and is associated with loss of soil moisture as a result of the total removal of the natural vegetation. This is often attributed to the expansion of cultivation, over-grazing,
and deforestation, for purposes of obtaining fuelwood and construction materials. Increased population pressures have led to farming on very steep slopes, leading to further deterioration of the environment and of the quality of the soils in particular. Therefore, there is an urgent need to rehabilitate these degraded watersheds and protect the natural resources of Eritrea so as to improve agricultural productivity and restore the environment.

B.6.2.3 Forest and Woodland Fires

There are no reliable data regarding the magnitude of past highland forest lost owing to fire, although the destruction and irreversible damage that fire caused to the Eritrean highland forests was enormous. However, it is clear that ancient settlers used fire to clear highland forests in order to establish their settlements, a practice that continued as population numbers increased. This established a tradition, so that the rural population now has a culture of using fire when additional land is required for cultivation. Today, the repetitive burning over of highland forest areas is in some cases done unknowingly, but appears usually to be deliberate.

Inhabitants of the Lowlands Zones are pastoralists or agro-pastoralists. Wherever they settle with their livestock they start fires for cooking purposes and for chasing wildlife away from their livestock during the night. They usually do not extinguish those fires, and thus they often spread rapidly by wind. Aside from this, pastoralists set fire to the grasslands every year before the onset of the rainy season in order to encourage the subsequent growth of palatable green grass. Farmers are also using fires to avoid or reduce the manual labour required to clear plots for cultivation. Such fires spread easily into the nearby highland forest or woodland, causing much damage. There is also some incidence of fire caused by lightning around Mensura, in the Western Lowlands Zone.

The farmers setting fires in the highland forests have quite a different reason for doing so than the farmers in the Lowlands Zones. Farmers in the Central Highlands Zone burn the highland forest to claim more land for cultivation. They also set fire to the highland forest to increase soil fertility. Besides encroaching into the highland forests, they place their traditional beehives on the trees. They set fires in the middle of the forest to fumigate the bees, which otherwise would attack the farmers. The fires left burning in the forest after removing the honey becomes another major cause for highland-forest destruction.

A report of the MoA indicates that *circa* 71,247 ha of grazing lands (savannas) have been burnt during the

period 1993-1999 in the South-western Lowlands Zone. In addition, a total of 1,600 ha of highland forest was damaged owing to fires in the Green Belt Zone (eastern escarpment).

B.6.2.4 Land or Tree Tenure, Institutional, and Legal Issues

The existing land-tenure system provides no incentive for the farmer to carry out permanent improvements. In such a situation, the promotion and extension of agro-forestry, which is one component of environmental restoration, is not viable. Now, thanks to the recent Land Reform Proclamation (No. 58/1994), which bestows upon the Government the right of ownership to all lands in the State, eliminating the old Village or family ownership systems, a lasting solution to the problem might be at hand.

Under this Proclamation, the Government, as ultimate owner of the land, retains the right, to distribute land to the Villagers who are by usufruct right entitled to a piece of land for their lifetime. The land cannot be sold or transferred and cannot be mortgaged. This new land tenure is not yet implemented owing to technical reasons. However, agro-forestry demonstration plots have been established in some areas of Eritrea, so that everybody can be made aware of the means of incorporating high-value multi-purpose trees and shrubs into the farming system. Thus, after the new land-tenure system is implemented, every farmer will be readily able to institute such agro-forestry technologies. Farm woodlots could also be established by setting aside a portion of the farmlands once the new tenure system is in place.

The pre-existing policy, and associated legislation, is known as the Forest & Wildlife Conservation & Development Act (No. 192/1980), was inherited from the colonial administration of the time. In addition, there are rules and regulations that were being used during our War of Liberation of 1961-1991 in the then liberated areas. Based on the GoE Macro-policy Document of November 1994 (Article 1.2), the Government intends to replace the aforementioned forestry and wildlife rules and regulations, and the pertinent draft legislation is now ready. This draft defines several sub-sector objectives dealing with a number of strategic elements, such as:

- Promotion of soil conservation through afforestation.
- Production of fuelwood and construction materials in a sustainable fashion through community participation.
- Rehabilitation of catchments by establishing permanent and temporary enclosures, augmented where necessary by reforestation.
- Promotion of the use of multiple-use tree species and the development of agro-forestry.
- Ensuring the development and sustainable exploitation of wood and non-wood forest products.

However, this draft legislation has not as yet been promulgated, so there is still a problem to fully implement such afforestation and forest-conservation activities.

B.6.2.5 Non-wood Forest Products

Like any other forest component, trees and shrubs which produce high-value non-wood forest products also play an important role in improving soils, protecting watersheds, ameliorating climate, reducing salinisation, etc. Among others, the most important non-wood forest products in Eritrea are Gum Arabic, Gum Olibanum, doum palm leaves, and cactus fruits (see Table B.16).

Gum Arabic, which is obtained from *Acacia senegal*, is one of the most important non-wood forest products in the Western Lowlands Zone. The Sudanese introduced the business of Gum Arabic collection to Eritrea in the early 1950s.. However, owing to our protracted War of Liberation of 1961-1991, the exploitation of gums in Eritrea is now minimal.

The bitter frankincense (*Boswellia papyrifera*), which produces Gum Olibanum (frankincense), is found in the Western Lowlands Zone in the following areas: Berakit, Zaide Kolom, Arewai, Tsebab, Jengeren, Mesehalit, Shilalo, Augaro, and *Adi* Tseser. Tapping and collecting of Gum Olibanum was started in 1925 by the Somali people, who eventually transferred this knowledge to the local people.

The leaves of doum palm (*Hyphaene thebaica*) provide another important non-wood forest product. Doum palm is the main component of the riverine woodlands, mainly in the intermittent basin of the Barka River, especially in Mensura, Shegelgel, Engerne, Garsai, Ker-Ubel, Tekreret, Shiglet, Mogoribe, and Hademdemit; and also in the intermittent basin of the Gash River, especially in Ghurguji, Hykota, and Alebu.

Prickly-pear cactus (*Beles*) (*Opuntia ficus-indica*) is an exotic plant introduced to Eritrea in the late 1980s by a French Catholic missionary and planted around Digsa, Akrur, and Hebo (all in the eastern part of *Zoba* Debub). During railway construction, it was also planted along the steep slopes of Arbe Rebu in order to stabilise the soil and prevent it from sliding onto the railway line. This plant has spread dramatically into many parts of the Green Belt Zone (eastern escarpment).

The main issues that have to be addressed in relation to the above species are:

- Unwise pealing of the bark of *Acacia senegal* for the production of Gum Arabic, as well as the cutting of those trees for fuelwood and farm fences, have resulted in land degradation in the South-western Lowlands Zone.

- Production of Gum Olibanum, which was *circa* 2,500 tonnes/year in the early 1930s, has in recent years declined to *circa* 450 tonnes/year owing to unwise tapping, indiscriminate cutting, and excessive trimming of bitter frankincense (*Boswellia papyrifera*) for feeding livestock during *Hagay* (the October-February dry season).

- The main shoots of doum palm (*Hyphaene thebaica*) are excised by the local people for the production of artifacts, and the inflorescence is cut by pastoralists to feed their cattle and small ruminants during *Hagay* (the October-February dry season). These activities affect regeneration and, if carried out too extensively, could lead to desertification.

- Despite all the benefits obtained from the prickly-pear cactus (*Opuntia ficus-indica*), it is highly competitive for moisture, nutrients, and light. It thus creates undue

competition for the economically and potentially valuable indigenous species found in Eritrea, such as African olive (*Olea africana*) and African pencil cedar (*Juniperus procera*), especially in Semenawi Bahri.

Table B.16 Major Non-wood Forest Products

Name	Source (species)	Estimated area (km^2)	Potential production (tonnes/year)	Current production (tonnes/year)	Common uses
Gum Arabic	*Acacia Senegal*	4,041	>1,000	250	-Ingredient for confectionery, beverages, flavourings, and pharmaceuticals
Gum Olibanum	*Boswellia papyrifera*	2,198	>2,500	450	- Incense
Doum Palm Leaf (*Laka*)	*Hyphaene thebaica*	150	381,000	1,000	- Baskets, mats, hats, and other artifacts, edible fruit
Cactus Fruit	*Opuntia ficus-indica*	100	24,000	4,800	- Edible fruit, leaf for animal feed

B.6.2.6 Land-clearing for Rain-fed and Commercial Agriculture

The MoA has identified the SWLZ in *Zoba* Gash-Barka as an area of high potential for agricultural development and ecological richness. This *Zoba* contains dry *Acacia* woodland and riverine woodland that harbour different species of birds, mammals, and other biotic elements that contribute highly to the biodiversity of Eritrea. These woodlands have been encroached upon to support rain-fed agricultural expansion geared to the achievement of food-security strategies. This has been done by the allocation of small plots to returnees from the Sudan and Ethiopia and to ex-combatants on the one hand; and by granting concessions to investors on the other. Some of the cleared areas are located around Golij, Sabonite, Gergef, Tebeldia, Swateb, and Kachero.

The people settling around those cleared areas construct their houses from *Acacia* and the leaves of the doum palm (*Hyphaene thebaica*), thereby contributing to the destruction of Eritrea's woody vegetation. The Mereb, Gash, and Barka River basins are very fertile, and therefore, small-scale farmers and agricultural concessionaires are extremely interested in developing commercial farms there through irrigation. Around Akordet, 86 investors were granted concessions totalling 816 ha, out of which 532 ha has already been developed with different horticultural crops. In addition, in the Gash River basin around Haikota, 22 investors have developed horticultural crops on 423 ha.

B.6.2.7 Salinity and Seedling Survival

It is very difficult to carry out afforestation through the development of plantations in the North-western Lowlands Zone because of the salinity of the groundwater. Most seedlings raised in nurseries die immediately after germination. This condition is also common in the eastern portion of the Coastal Plains Zone. Therefore, salt-tolerant species have to be identified.

B.6.2.8 Salt-pan Evaporation Ponds and Mangroves

Evaporation ponds for the purpose of salt production are expanding, particularly around Massawa and Assab. These salt fields are constructed at the seacoast, where mangrove vegetation is found, and accordingly affect the marine environment. *Avicennia marina* and *Suaeda monoica* are common species in those littoral mangrove ecosystems.

B.6.3 Efforts Undertaken

B.6.3.1 Enclosure Establishment

As grazing animals are amongst the main causes of deforestation, the only sure measure to guarantee a sustained regeneration process of the shrubs and tree species is to designate potential areas closed, either temporarily or permanently. A nationwide survey was carried out recently by an FAO pre-investment study mission, which has produced the first comprehensive assessment of the extent of the enclosure system in Eritrea (FAO, 1997). This survey was initiated with the mandate to evaluate, review, and recommend expansion or improvements. According to that study, there is no doubt that the closing of an area provides a better opportunity for regeneration to the young shrubs and trees. Good examples are the existing highland forests of Semenawi and Debubawi Bahri and the remnant *Juniperus* forest of Rura Habab, all of those believed to exist owing to enclosures. In 1999, total enclosures in Eritrea were found to come to *circa* 192 thousand ha in order to encourage the return of woody vegetation (both trees and woodland shrubs) (see Table B.17). This represents *circa* 1.5% of all Eritrea, but *circa* 2.5% of its total vegetational cover of 7.7 million ha (see Table A.1). This is still substantially less than the 10% sometimes recommended.

Table B.17 Enclosures Established for Woody-plant Regeneration by *Zoba (*as of 1999)

Zoba	Total area (thousand ha)	Area enclosed (ha)	% enclosed
Maekel	143	9,490	6.6
Debub	852	15,213	1.8
Anseba	2,258	73,337	3.2
Gash-Barka	3,405	32,285	0.9
Semenawi Keyih Bahri	3,387	61,332	1.8
Debubawi Keyih Bahri	2,387	0	0
Total/Mean	**12,432**	**191,657**	**1.5**

Note: For areas of the various land-use types, see Table A.1.
Source: FAO (1997).

B.6.3.2 Afforestation on Degraded Catchments

Prior to liberation in 1991, though few accurate records were maintained, tree planting was concentrated within a number of catchments – namely Anseba, Mereb, Nefhi (a Mereb tributary), Damas, Ferendyt, and Leghede (the last three all within the Red Sea basin (see Table B.7) – as part of a soil- and water-conservation strategy, based on 'food-for-work'. In this way *circa* 10 thousand ha of plantation were established, mainly consisting of *Eucalyptus cladocalyx*, but also of *E. globulus*, *E. camaldulensis*,

Acacia saligna, *A. decurrens*, *A. mearnsii*, etc. Tree planting for their amenity value by municipalities has also taken place to good effect in the past, but owing to the uncertainties prevailing during recent years, existing trees have been damaged or have died, and there has been little management or replacement. Following liberation, *circa* 61 million seedlings have been planted between 1991 and 2001 (see Table B.18). The survival rate of the planted seedlings, has been 60%-70% in the Central Highlands Zone, and 30%-40% in the Lowlands Zones. All these activities are carried out with community participation.

Table B.18 Afforestation Achievements (1991-2001)

No.	Activity	Achievement
1	Hillside terrace construction	18,401 ha
2	Check dam construction	2,307
3	Micro-basin construction	1,118,828
4	Seed collection	27,310
5	Seedling production	97,303,700
6	Planting or replanting	60,959,442
7	Spot weeding & cultivation	10,004 ha
8	Nursery establishment	47
9	Peasant training	4,761

B.6.3.3 Village Woodlot, Farm Forestry, and Community Forestry Development

Although a community-managed system is generally considered to be inefficient, owing to disincentives for individual motivation, if properly applied, this need not be the case. A case in point is the community woodlots of some Villages in the Central Highlands Zone whereby land is allocated annually by the Village Council (*Baito)* to individual Village families for them to plant trees. The families are responsible for subsequent maintenance and care, and, as owners of the trees, they are free to cut them at any time, be it for their own use or for sale. The Government is now moving a step further by allocating Government lands with trees already established on them to individual families for them to look after and become the ultimate owners of, with the right to cut and sell mature trees. Another successful application of social forestry involves the involvement of home compounds, roadsides, and institutions such as churches, mosques, schools, and hospitals.

With the participation of the communities, trees are also planted in different areas for their amenity value. These include roadside planting, especially along major roads radiating from Asmara, and associated with school compounds, sacred areas, cemeteries, parks, riverbanks, scenic sites, and the like. Planting multi-purpose and high-value trees and shrubs, such as *Acacia senegal* and *A. seyal* (both gum-producing trees), other fodder trees and shrubs such as *Acacia etbaica, Leucaena leucocephala*, and sesban (*Sesbania sesban*), as well as fruit trees, are the main focus at community-forestry afforestation sites.

B.6.3.4 Popular Participation (Student Vacation Campaign and National Development Campaign)

Since 1994, Eritrean students throughout the country have been participating in afforestation and soil-conservation campaigns during their school vacations, during *Kremti* (June-September), organised by the Ministry of Education (MoE) with the Ministry of Agriculture. *Circa* 19 thousand students have participated for 45 days every year since 1994. To mention some of the major undertakings, 732 ha of hillside terraces have been constructed and planted with 11.5 million tree seedlings.

As an integral part of this development plan, the first round of a National Development Campaign was organised on May 1998 with wide participation and financing by the Eritrean population. In this Campaign, 25,893 people from the National Service were deployed on 10 degraded catchments for three weeks. The work accomplished during the Campaign was both astonishing and impressive. Thus, 400 ha of hillside terraces, 167 km of check-dams, and 20 ha of micro-basins were constructed, and 439,408 pits for planting seedlings were prepared.

B.6.3.5 Development of Forestry Research and the MoA National Tree Seed Centre

B.6.3.5.1 Research

Forestry research at the MoA Department of Agricultural Research & Human Resources Development started in 1994, with the first field experiments established in 1995. More recently, the Department has established a Forestry Research Unit. Some of the ongoing research activities are:

- Species elimination trials, at Shambuko, Halhale, *Adi* Keih, Merhano, and Ghinda.
- Evaluation of several *Eucalyptus* spp and provenances, at Merhano, *Adi* Keih, and Halhale.
- Fodder species trials with *Gliricidea sepium*, *Leucaena leucocephala*, sesban (*Sesbania sesban*), etc., at Halhale.
- Spacing and crop-performance trials with *Cordia africana* and *Jacaranda mimosifolia*, at Halhale.
- Agro-forestry research and demonstration trials of planting pigeon pea (*Cajanus cajan*) together with commonly planted crops such as wheat, barley, and pulses; of alley-cropping trials with *Leucaena leucocephala*, at Halhale; and of the potential for tree planting on field boundaries and terrace hedges, at Halibmentel.
- Seed pre-treatment, germination, and seedling pot-size trials, at the Bietghiorgis Nursery.

B.6.3.5.2 The MoA National Tree Seed Centre

The MoA National Tree Seed Centre (NTSC), funded by DANIDA, has been fully integrated into the MoA Department of Agricultural Research & Human Resources Development since 1996. It is not likely that NTSC will develop into an independent seed-supplying organisation. Instead, NTSC is to become the

national focal point for tree-seed quality-control, and is to offer advisory services on procurement of quality seed. Thus, NTSC will support zonal activities on seed procurement through training, information, research, minor physical inputs, and identification and arrangement of seed sources.

Inasmuch as the zonal Land Resources & Crop Production Sub-divisions of the MoA Forestry & Wildlife Units, are responsible for the planning of seedling production, NTSC should assist by providing information on seed quality.

NTSC is to focus on gene-conservation efforts only to the extent that those activities directly support the seed-procurement objectives. In practice, this means that the Centre will only be engaged in *ex situ* conservation activities which are directly related to, and combined with, the establishment of seed sources of species in high demand or are indigenous species threatened with extinction. NTSC must thus prioritise its *ex situ* conservation activities regarding seed-source establishment between species in high demand and threatened indigenous species.

B.6.3.6 Non-wood Forest Products

Since 1994, much effort has been devoted to developing *Acacia senegal* plantations. More than 1.4 million seedlings have been planted at sites in Mereb, Berakit, Barentu, Omhajer, and Asmat. Survival rate has been very good (*i.e.*, 70%-80%) in comparison with other species planted at those sites. Similarly, propagation of bitter frankincense (*Boswellia papyrifera*) was initiated, through cuttings and from seeds, in the *Mai* Tsebri and *Ruba* Anseba nurseries. However, for this species survival has been very low (15%-20%) owing to a lack of knowledge or experience with its silvicultural aspects. The MoLG Eritrean Community Development Fund (ECDF) and the division of the Ministry of Agriculture of *Zoba* Anseba initiated a three-year project for the development of bitter frankincense and other high-value trees at Fre-Darib in Keren. To upgrade the technical know-how of tapping bitter frankincense for Gum Olibanum and *Acacia senegal* for Gum Arabic, on-the-job training is now conducted at least annually as an integral part of the overall human-resources development programme of the Ministry of Agriculture.

The Ministry of Agriculture, funded by SOS Sahel International (London), has implemented a project with the main objective of assessing the available resources in the riverine woodlands, mainly the doum palm, along the riverbanks of the Barka and Gash Rivers. The project has produced a management plan for the development and wise utilisation of those resources. Clearly presented in that plan are the allowable annual harvest of doum palm leaves and the appropriate land-use patterns of the riverine woodland. Thus, this plan will be able to assist the relevant decision-makers in determining the amounts of doum palm leaves
that can be safely harvested each year, and which portions of the riverine woodland can be used for commercial agriculture without adversely affecting the ecosystem.

B.6.4 Actions Required

B.6.4.1 Developing Conservation Education

Since most Eritreans live in the rural areas, deforestation, soil erosion, land degradation, loss of surface water and groundwater, fire hazards, and other symptoms of environmental degradation and desertification affect them directly.

To solve these problems, a great deal of work will be required in order to create awareness that would motivate a change in attitude. Approaches that could be employed include use of the mass media, group meetings, and public presentations, particularly to key groups such as women and youth.

B.6.4.2 Encouraging Fuelwood Conservation and Wood Production

Fuelwood and construction wood are becoming increasingly difficult to obtain, particularly in the major urban centres of Eritrea. To alleviate this problem, the following actions are suggested:

- Promotion of programmes to increase wood production, through the establishment of fuelwood plantations and farm woodlots; and

- Promotion of programmes that will reduce fuelwood demand, through the use of energy-efficient wood stoves.

B.6.4.3 Developing Alternative Energy Sources

Comparative studies for energy-conservation efficiency were carried out in Fiji to demonstrate the importance of alternative energy sources over fuelwood (Hardwood & Boland, 1994). Based on that study, the advisory visit from the Commonwealth Scientific & Industrial Research Organisation (CSIRO) of Australia together with the International Centre for Research in Agroforestry (ICRAF) produced the following calculations, considering local factors such as the prices in Asmara for fuelwood, kerosene, and gas. The results were:

- The least expensive source of fuel is kerosene;
- The highest conservation efficiency is achieved with gas; and
- The greatest net calorific value is also achieved with gas.

Owing to the purchase-cost factor, many households in Asmara, other Towns, and some Villages are already using kerosene in wick-stoves for cooking food – except for the making of *Injera*, a traditional food that is generally baked by burning fuelwood or gas. Therefore, there is a need to:

- Promote the development of natural gas, liquified petroleum gas (LPG), bio-gas, wind energy, solar energy briquettes, etc.;
- Develop electricity; and
- Promote substitutes for construction wood, such as the use of iron or concrete beams for pillars and rafters and corrugated iron sheets or other non-wood materials for roofing.

B.6.4.4 Enhancing Afforestation and Soil Conservation

Given the magnitude of the problems associated with forest and soil conservation, it is recognised that the only way to tackle the problems of soil degradation and the fuelwood and construction-wood crisis at acceptable cost is to work through a catchment approach and initiate community-based tree-planting programmes. The major practices under a catchment approach would be:

- Construction of hillside terraces and micro-basins on uncultivable lands, planted with

perennial plants (trees and shrubs) for purposes of soil conservation, fuelwood and construction-wood production, dam-site protection from siltation, etc.;
- Construction of check dams along waterways, planted with grasses and shrubs, in order to slow down runoff water and reduce soil loss;
- Construction of on-farm bunds, such as stone bunds or soil bunds, planted with leguminous trees and shrubs as well as with grasses;
- Establishment of tree nurseries and grass-multiplication centres. Seedlings could be located all over the catchments to stabilise the structures; and
- Construction of diversion structures, using gabions, concrete, etc.

In addition, tree planting through popular participation has to be encouraged at homesteads, roadsides, school compounds, sacred places, scenic sites, waterways, etc.

B.6.4.5 Encouraging Area Enclosures for Natural Regeneration

The over-exploitation of economically valuable indigenous tree species has led to significant ecological disturbance. In order to reverse this situation, a lot of efforts have been carried out over the past eight years on afforestation through the planting of trees and on encouraging natural regeneration through the establishment of enclosures.

Closing an area provides an excellent opportunity for regeneration of trees and shrubs. Owing to this fact, many temporary and permanent enclosures have been established. In most parts of the Central Highlands Zone, areas are temporarily closed by the *Baitos*, for periods that last for only few years, which unfortunately do not allow sufficient time for an adequate regeneration process. This is done because of the shortage of grazing land in this part of Eritrea. Therefore, in order to make enclosures sustainable, the following must be observed:

- Temporary enclosures must be kept closed for at least 4-7 years, depending upon local conditions, in order to ensure adequate regeneration;
- Enrichment planting is required in any gaps within enclosures;
- Palatable and nutritious grasses must be sown in enclosures; and a system of cut-and-carry to feed livestock must be promoted; and
- A strong joint-management system with surrounding communities must be developed through frequent discussions for joint planning and management.

B.6.4.6 Improving Land Use and Land Husbandry

Land-use planning must precede development activities and be in harmony with all the concerned uses. Development activities should be undertaken based on criteria established for this purpose.

Physical conservation structures, such as soil bunds and contour ridges, must be complemented by various other approaches: (a) the use of farmyard manure; (b) rotation with leguminous crops and the use of commercial fertilisers to improve soil fertility; and (c) the use of high-yielding varieties. As to the high-yielding crops, this will necessitate a strong research base in order to determine what is best for the local conditions. Additionally, the old land-tenure system, which acted as an obstacle to farmers to make long-term investments in the land, must give way to lifetime usufruct rights. This will encourage farmers to develop a sense of belonging to their land, so as to more readily invest in it. Therefore, the recent Land

Reform Proclamation (No. 58/1994), which bestows upon the Government the right of ownership to all lands in the State, eliminating the old Village or family-ownership system, must now be implemented (see Fact Sheet B.1).

B.6.4.7 Developing Agro-forestry

Agro-forestry offers a practical way to apply specialised knowledge and a variety of skills to the development of a sustainable system of rural production. This is especially important in difficult environments, such as in the Central Highlands Zone, where people must manage steep slopes, dry conditions, and fragile lands in order to survive and earn their livelihood. Agro-forestry is a system frequently invoked as part of the solution to problems of land and water degradation as well as an answer to:

- Shortages of fuelwood plus charcoal wood (which together are the source of *circa* 55% of the total energy requirements of the population – see Section B.4.3 & Table B.13);
- Shortages of food, cash income, animal fodder, and building materials; and
- Soil- and water-conservation problems.

The challenge is to see whether the existing local practices, now under threat, can fully address the production and conservation problems that the Central Highlands Zone face. In fact, that challenge cannot be met without adapting to the changing conditions. But building improved agro-forestry practices based on our traditional ones will, if augmented by boundary planting, tree planting on soil-conservation structures, and establishment of live fences. These adaptations can produce food, wood, and fodder – and thus be in line with environmental conservation.

B.6.4.8 Encouraging Forestry Research

Many tree species indigenous to Eritrea have become endangered and some have disappeared completely. On the other hand, undesirable plants such as white tobacco (*Nicotiana glauca*) are widely distributed. Prickly-pear cactus (*Opuntia ficus-indica*) is also competing with the remnant highland forest, particularly in Semenawi Bahri, and the same is true for mesquite (*Prosopis chilensis*) in the riverine areas of the Lowlands Zones. *Eucalyptus* also plays a controversial role in the environment.

Environmentally sound highland-forest development will not be possible without sound investigations and the application of test results to actual forest practices. The Ministry of Agriculture is undertaking research in the field of forestry, especially with regard to establishment of agro-forestry trials using provenance trials of new species. However, further steps should be taken to promote regeneration of endangered species, and to select the best tree species for afforestation.

B.6.4.9 Promoting the Wise Use of Non-wood Forest Products

In order to minimise or even reverse the effects of desertification resulting from destruction of highland-forest resources through the unwise utilisation of non-wood forest products, the following actions are called for:

- Developing improved technologies for the extraction of non-wood forest products;
- Promoting joint forest-management practices;

- Encourage reforestation and agro-forestry;
- Assessing the potential pros and cons of prickly-pear cactus (*Opuntia ficus-indica*)**;** and
- Promoting research, especially on the propagation of bitter frankincense (*Boswellia papyrifera*).

B.6.4.10 Introducing Mechanisms for Fire Prevention

It has been reported that uncontrolled fires devastate a lot of grassland (often with scattered shrubs) in the Western Lowlands Zone. Efforts are being carried out to control the fires when they occur. However, preventing the occurrence of fire is by far better than controlling one that has already started. Therefore, the following actions are required in order to minimise the effects of uncontrolled fire:

- *Public Awareness:* This must be developed through the mass media (radio, television, newspapers, magazines, etc.) and by organising community meetings at the grassroots level.

- *Law Enforcement*: The pre-existing forest legislation, inherited from the colonialists, states that starting a fire in any forest, be it intentional or owing to negligence, is prohibited. But those laws have not been properly enforced. Therefore, the new draft forest conservation and development legislation which includes fire protection has to be promulgated soon, and then followed by appropriate guidelines.

- *Construction of Fire-prevention Structures*: Construction of such structures builds upon ordinary methods of constructing firebreaks at strategic places. The construction of firebreaks should be made to standard specifications, and an optimal ratio of firebreak to fire danger should be worked out. Once established, firebreaks should be maintained regularly to exclude fuel from their surface.

B.6.4.11 Implementing a Management Plan for Riverine Woodlands

The Assessment & Management of the Riverine Woodland Project has come up with a management plan for the riverine woodlands of the Western Lowlands Zone. This plan has considered a proper balance among technical, economic, social, and environmental considerations in order to achieve the rational and sustainable utilisation of the natural resources of the riverine woodlands. It is a comprehensive plan in that it takes into account all the natural resources present in the riverine woodlands, and the processes via which the community can obtain access to them. Therefore, the management plan needs to be implemented as soon as possible so that the involved natural resources and traditional land uses can co-exist harmoniously.

B.6.4.12 Enhancing International and Regional Co-operation on Forest Conservation and Development

To tackle the problems of soil degradation, of the fuelwood and construction-wood crisis, and of protecting the natural heritage and terrestrial biological diversity at an acceptable level, Eritrea will have to work in collaboration with regional and international organisations. Some of the international governmental and nongovernmental organisations (NGOs) that could actively participate in Eritrea's afforestation and soil-conservation efforts, or continue to do so, include: FAO, EU, DANIDA, SOS Sahel International

(London), World Vision International (Monrovia, California, USA), and Grassroots International (Boston). The MoA Forestry Research sector is also working in collaboration with international organisations such as CSIRO, the International Centre for Research in Agroforestry (ICRAF), and the Danish Forest Seed Centre (DFSC).

Therefore, further regional and international co-operation is required especially on:

- The development of criteria for sustainable highland-forest development;
- Financial assistance, scientific research, and technology transfer;
- Trade in highland-forest products; and
- Sectoral and cross-sectoral linkages in solving forest-related issues at the national and international levels.

B.6.5 Conclusion

Numerous efforts have been initiated in Eritrea for purposes of reversing deforestation and of developing sustainable highland-forest management. These include: (a) addressing the causes of deforestation and highland-forest degradation; (b) involving the whole community in afforestation and forest-conservation efforts; (c) supporting efforts for the re-greening of the degraded landscape and of combating desertification; and (d) developing sound rules and regulations that provide a balanced approach between the environmental and developmental functions of highland forests and the needs of the local community living in and around the highland forest or woodland.

B.7 LIVESTOCK AND RANGELAND ISSUES

B.7.1 Background

FAO Report (1994) indicated that 49 percent of the total surface area of Eritrea is rangeland suitable for grazing. The rangelands get less than 400 mm/year of rainfall and cover most of the Eastern and Western Lowlands Zones. They are dominated by various grasses (mostly annual), forbs, and small browse species of *Acacia*.

Eritrea is endowed with large numbers of various livestock. Agriculture contributes 26% to Eritrea's gross domestic product (GDP). Of that value, livestock accounts for 15%. According to the latest survey of the MoA Department of Animal Resources, Eritrea has 1,927 thousand cattle, 4,662 thousand goats, 2,129 thousand sheep, 504 thousand donkeys, 9 thousand mules, 5 thousand horses, and 319 thousand camels (DoAR, 1997) (see Table B.19). These numbers are expected to increase at a diminishing rate over the coming years.

As to their distribution, 48% of the cattle, 37% of the goats, 32% of the sheep, 35% of the donkeys, and

36% of the camels are found in the sparsely populated *Zoba* Gash-Barka . Out of the total population of mules and horses, 79% and 70%, respectively, are found in *Zoba* Debub (in the medium- and high-altitude zones). The most densely populated *Zobas* – Maekel and Debub – have the lowest number of cattle, goats, sheep, and camels, as compared with the Eastern and Western Lowlands Zones.

Table B.19 Projected Livestock Numbers (1997-2015)

Type of livestock	Numbers (thousand)					
	1997	2002	2005	2010	2015	
Cattle	1,927	2,075	2,152	2,232	2,284	
Goats	4,662	5,008	5,180	5,351	5,454	
Sheep	2,129	2,287	2,366	2,443	2,490	
Donkeys	504	551	574	599	613	
Mules	9	10	10	11	11	
Horses	5	5	6	6	6	
Camels	319	340	354	368	379	

Note: For projected livestock drinking-water demand, see Table B.11.
Source: Modified from DoAR (1997).

In Eritrea, there are three major livestock-production systems: (a) mixed farming; (b) agro-pastoralism; and (c) nomadic pastoralism. Mixed farming is practised primarily in the Central Highlands Zone (CHZ), whereas agro-pastoralism and nomadism are characteristic features of the Eastern and Western Lowlands Zones. Nomadic pastoralists are only found in the extreme northern Sahel and southern extreme of *Zoba* Debubawi Keyih Bahri. Of the Eritrean population, *circa* 75% depend on livestock and livestock products for their livelihood.

B.7.2 Processes of Desertification in the Main Geographical Zones

The major processes that are involved in land deterioration or desertification insofar as the livestock and rangeland sector is concerned are degradation of vegetational cover, soil erosion, and soil compaction. The first two processes have severe effects on the land and play a significant role in determining both environmental quality and human well-being. These processes affect every part of Eritrea. Some of the processes that result in land degradation in the rangelands have been over-grazing and the indiscriminate felling of woody plants for fuelwood, charcoal, construction purposes, reinforcement of fighting trenches during our War of Liberation of 1961-1991, and shifting cultivation. Therefore, for the sake of clarity it is necessary to see the effects of desertification processes on the main geographical locations of Eritrea.

B.7.2.1 Central Highlands Zone (CHZ)

The Central Highlands Zone (CHZ) harbours 23% of the total livestock population of Eritrea. It is the most densely populated Zone. The unwise use and cutting of trees for fuelwood, construction wood, and cultivation have led to the loss of the topsoil and exposure of the land to wind and water erosion. The soils of the CHZ have lost their fertility as a result of the continued action of backward agricultural practices promoted by the traditional land-tenure system, which forces change in ownership every 7 years or so, although such distribution had been designed to ensure equity in the ownership of land. The system is so destructive of the land because it discourages farmers from applying all the necessary inputs and conservation measures that protect the soil from further deterioration and loss of fertility.

The farmers of the CHZ primarily practise mixed farming. The majority of their livestock are goats and sheep. Besides, each individual farmer owns a pair of oxen and at least one milking cow that provides milk and replacement oxen to the family. As the land is so densely populated, there is not enough grazing land for all the livestock present. As a result, the farmers move to the highly fragile steep slopes of the Green Belt Zone (eastern escarpment) for cultivation and to graze their livestock. One exception here is that each Village has its own communal grazing land, which is enclosed for *circa* 4 months/year and opened for grazing during *Hagay* (the October-February dry season). As the name indicates, the land is available to all in the Village in common. Every Villager wants to maximise his or her profit by increasing his or her livestock numbers no matter what the consequence on the quality or sustainability of the common grazing land might be – a classical example of the 'tragedy of the commons'.

Major problems of the CHZ:

- Dense human population, resulting in severe destruction of the vegetational cover;
- Lack of proper land use and land classification;
- A backward land-tenure system, resulting in the loss of topsoil and soil fertility; and
- Grazing of the communal grazing lands beyond their sustainable capacity (the 'tragedy of the commons').

Programme of action:

1. The animal-production system should be changed from traditional to modern;
2. The land-tenure system must be changed from traditional to modern, as the traditional system of periodic land redistribution fosters land deterioration – each farmer must be able to retain his or her own farmland in perpetuity;
3. Steep slopes should be terraced and covered with erosion-preventing grasses and trees;
4. High-quality grasses and legumes should be introduced in terraced areas and enclosures for cut-and-carry use and for conserving soil and water; and
5. A system should be developed that enables farmers to improve their traditional hay and straw conservation measures, *e.g.*, by baling of harvested grasses and straw and by treating the straw with feed-grade urea.

B.7.2.2 Coastal Plains Zone (CPZ)

The Coastal Plains Zone (CPZ) extends from the northern-most point of Eritrea (Ras Kesar) to its southern-most (Ras Dumera), located adjacent the Red Sea. The CPZ encompasses arid and semi-arid areas that get less than 200 mm/year of rainfall. The Zone has very extensive spate-irrigated lands. It is characterised by diverse climatic conditions and vegetational covers. It is a sparsely populated zone because of its inhospitable climate and landscape. The inhabitants of the CPZ are primarily pastoralists. Some of them practise nomadic pastoralism, migrating from place to place in search of forage and water. The vegetational cover of the rangeland has become highly deteriorated because of the pressures inflicted upon it by excessively large numbers of livestock. The desirable carrying capacity for cattle on our rangelands is 1.4/ha, whereas for sheep it is 7.0/ha – but those limits have now been exceeded by over 200%. As a result, the negative impact on the rangelands is quite significant. Moreover, the value of the rangelands is diminishing because most of the desired grass species are being replaced by less desirable ones.

In terms of livestock population numbers, the CPZ is second to the Western Lowlands Zone. It harbours 28% of the total livestock population of Eritrea. But reducing livestock numbers alone is not enough. The

animal-production sector needs to devise efficient mechanisms and production systems that could enable the pastoralists to improve their husbandry practices, and thereby the productivity of their rangelands and livestock. Some grazing lands of the CPZ still have a good potential for improvement if the MoA Department of Animal Resources and the pastoralists work together towards the proper development and management of the range resources.

Major problems of the CPZ:

- Sparse vegetational cover owing to low precipitation and livestock over-population;
- Too much emphasis on livestock numbers rather than on livestock quality;
- Lack of interactions between the pastoralists and livestock experts, hindering proper development of the animal resources sub-sector;
- Insufficient veterinary and extension services, including a lack of drugs and vaccines, the improper use of available drugs, paucity of qualified veterinary personnel, and poor accessibility to them;
- Excessive tree felling for fuelwood, housing, and construction of flood diversion structures;
- Inadequate taxonomic knowledge of the native grasses, legumes, and forbs;
- Lack of markets and of marketing information for livestock;
- Insufficient watering points, owing to the dryness of the area and to the high rates of evapo-transpiration; and
- Prevalence of dust storms.

Programme of action:

1. Provision of sufficient veterinary services, through the establishment of mobile clinics and the assignment of qualified personnel in all of the CPZ sub-zones;
2. Establishment of pilot rangeland development projects which could help in the development and improvement of rangeland productivity;
3. Assessment of the trends in rangeland conditions, aimed at improving vegetational coverage, plant quality, and species composition;
4. Improvement and establishment of marketplaces and networks in the most essential parts of the CPZ, in order to increase and improve livestock marketing possibilities;
5. Establishment of watering points at reasonable distances from each other;
6. Introduction of an efficient extension service that could change the attitudes of pastoralists; and
7. Establishment of shelterbelts.

B.7.2.3 The Western Lowlands Zone (WLZ)

The Western Lowlands Zone (WLZ) can be divided into the North-western Lowlands Zone (NWLZ) and South-western Lowlands Zone (SWLZ). The WLZ gets less than 600 mm/year of rainfall. It harbours 49% of the total livestock population of Eritrea. Rainfall decreases from south to north. The Zone is characterised by diverse vegetation, flat land, and highly rugged terrain. Its flat land is highly prone to both wind and water erosion. The dominant tree and shrub types are various species of *Acacia*; other vegetation includes various grasses. The vegetational cover of some parts of the WLZ is totally damaged because of over-grazing, low precipitation, and such destructive human activities as shifting cultivation. In the extreme north of the Zone there are some nomadic pastoralists, but the majority of the inhabitants are agro-pastoralists.

Major problems of WLZ:

- Land degradation, attributed to over-grazing, extensive tractor-based farming, excessive tree felling, and shifting cultivation;
- Erratic and uneven distribution of rainfall;
- Backward traditional livestock-production systems;
- Lack of all-weather roads to link the rangelands with veterinary clinics and livestock marketplaces;
- Shortage of watering points;
- Insufficient access to extension services, owing in part to the migratory nature of the livestock owners;
- Shortages of veterinary drugs and vaccines;
- Limited know-how and lack of awareness by the livestock owners to conserve and enclose grassland areas for use during *Hagay* (the October-February dry season);
- Expansion of settlements and of commercial farms into the traditional rangelands; and
- Lack of adequate market information.

Programme of action:

1. Identification and development of deteriorated rangelands, through inventory and the introduction of highly productive grass and legume seeds;
2. Establishment of pilot rangeland development projects in some areas, through the construction of irrigation and river-diversion structures;
3. Establishment of mobile veterinary clinics at accessible sites in areas which have the highest concentrations of livestock;
4. Development of watering points;
5. Directing and strengthening of extension services, so as to acquaint farmers with modern husbandry practices and grazing-land management;
6. Application of appropriate soil- and water-conservation measures;
7. Discouraging the use of tractors for intensive farming, because of the highly fragile, structureless, and undeveloped nature of the WLZ soils;
8. Design of a proper land-use system, inasmuch as commercial farming is spreading widely into communal grazing lands and riverine woodlands. This spread could lead to excessive grazing on the remaining rangelands, to blockage of livestock routes, and to severe land degradation; and
9. Establishment of an appropriate livestock-marketing information system.

B.7.3 Means of Combating Desertification in Rangelands

Deterioration of the rangelands in terms of vegetational changes and soil erosion can be traced to the current management systems. Therefore, any measures that focus on correcting or modifying the adverse factors that cause land degradation or desertification should stress proper range-management systems. Some of the measures that should be applied to combat desertification follow:

1. The most crucial problem facing range management is over-grazing. Proper stocking levels must be introduced in order to balance livestock numbers with the productive capacity of the land, thereby halting further land deterioration.

2. Distribution of livestock types must be controlled inasmuch as different kinds of livestock have differing feeding habits, influences on the habitat, and values to their owners.

3. Animals should be moved from place to place according to the seasonal production of herbage plants and the plants' capability to withstand grazing, so as to allow regeneration of plant growth and re-seeding.

4. Elimination or suppression of undesirable plant species has to be achieved, by proper grazing management and plant control.

5. Soil-conserving practices must be instituted, to conserve water and halt erosion.

6. Natural pastures should be enriched, through the use of trenches and flood banks in areas of natural flooding.

7. Destruction of range vegetation for cultivation by agriculturists should be strongly opposed. The replacement of deep-rooted indigenous range plants by farmers with their shallow-rooted crop plants that transpire less water exposes the land to salinisation. Moreover, in situations where climatic conditions do not favour arable farming, farmers will abandon the land and expose it to wind and water erosion.

8. Restrictions should be placed on cattle numbers. Restrictions should also be placed on cattle owners who use communal grazing lands in order to make every owner responsible for range management and development on the land he or she uses. The primary reason pastoralists own large numbers of livestock is because they consider that to be a measure of wealth that imparts prestige. They also use livestock as insurance for securing their livelihood at times of disaster or for a bride price or dowry. If not controlled, excessive livestock numbers inevitably lead to land degradation.

9. In communal grazing lands, livestock numbers now almost always exceed the potential stocking capacity. Hence over-grazing dominates and de-stocking becomes difficult to achieve. Under such conditions effective approaches must be devised in order to modify the land-tenure system and the social structure of the livestock owners before promoting new range-management practices.

10. Fast-growing and drought-tolerant multi-purpose trees must be planted in those semi-arid and arid areas that have lost their vegetation because of excessive tree felling. Such trees can serve as shelterbelts to reduce the speed of violent winds to a tolerable level. Shelterbelts also provide feed and cover for domestic and wild animals. They will additionally serve as a benefit and source of income by providing fuelwood and meeting the energy requirements of the community.

11. The introduction of new techniques and equipment to dryland ecosystems should be given great attention, as the misapplication of modern innovations can have a great impact on the fragile soils of arid and semi-arid lands and on the livelihoods of the local people.

12. Improving livestock quality through applicable breeding programmes should be promoted so as to increase milk and meat yields.

B.7.4 The Human Aspect

Generally speaking, desertification is a human problem, and measures to combat it must ultimately be directed towards people, sustaining and improving their livelihoods. The willing participation of local communities needs to be assessed if the measures to combat desertification are to be successful. The involvement of the community must be sought in advance. There is need to work through the existing livelihood systems and established social patterns. In order to obtain a more precise understanding of the state of people in the dry lands, surveys should be conducted concerning their demographic characteristics, the state of their health, and their social and economic circumstances.

B.7.5 Role of the MoA Department of Animal Resources

The only Government institution responsible for the management and development of rangelands is the MoA Department of Animal Resources. The major resources of rangelands are land, livestock, vegetation, and water. Other resources, which are less utilised at present, are mineral and human resources. The MoA Department of Animal Resources is undertaking the following management and development programmes to efficiently utilise and increase the productivity of rangelands:

1. Establishment of enclosures in highly deteriorated areas in order to restore the native grass and woody species.

2. Establishment of pilot rangeland management schemes. The purpose of these schemes is to control further degradation and to enhance the proliferation of palatable plant species. This is done by fencing in a potential area, harvesting seasonal rivers, and developing wells.

3. Establishment of forage-production and seed-multiplication stations in different agro-ecological zones of Eritrea. The aims are to acquaint livestock owners with highly productive forage species and to collect the seeds of highly desired plants for re-seeding or over-sowing.

4. Development of communal grazing lands by diverting seasonal streams and rivers for use by the communities.

5. Development of livestock routes, markets, and watering points.

6. Establishment of veterinary clinics and regional laboratories in order to control the economically important livestock diseases.

B.7.6 Management of Resources by Livestock Keepers

In addition to the above-mentioned management practices, livestock keepers also have their own systems of conserving and developing rangelands. Some of those practices are:

- Protecting highly desired or respected browse trees and shrubs, such as *Acacia tortilis*, *A. nilotica*, and desert date (*Balanites aegyptiaca*) from being cut down. This is done because those plants are an important source of shade and feed during the most critical season, *Hagay*

(the October-February dry season);

- Protecting the cutting of riverine woodlands located along the sides (embankments) of the main seasonal rivers, whether for fuelwood or commercial farming. The livestock keepers do this because the trees and shrubs ('trubs') in question are important sources of feed during *Hagay* (the October-February dry season); and also to avoid destroying the fragile riverbank soils; and

- Migrating to neighbouring countries in search of water and forage. This helps to minimise the pressures inflicted on the limited feed resources of their rangelands; and also to help avoid further deterioration through soil compaction, brought about by the trampling of livestock hooves, which reduces the capacity of the soil to absorb water, thereby causing runoff and erosion.

B.7.7 Rangeland Laws, Regulations, and Institutional Arrangements

Priority actions with reference to rangeland laws, regulations, and institutional arrangements include:

- Revising and updating the existing customary (traditional) laws on the utilisation and management of communal grazing lands;

- Reviewing and updating the existing land tenure system of the CHZ, based on the Land Reform Proclamation (No. 58/1994); and

- Developing regulations that encourage livestock owners to keep livestock numbers that do not exceed the carrying capacity of the rangeland.

B.7.8 Monitoring of Rangelands

Monitoring the status of dryland ecosystems regularly is vital in order to provide early warning of adverse range trends, to identify those rangelands in which unfavourable change is taking place, and to provide a basis for investigating the causes and processes of rangeland degradation. It will only be in terms of such information that measures for prevention or reclamation can ultimately be designed and instituted.

B.7.9 Issues that Need International Co-operation

Since desertification is a global problem, monitoring and the exchange of information and data should be carried out regularly on a worldwide basis. This could be achieved through direct linkages with international offices and organisations, *e.g.*, with the Regional Office for Mapping & Remote Sensing (RMRS) in Nairobi, which serves central, eastern, and southern African countries. Among other services, RMRS provides member states with satellite maps. Both RMRS and IGAD could provide satellite information on the changes in plant cover, soil type, and water conditions of the regional dryland ecosystems. However, the information obtained from satellite maps should be checked on the ground.

B.8 HUMAN-SETTLEMENT ISSUES

B.8.1 Urban Development and Growth

Eritrea is predominantly a rural society and only *circa* 22% of the population live in urban areas (see Table B.20): primarily in Asmara (with a population of *circa* 487 thousand), Keren (*circa* 71 thousand), Assab (*circa* 57 thousand), and Massawa (*circa* 39 thousand). Another 10% of the population live in secondary urban centres. The predominance of Asmara in the urban hierarchy is evident, as about one out of two Eritrean urban dwellers lives there. Despite minimal investments in urban infrastructure over the past 20 years, the management of urban services is not currently a significant problem, although it is likely to become one in the foreseeable future. Estimated urban growth rates of 5.0%/year will lead to a doubling of those populations in only 14 years – and they could, of course, be even more rapid than that. Consequently, considerable investment will be required to prevent a further deterioration of infrastructure and to meet the needs of these growing populations. The large demands for urban housing are currently not being met, and although the existing urban-services infrastructure can cope reasonably well with existing demands based on current housing stocks, they would be inadequate for meeting the significantly

greater demands implicit in the expected population increases and planned programmes of investment and expansion.

B.8.1.1 The City and the Hinterland: Accord or Discord?

In discussing human settlements and desertification, two opposite axioms come to mind:

> ***The first axiom*** suggests that Towns, particularly when they sprawl and spread without control or restraint, despoil Eritrea's countryside and cause land degradation. Towns appear to be the very antithesis of pastoral areas. In the wake of major urban sprawl, or even of small-town growth, the land is stripped of its vegetational cover, soil characteristics are changed, productive agricultural land is covered with asphalt or other paving material, and watercourses and flood patterns are modified. The city is a precursor of land degradation. The powerful economic base of the city seems to subdue agriculturally based economies. With urbanisation, land values increase, encouraging conversion of agricultural land to housing and infrastructure. Without deliberate and concerted community control, agricultural lands in the vicinity of urban areas quickly disappear. An unfettered market approach as a means of allocating scarce resources means that land will all be allocated to its highest bidder. Agricultural land cannot compete with residential land. The Town destroys self-reliant agricultural subsistence livelihoods without necessarily replacing them with any alternative economic activity. The city is a voracious consumer of natural resources, *e.g.*, of fuelwood. In return, the city sends its wastes to the rural areas.
>
> ***The second axiom*** suggests that Towns are complementary to rural areas. They provide the first fallback position to rural areas under stress. They become centres of refuge to migrants, providing employment and specialised services for rural dwellers, both farmers and pastoralists. They act as relief valves for the population pressures that often build up in farm or pastoral areas.

We shall examine data, albeit incomplete, corroborating or disproving those two opposing axioms. However, before doing so, it may be useful to briefly review the nature of urbanisation in Eritrea. The accompanying tables give an indication of the size and distribution of the urban populations of Eritrea by *Zoba* (see Tables B.20 & B.21).

Table B.20 Urban Population Sizes and Distributions by *Zoba* (2002)

	Name	Population (No.)	Urban area (ha)	Green area (m^2/*capita*)
	***Zoba* Maekel**			
1	(*Mai* Temenai area)	4,960	55.78	2.3
2	Asmara	487,440	7,000.	[na]
	Sub-total	**492,400**	**7,056.**	
	***Zoba* Semenawi Keyih Bahri**			
3	Massawa	39,040	692.16	[na]
4	Ginda	19,910	328.	[na]
5	Nefasit	4,010	82.	[na]
6	Gahtelai	2,550	128.	[na]
7	Huntublo	6,210	106.	211.
8	Afabet	24,820	303.62	151.
9	Nakfa	17,420	415.5	309.
	Sub-total	**113,960**	**2,055.**	
	***Zoba* Debub**			
10	Segeneiti	7,400	101.71	331.81
11	Mendefera	24,640	581.27	[na]
12	Dekemhare	26,220	616.46	[na]
13	*Adi* Quala	11,470	315.30	[na]
14	*Adi* Keyieh	2,150	41.3	237.
15	Senafe	15,580	327.	[na]
16	Dbarwa	5,800	163.	[na]
	Sub-total	**93,260**	**2,146.**	
	***Zoba* Anseba**			
17	Keren	71,230	?	[na]
18	*Adi* Tekelezan	12,320	296.04	[na]
	Sub-total	**83,550**	**296.**	
	***Zoba* Debubawi Keyih Bahri**			
19	Assab	56,660	?	[na]
	Sub-total	**56,660**	**?**	
	***Zoba* Gash-Barka**			
20	(Agordat)	5,150	84.47	203.
21	(Barentu)	10,650	574.85	7.8
22	(Tesseney)	37,770	454.48	149.
	Sub-total	**53,570**	**1,114.**	
	Grand total	**893,400**	**12,667.**	

Note: For the areas of Eritrea's six *Zobas*, see Table B.21.

Source: Modified from DoTP (1999), being based on an estimated urban growth rate since 1997 of 5.0%/year.

Table B.21 *Zoba* Areas and Urban Hierarchy (2002)

No.	*Zoba*	Area (thousand ha)	Area (%)	Urban population (No.)	% of national urban population
1	Maekel	143	1.2	492,400	55.1
2	Semenawi Keyih Bahri	852	6.9	113,960	12.8
3	Debub	2,258	18.2	93,260	10.4
4	Anseba	3,405	27.4	83,550	9.4
5	Debubawi Keyih Bahri	3,387	27.2	56,660	6.3
6	Gash-Barka	2,387	19.2	53,570	6.0
	Total	**12,432**	**100**	**893,400**	**100**

Note: For areas of the various land-use types, see Table A.1.
Source: Table B.20.

The urban primacy of *Zoba* Maekel (which contains Asmara) is very marked. *Circa* 55% of the urban population of Eritrea lives in Asmara (see Table B.20). It follows that the relationship of urbanisation to desertification will be most pronounced in *Zoba* Maekel. One indicator of this relationship is the source of fuelwood for Asmara's population. The extent to which Asmara depends on the other *Zobas* for its fuelwood supply might be an indication of the extent to which desertification is induced in the other *Zobas* (see Table B.22).

Table B.22 Sources of Fuelwood for Asmara by *Zoba* (2002)

No.	Source	Amount of fuelwood imported (tonnes/year)	%
1	*Zoba* Gash-Barka	96,800	51
2	*Zoba* Anseba	77,440	40
3	*Zoba* Debub	9,680	5
4	*Zoba* Semenawi Keyih Bahri	5,808	3
5	*Zoba* Maekel	1,936	1
6	*Zoba* Debubawi Keyih Bahri	0	0
	Total	**191,664**	**100**

Note: For the areas of Eritrea's six *Zobas*, see Table B.21.

B.8.1.2 Conversion of Agricultural Land for Urban Development

Eritreans have always built their Villages and Towns away from agricultural land. Invariably these have been located either on hilly ground unsuitable for tillage or on land that is barren and unproductive. However, in recent times Towns seem to be encroaching on rich agricultural lands. Two factors account for this recent development:

First, population growth in small Towns has been dramatic and intense. The pace at which

it is taking place does not always permit other alternatives for the needed urban expansion; and

Second, nearly all Villages and small Towns are located in the vicinity of agricultural land, even when the Village boundary is confined to barren land. As the Village or small Town grows, it begins to encroach on arable land. In the past, Villagers were extremely careful to consider land capability when deciding where and how Villages were to grow. The local knowledge and the good practices it fostered seem to have disappeared.

Estimates of agricultural land lost to urbanisation:
Estimates of amounts of agricultural land converted to urban development are not likely to be very reliable. In estimating this parameter, it is assumed that there is a positive correlation between urban population growth and urban area growth. Below are presented three alternative estimates based on that assumption and on the further assumption that urban population growth rate will progress at 5.0%/year for the next two decades (see Figure B.1):

1. The ratio between urban population growth rate and urban area growth rate is 1, *i.e.*, urban areas grow at the same rate as the urban population. Under this assumption extensive amounts of agricultural land are likely to be converted.

2. The ratio between urban population growth rate and urban area growth rate is 0.5, *i.e.*, urban areas grow at one-half the rate of the urban population. Under this assumption moderate amounts of agricultural land are likely to be converted.

3. The ratio between urban population growth rate and urban area growth rate is 0.25, *i.e.*, urban areas grow at one-quarter the rate of the urban population. Under this assumption minimum amounts of agricultural land are likely to be converted.

The analysis indicates that conversion of agricultural land for human settlements is not as significant as might appear initially. The totals for five *Zobas* are as follows (unfortunately there is no information on *Zoba* Debubawi Keyih Bahri):

- At a 5.0% rate of growth for urban areas (*i.e.*, the first option), arable land converted to human settlements would be 3500 ha, *i.e.*, 0.8% of the total arable land of Eritrea (439 thousand ha) (see Figure B.2).

- At a 2.5% rate of growth for urban areas (*i.e.*, the second option), arable land converted to human settlements would be 1665 ha, *i.e.*, 0.4% of total arable land (see Figure B.3).

- At a 1.25% rate of growth of urban areas (*i.e.*, the third option), arable land converted to human settlements would be 817 ha, *i.e.*, 0.2% of total arable land (see Figure B.4).

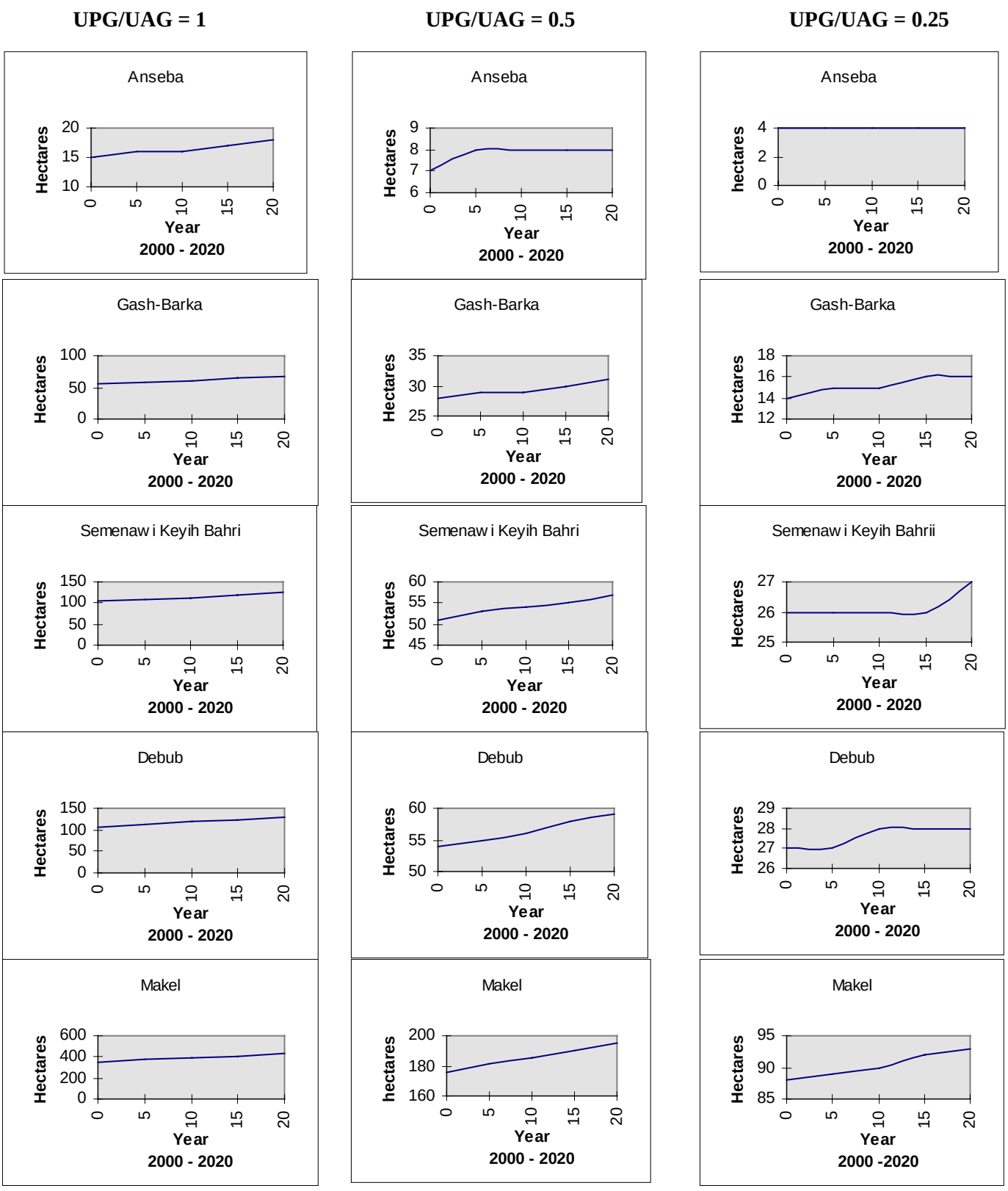
Having found that only a tiny fraction of Eritrea's arable land is likely to be lost to urban expansion over the next few decades, it does not mean that there are no problems being faced or that there are no groups which may be adversely affected by conversion of agricultural land to urbanisation.

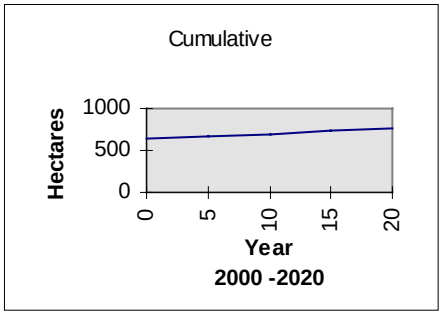
Zoba Maekel will contain more than half of the agricultural land likely to be converted to human settlements. This is clearly an indication of the primacy of Asmara in the urban hierarchy. Therefore, in

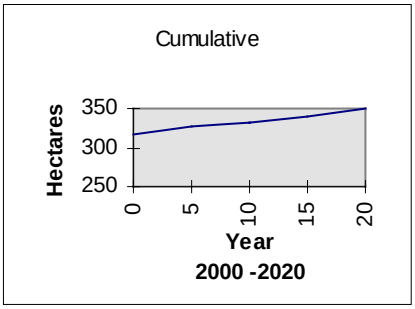
terms of policy orientation, concentrating on *Zoba* Maekel would be the most logical approach when addressing conversion of agricultural land to human settlements. Thus, there is need for further research to determine whether competition for land use between agriculture and housing, particularly around Asmara, is causing landlessness. Landlessness has never been a problem in Eritrea, but may now become one. The loss of land in subsistence agriculture must be equated with the loss of livelihood.

Clearly there is a great deal that needs to be researched on conversion of agricultural land to urban uses particularly in the vicinity of Asmara. What will happen to the inhabitants of the 13 Villages recently incorporated into the municipal boundary would be a good case-study to undertake. An important research question here is to determine if those who lose their agricultural source of livelihood are able to obtain alternative livelihoods. Tenure transformation could cause much difficulty to the most vulnerable in the society, *e.g.*, women: (a) women have fewer alternative livelihood options when faced with loss of land for farming; and (b) when women drop out of agriculture they are more likely to lose their means of livelihood.

Figure B.1 Projections of Agricultural Land Converted to Human Settlements by *Zoba* (2000-2020): Urban Population Growth/Urban Area Growth (UPG/UAG) = 1 or 0.5 or 0.25




Cumulative
Hectares
1000
500
0
0
5
10
15
20
Year
2000 -2020


Cumulative
Hectares
350
300
250
0
5
10
15
20
Year
2000 -2020

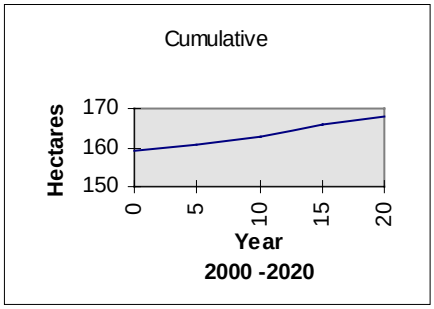

Cumulative
Hectares
170
160
150
0
5
10
15
20
Year
2000 -2020

Figure B.2 Projections of Agricultural Land Converted to Human Settlements by *Zoba* (2000-2020): Urban Population Growth/Urban Area Growth (UPG/UAG) = 1

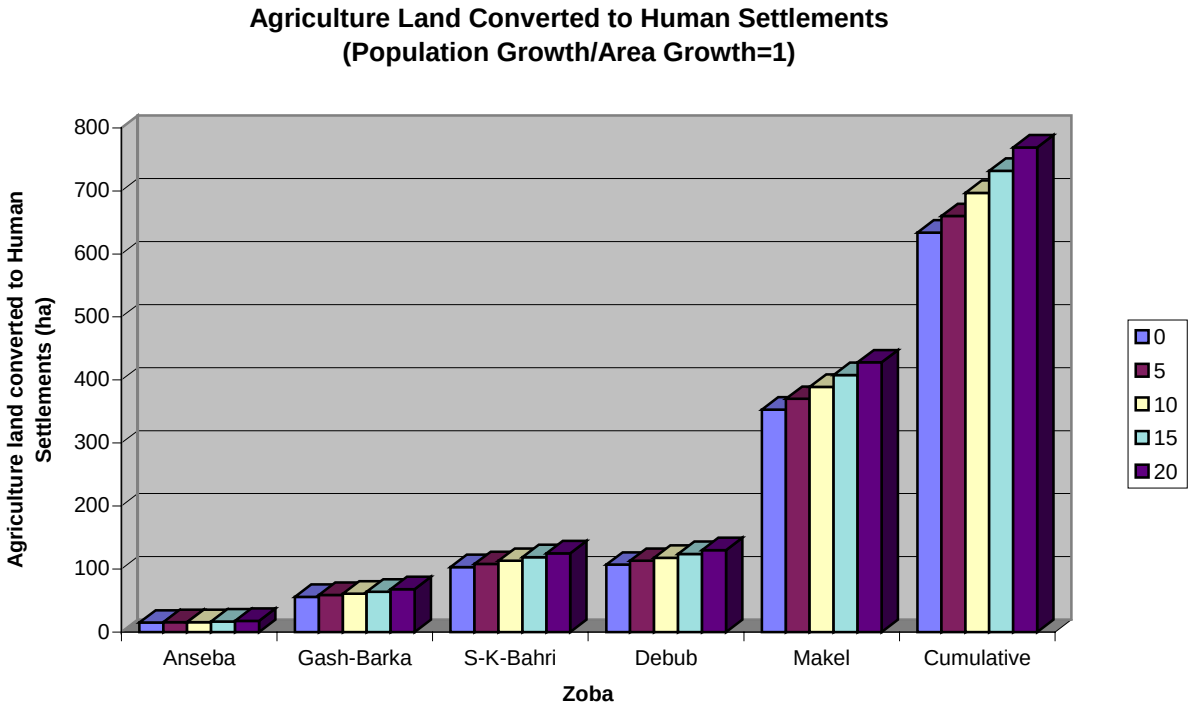


Figure B.3 Projections of Agricultural Land Converted to Human Settlements by *Zoba* (2000-2020): Urban Population Growth/Urban Area Growth (UPG/UAG) = 0.5

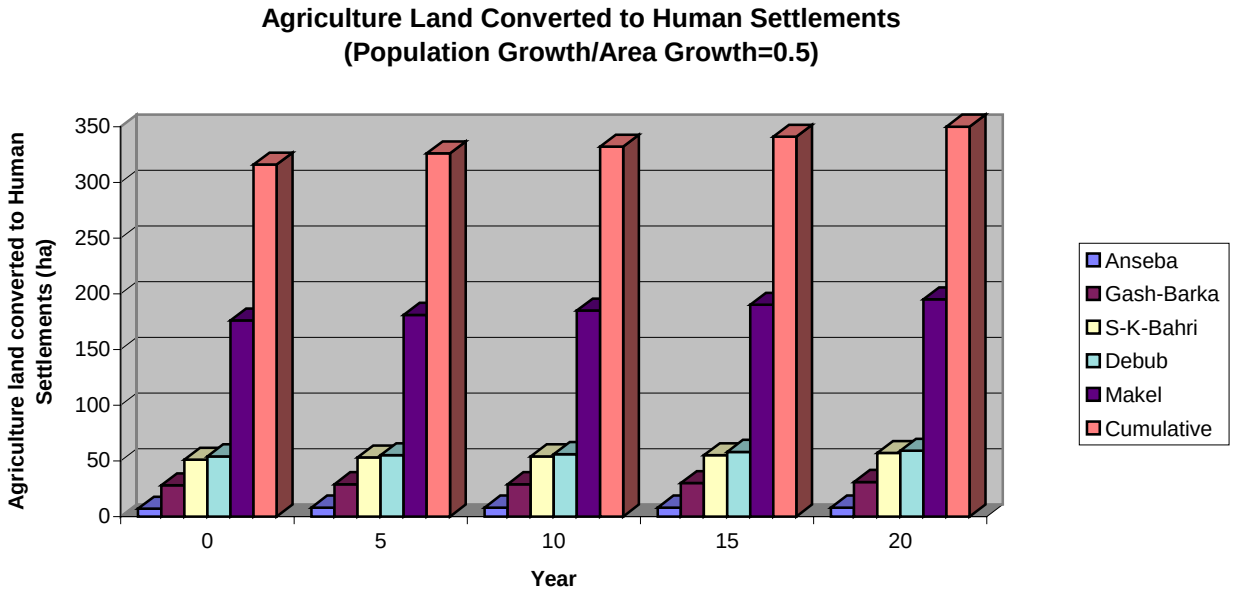
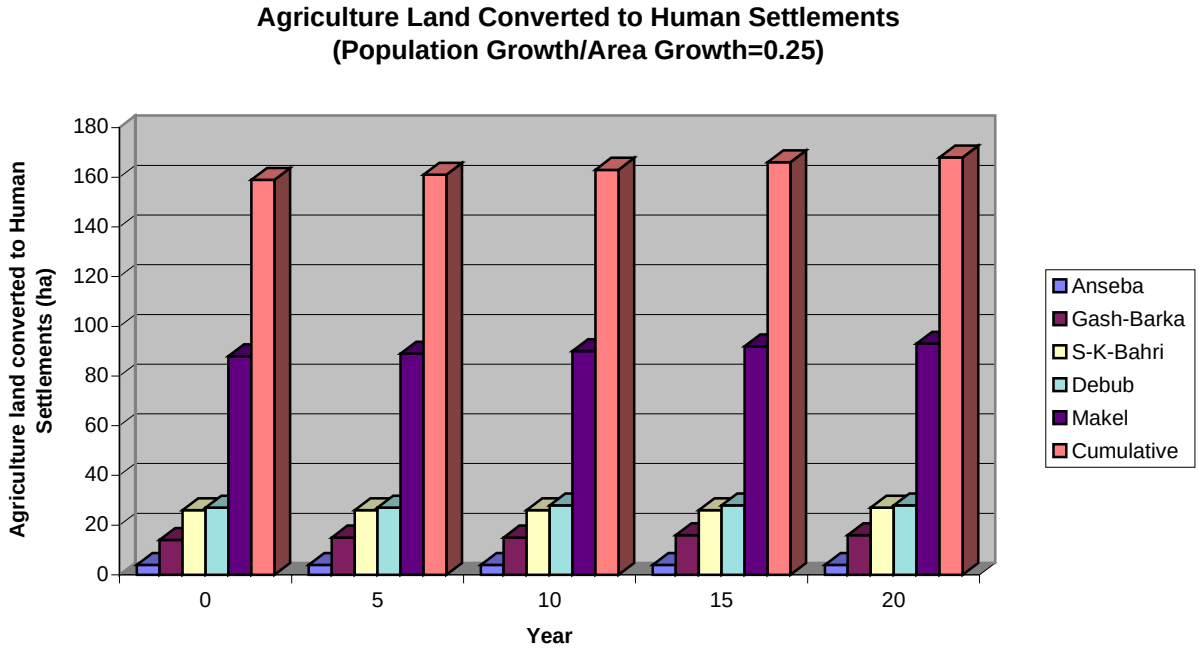


Figure B.4 Projections of Agricultural Land Converted to Human Settlements by *Zoba* (2000-2020): Urban Population Growth/Urban Area Growth (UPG/UAG) = 0.25



B.8.2 Urban Agriculture

In Eritrea not much consideration has been given to the issue of urban agriculture. Indeed, there may be a bias against it, as occasionally municipal officials express reservations about farming and livestock-keeping within city limits. We hear of plans to relocate urban dairy farms (*Stallas*), and we note a general concern about recycling of wastewater for urban agriculture, *e.g.*, in *Mai* Bela.

The bias against raising food in the urban setting in Eritrea may be a recent phenomenon, perhaps from the time of colonial administration when modern Town planning concepts were introduced. Eritreans seem to have grown crops and kept livestock within their living areas for millennia. Recent archaeological discoveries around present-day Sembel attest to this. Hundreds of years ago around Asmara advanced farming and livestock-keeping were practised. Indeed, Eritrea is not alone in this. Food production has always been an important activity in the more advanced urban settlements of ancient civilisations, *e.g.* at Uruk (Iraq), Thebes (Egypt), Akhetaton (Egypt), Vulubilis (Morocco), Tlatelolco (Mexico), and Tecuman (Guatemala); Mexico's ancient artificial agricultural islands (*Chinampas*) should also be noted here. Eritrea's ancient farming community might conceivably be in the same class as those just mentioned. But now in the 21st century, we seem to ignore the potential of urban agriculture. Indeed, as in many other countries, we now seem to discredit, discriminate, harass, and even outlaw urban agriculture – even when the avowed national policy is to grow

more to achieve food security.

There are compelling reasons why urban agriculture, also called urban food production, should be encouraged in Eritrea:

- Urban agriculture provides an effective means of meeting nutritional requirements for the urban poor. For example, in India 6 m^2 of space is considered enough to grow all the vegetable needs for a family of four, and 200 m^2 is said to provide one-third of all food intake for a family of five.

- Worldwide in 1995, 15%-20% of world food requirements were raised in urban areas. By 2005, one-quarter to one-third of world food requirements are expected to be raised in urban areas.

- Increases in urban hunger are now very serious throughout the world. It is as if food were no longer a basic need for the urban poor, but rather a luxury. In Kenya food accounts for 40%-50% of average income. In the Democratic Republic of the Congo the figure is 67%. In the least developed countries generally it is 50%-80%. By contrast, in the richer countries, such as the USA, food accounts for only 9%-15% of average income.

- Food prices in urban areas are typically 10%-30% higher than in the rural areas.

- Food insecurity is becoming more acute in urban areas. Urban vulnerability to food shortages is also becoming more acute.

The above statistics indicate that there is a pressing need for local authorities to change their attitude to city farming. Singapore, a city much admired for setting a progressive example, has been able to meet its entire requirement for meat without importing anything from the outside. Both Singapore and Hong Kong consume 70 kg/*capita*/year of poultry and other meat. Singapore, the quintessential city, was able to meet its requirements by organising urban agriculture. If a city-state such as Singapore is able to do so, there is no reason why the urban centres of Eritrea, in particular Asmara, are not able to engage in urban farming.

In short, the option of doing nothing about urban agriculture is not reasonable. Equally, stamping out urban agriculture is not a viable option. The only sensible alternative is to adopt a policy of regulating and promoting urban agriculture.

B.8.3 Urban Settlements and Pastoralism

In Eritrea, preliminary evidence seems to indicate the existence of a positive synergy between small Towns and pastoral communities:

- Small urban centres function as safety valves for pastoralists against negative effects of increased population pressures and against prolonged drought.

- During difficult periods, such as during periods of prolonged drought, pastoralist households have been known to send an occasional member to urban centres in

order to relieve the burden of feeding an extra mouth.

- Small urban centres offer increased monetary income to rural populations through trade.

- From the pastoralist perspective, the small Town forms an asset, providing temporary employment in the wage-earning market.

- Pastoralists normally have to go to Town for a few weeks each year in order to earn cash for purchasing coffee, tea, and sugar.

Risk and risk-spreading:
The pastoral way of life is very risky even during the best of times. Population pressures, drought, changes in land use, diminishing grazing lands, and the decreasing productivity of the land all increase the risk of survival in the rural setting. In this context, the presence of a vibrant small Town provides an opportunity for risk-spreading through the multiplicity of alternative economic activities. Access to relief through 'food-for-work' or 'cash-for-work' programmes is facilitated by the very presence of small Towns.

Eritrean experience indicates that most pastoralists stay in Town for short periods with the hope of rebuilding family herds. When that is accomplished they nearly all return to the nomadic way of life. In the event of longer stays, it seems that pastoralists become Town dwellers (*i.e.*, traders, wage earners) rather than farmers.

Town pastoralists:
The concept of the absent pastoralist, or Town pastoralist, has been a concern of some scholars. A Town pastoralist is a livestock owner who settles permanently in Town, employs herders, and exploits a system with private herds on collective land. This differs sharply from the more typical pastoralist, who comes to Town temporarily to earn a cash income. The prevalence of Town pastoralists is not clearly known in Eritrea. But in terms of policy orientation, it would be appropriate to ensure that Town pastoralists do not exploit both the rural and urban economies and take unfair advantage of the traditional rural-based pastoralists. Eritrean policy is likely to regard Town pastoralists in the same light as absentee landlords.

B.8.4 Conclusion and Policy Orientation

As to human-settlement issues:

- There is no *prima facie* evidence connecting urbanisation with land degradation – indeed, there seem to be positive links between small Towns and the pastoralist lifestyle.

- There is little evidence to indicate that the conversion of agricultural land to human settlements is a significant problem in Eritrea. However, given the limited amount of arable land in Eritrea, urban expansion should be sensitive to the preservation of such lands.

- Cities, particularly Asmara, should minimise their dependence on the hinterland *Zobas* for their fuelwood supplies, *inter alia*, by improving energy efficiency and by encouraging alternative sources of domestic energy.

- Urban agriculture should become an important activity and local authorities should begin to regulate and promote it.

B.9 DROUGHT-PREPARDENESS ISSUES

B.9.1 Background

Drought is a common phenomenon in Eritrea. However, it is less common in its more dramatic forms, namely a catastrophe ending in massive starvation. Because the coping mechanisms of Eritrean society are well established, the catastrophic impact of drought is less frequent in Eritrea than in Ethiopia or in the Sahelian Zone of East Africa in general.

Drought has always been a regular part of the natural cycle that affects dry lands. Human activity has exacerbated the effects of drought in many parts of the world. For example, in the USA in the 1930s poor agricultural practices converted especially that country's south-western prairies (grasslands) into a 'dust bowl'. This has been considered to be one of the worst environmental disasters of modern times. The Sahelian drought of the 1970s dislocated the economies of the Sahelian countries. Blame for the dust bowl has generally been fixed on poor farming techniques and land mismanagement, just as agricultural and water mismanagement, together with social and economic factors, have been blamed for the famines in the Sahelian Zone of East Africa during the 1970s.

B.9.2 Climate Variation and Drought

The six *Zobas* of Eritrea are all dry to a greater or lesser extent, two (Maekel, Debub) being classified as dry sub-humid, three as semi-arid (Gash-Barka, Anseba, Semenawi Keyih Bahri), and one (Debubawi Keyih Bahri) as arid (see Table B.23). However, there is a dearth of detailed information on drought and aridity for Eritrea. As an indication, the recent UNDP-UNSO report on *Aridity Zones and Dryland Populations* fails to include any data on Eritrea, even though 47 of the 52 African countries were included (UNDP-UNSO, 1997). Nevertheless, some data of use to Eritrea could be extrapolated from it based on neighbouring countries having similar conditions.

Table B.23 Aridity Indices for Eritrea by *Zoba*

Zoba	Aridity index	Length of growing period (days)	Typical crops
Maekel	0.50-0.65 (Dry sub-humid)	120-179	Maize, beans, barley, wheat, teff
Debub	0.50-0.65 (Dry sub-humid)	120-179	Maize, beans, barley, wheat, teff
Gash-Barka	0.20-0.50 (Semi-arid)	60-119	Bulrush-millet, sorghum, sesame
Anseba	0.20-0.65 (Semi-arid)	60-119	Bulrush-millet, sorghum, sesame
Semenawi Keyih Bahri	0.20-0.65 (Semi-arid)	60-119	Bulrush-millet, sorghum, sesame
Debubawi Keyih Bahri	0.05-0.20 (Arid)	1-59	No crops, marginal pasture

Notes: (a) The Aridity Index is calculated as 'mean annual precipitation' divided by 'mean annual potential evapo-transpiration', both expressed in the same units, *e.g.*, mm/year.

(b) Bulrush-millet (*Pennisetum glaucum typhoideum*) is a variety of pearl-millet (*P. glaucum*).

Long-term climatic data for Eritrea indicate three important factors affecting agriculture and land degradation:

First, Eritrea's water-balance – the gap between potential evapo-transpiration and rainfall – has been steadily worsening over the past century. In fact, rainfall exceeds potential evapo-transpiration during only two months of the year, namely July and August.

Second, Eritrea has experienced a decrease in rainfall over the past century. The 1905-1995 data suggest that rainfall has been declining, on average, by *circa* 0.4 mm/year.

Third, the period between onset and cessation of the rainy season has been getting shorter over the past century, thereby reducing the annual growing periods.

B.9.2.1 Relationship between *El Niño* Events and Drought Occurrence

An attempt is made here to answer the question of whether there is a discernible relationship in Eritrea between the occurrence of drought and *El Niño* events. *El Niño* refers to the naturally recurring phenomenon of a warming of surface waters in the entire equatorial zone of the central and eastern Pacific Ocean off the Peruvian coast, and which affects atmospheric circulation worldwide. It usually peaks around the time of Christmas, thus coinciding with the celebration by Christians of the birth of Christ – hence the name '*El Niño*', which is Spanish for 'the child' in reference to the Christ child.

Like many normal atmospheric phenomena, *El Niño* occurs at more or less regular intervals (pseudo-cycles). Major *El Niño* events were recorded in: 1877, 1918, 1925, 1940, 1941, 1957, 1958, 1965, 1968, 1969, 1972, 1973, 1976, 1977, 1982, 1983, 1986, 1987, and 1997. The accompanying three tables provide rainfall data from the Asmara Meteorological Station during all 16 of the *El Niño* years during the 58 inclusive years 1940-1997, comparing these with the mean rainfall for the 66 inclusive years 1932-1997 (see Tables B.24, B.25, & B.26).

Table B.24 Mean Annual (January-December) Rainfall at Asmara (1940-1997)

No.	*El Niño* year	Annual rain (mm)	% of normal	Below normal	Normal	Above normal	
1	1940	503.8	97		■		
2	1941	326.0	62	■			
3	1957	469.6	90		■		
4	1958	478.3	92		■		
5	1965	441.7	85		■		
6	1968	390.3	75	■			
7	1969	208.7	40	■			
8	1972	381.2	73	■			
9	1973	367.7	70	■			
10	1976	526.2	101		■		
11	1977	803.2	154			■	
12	1982	688.7	132			■	
13	1983	448.1	86		■		
14	1986	489.0	94		■		
15	1987	559.2	107		■		
16	1997	688.6	132			■	
	Mean/Total	**485.6**	**93**	**5 of 16**	**8 of 16**	**3 of 16**	
	%			**31**	**50**	**19**	

Note: '% of normal' is based on the mean annual rainfall for the 66 inclusive years 1932-1997, which is **521.7 mm**. 'Below normal' refers to <75% of normal. 'Normal' refers to 75%-125% of normal. 'Above normal' refers to >125% of normal.

Mean Annual (January-December) Rainfall at Asmara

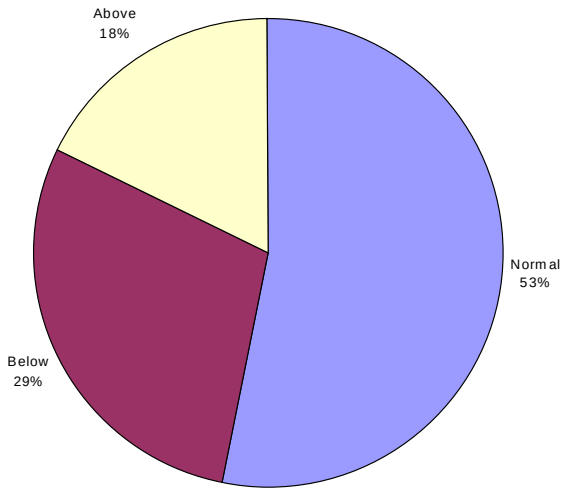


Table B.25 Mean *Akeza* (March-May) Rainfall at Asmara (1940-1997)

No.	*El Niño* year	Annual rain (mm)	% of normal	Below normal	Normal	Above normal	
1	1940	142.1	110		■		
2	1941	81.4	63	■			
3	1957	128.0	99		■		
4	1958	81.9	64	■			
5	1965	114.6	89		■		
6	1968	182.4	142			■	
7	1969	32.4	25	■			
8	1972	97.6	76		■		
9	1973	85.9	67	■			
10	1976	91.3	71	■			
11	1977	152.8	119		■		
12	1982	231.5	180			■	
13	1983	112.4	87		■		
14	1986	132.3	103		■		
15	1987	251.6	195			■	
16	1997	303.6	236			■	
	Mean/Total	**138.9**	**108**	**5 of 16**	**7 of 16**	**4 of 16**	
	%			**31**	**44**	**25**	

Note: '% of normal' is based on the mean annual rainfall for the 66 inclusive years 1932-1997, which is **128.9 mm**. 'Below normal' refers to <75% of normal. 'Normal' refers to 75%-125% of normal. 'Above normal' refers to >125% of normal.

Mean *Akeza* (March-May) rainfall at Asmara

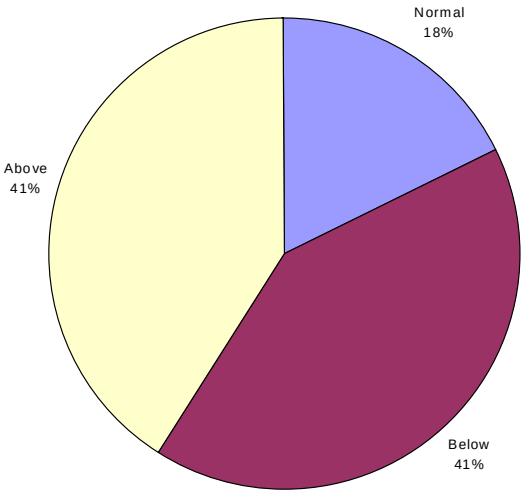
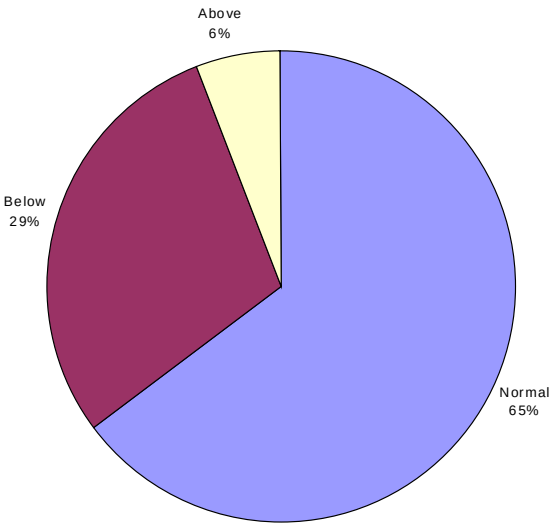


Table B.26 Mean *Kremti* (June-September) Rainfall at Asmara (1940-1997)

No.	*El Niño* year	Annual rainfall (mm)	% of normal	Below normal	Normal	Above normal	
1	1940	361.7	92		■		
2	1941	244.6	62	■			
3	1957	341.6	87		■		
4	1958	396.4	101		■		
5	1965	327.1	83		■		
6	1968	207.9	53	■			
7	1969	176.3	45	■			
8	1972	283.6	72	■			
9	1973	281.8	72	■			
10	1976	434.9	111		■		
11	1977	650.4	166			■	
12	1982	457.2	116		■		
13	1983	335.7	85		■		
14	1986	356.7	91		■		
15	1987	307.6	78		■		
16	1997	385.0	98		■		
	Mean/Total	**346.8**	**88**	**5 of 16**	**10 of 16**	**1 of 16**	
	%			**31**	**62**	**6**	

Note: '% of normal' is based on the mean annual rainfall for the 66 inclusive years 1932-1997, which is **392.8 mm**. 'Below normal' refers to <75% of normal. 'Normal' refers to 75%-125% of normal. 'Above normal' refers to >125% of normal.

Mean *Kremti* (June-September) rainfall at Asmara



Conclusion:
The data presented here show that the mean annual (January-December) rainfall in Asmara of 485.6 mm for the 16 *El Niño* years which occurred during the 58 years 1940-1997 was 7% below the mean annual rainfall of 521.7 mm for the 66 years 1932-1997 (see Table B.24). Looked at another way, the mean annual rainfall was at least 25% below normal for 5 of the 16 *El Niño* years during the period 1940-1997, as compared with only 3 of the 16 at least 25% above normal (see Table B.24).

Mean annual rainfall can be split into its two components, what occurs during *Akeza* (the March-May short rainy season) as opposed to what occurs during *Kremti* (the June-September long rainy season). Such disaggregation reveals that the *El Niño*-related shortfall is the result of a drop in rainfall during *Kremti* rather than during *Akeza.* Indeed, mean *Akeza* rainfall during those 58 *El Niño* years was 138.9 mm, or 8% above that season's 66 year average of 128.9 mm (see Table B.25). At the same time, mean *Kremti* rainfall was 346.8 mm, or 12% below the latter season's 66 year average of 392.8 mm (see Table B.26).

Mean annual rainfall during the 16 *El Niño* years was quite variable (erratic), the standard deviation of their mean of 485.6 mm being ±148.4 mm. When the annual data are disaggregated into mean *Akeza* rainfall and mean *Kremti* rainfall for those 16 *El Niño* years, it can be seen that the former was much more variable than the latter. The standard deviation of

the *Akeza* mean of 138.9 mm was ±71.5 mm, giving a coefficient of variation of 51%. At the same time, the standard deviation of the *Kremti* mean of 346.8 mm was ±111.2 mm, giving a coefficient of variation of 32%.

All in all, the above preliminary analysis is certainly suggestive of a relationship between *El Niño* events and drought in Eritrea. However, to take this analysis one step further would require that all of the above calculations be repeated for the 42 non-*El Niño* years during 1940-1997. Those data would then have to be compared with the 16 *El Niño* years during that same period and tested to see whether they differed significantly from each other.

B.9.2.2 History of Drought in Eritrea

November to January in some years, and January to March in other years, are the rainy months of *Zobas* Semenawi Keyih Bahri and Debubawi Keyih Bahri. Occasionally rains occur in July and August owing to severe thunderstorms which have drifted off the high ground of eastern Asmara. The period of mid May to mid September is extremely hot in *Zobas* Semenawi Keyih Bahri and Debubawi Keyih Bahri.

Simply speaking, drought is a long period of dry weather. Prolonged droughts will lead to complete crop failure, to the decimation of livestock, and often to widespread starvation of the local population. However, in Eritrea the history of drought and resulting famine is not properly documented. When drought is discussed in Ethiopia it has always been assumed that Eritrea was included. According to the chronology of C.A. Wood and E.O. Oladipo, there were since the 11th century, a substantial number of famines, in many cases suspected to be caused by drought or plague. To cite some of them (Wood & Oladipo, 19__???):

1066-1072: there was a failure of the Nile flood. As a result, a royal ambassador from Egypt was sent to Ethiopia to request of the King of Ethiopia to let the Nile flow to Egypt. This may imply drought in Ethiopia.

1543-1544: A terrible famine, which was said to have been worse than that which occurred at the time of the destruction of the second temple of Jerusalem. People believed that 'God had strengthened the fires of Hell, which devoured the trees, plants, and the earth itself'.

1560-1562: There was no rain for 3 years, especially in Harar, following the killing of Emperor Gelawdiwos.

1820-1830: Drought affected the Sahelian Zone of East Africa, the Ethiopian highlands, and the southern African zone. The flow of the Nile was reported to have been very weak and Lake Chad virtually dried up. There were great failures of both cotton and grain crops, and many cattle died.

1835: Many people of central Ethiopia (Shoa) died following failure of the rains. This is probably the same drought that the people of western Eritrea remember as 'the year of starvation'.

1865: Famine in northern Ethiopia, Tigray, and northern Begemdir (Gonder). A Village of 280 people was reduced to 60.

1880-1884: Drought practically throughout all of Ethiopia.

1888-1892: This was the most devastating famine recorded in Ethiopian history and affected nearly the whole country.

1895-1896: Failure of the *Akeza* (March-May) and Kremti (June-September) rains.
1899-1900: An unrecorded drought manifested through a fall in the level of Lake Rudolf (now Lake Turkana). The Nile flow was also abnormally low that year.
1913-1914: This widespread drought in northern Africa is well documented for the Sudan, and its effect in Ethiopia is indicated by a very low Nile flow (the lowest since 1895). At that time there was great starvation in northern Ethiopia (Tigray).
1924-1926: Failure of rainfall in some regions of Ethiopia.
1932-1934: The level of Lake Rudolf (now Lake Turkana) dropped, implying a serious decrease in rainfall in southern Ethiopia. A drought was recorded in northern Kenya, and in 1934 a relief camp was set up in British Somaliland (now northern Somalia) to aid the drought victims.
1953: Another undocumented drought in central and northern Ethiopia, Wollo, and Tigray.
1956: Drought in the Wollo region of Ethiopia.
1957-1959: More than 10 thousand people in Wollo and Tigray are reported to have died during 1958-1959 following drought and desert locust infestation.
1964-1965: Virtual failure of the *Akeza* (March-May) rains after 2 years of low rainfall. The north-eastern and south-eastern parts of Ethiopia were also affected.
1972-1973: The infamous Wollo and Tigray drought is remembered by many.
1982-1987: Serious drought in the northern Ethiopia.

What emerges from the foregoing drought chronology for Ethiopia is the absence of a clear pattern related to weather fluctuation. However, it is generally believed that the vicious cycle of rain failures in Eritrea occurs once in *circa* 7 years, such periods being closely correlated with years of poor harvest. This has been revealed by the history of drought in Asmara, where continuous meteorological records have been kept since 1896. Although a 7 year cycle of drought is widely accepted, it should not be taken as a definitive forecasting tool for drought years. This is because the complexity of atmospheric phenomena does not permit such simple conclusions. Among climatologists, there are generally two schools of thought concerning the application of weather statistics to contemporary problems. According to the one school, weather events from one year to the next are independent of each other and occur at random. According to the other school, such events relate to cyclic patterns. The important difference between these two schools is that those who adhere to the former see weather events as a static matter needing no further explanation, but those who adhere to the latter must postulate a cyclic forcing function or a dynamic cause.

Eritrea is a country with chronic and severe climatic variations. Analysis of data indicates that the ups and downs associated with climatic variations do not create a consistent pattern, *i.e.*, no 'cyclicity' or 'periodicity' can be discerned. So far there is no viable predictive tool that could be applied to forecasting weather anomalies.

B.9.3 Mitigating the Effects of Drought

B.9.3.1 Drought and Food Security

Indicative of our generally poor food and nutritional conditions, Eritrea is one of the least developed countries, being ranked by the United Nations Development Programme amongst the lowest in its Human Development Index. Contributing to this low rating are Eritrea's

high infant-mortality rate of 135 per 1000 live-births and its under-five child-mortality rate of 203 per 1000 live-births. It is estimated that 46% of under-five children are moderately to severely stunted, and that 44% of them are under-weight. Prolonged exclusive breast feeding and weaning with low-energy foods contribute to the high malnutrition rates of children under two. Equally, *circa* 40% of infants have an inadequate vitamin A status (serum retinal >30%/dL). Prevalence of goiter (indicative of iodine deficiency) in 9-11 year-old children is 22% (19% in girls and 26% in boys). Food availability and intake generally have been below requirements. Chronic and transitory food insecurity have also been prevalent amongst the agro-pastoralist population in several parts of Eritrea over the past decade because of the scarcity of food and accessibility to it during the cultivation periods of the year. Tens of thousands of households in semi-arid and drought-prone areas such as the Sahel and *Zobas* Semenawi Keyih Bahri and Debubawi Keyih Bahri often face severe food shortages. In these areas, food insecurity remains chronic. However, sometimes even areas such as the highlands of *Zobas* Maekel, Gash-Barka, and Anseba, which usually receive relatively high rainfall, also have transitory food insecurity caused by weather. Spotty and erratic rainfall is the major cause of fluctuations in food supplies. In addition, there is a high rate of soil erosion whereby a significant amount of topsoil is washed off by the annual rains. The resulting land degradation reduces soil fertility and productivity of arable lands, further diminishing the capacity of households to attain food security.

B.9.3.2 Traditional Coping Mechanisms

In the local setting, the spirit of community and the practice of sharing equally what is available are probably the most powerful means of coping with the effects of drought. Traditional Eritrean society is renowned for its commitment to egalitarianism and for its spirit of sharing – both traits being common particularly in times of stress. People in mourning are never left alone. Eritreans mourn together. They also celebrate together. They have developed the act of coping in times of stress to a very detailed degree. Destitution is tackled in a co-operative manner. Elaborate communal arrangements help the concerned individual, whether in sadness or in joyful celebration.

To a large degree, the sad spectacle of emaciated or dying children often seen in many African countries is mostly absent in Eritrea – and this is not because the severity of drought and the threat of starvation are any less than in, *e.g.*, Ethiopia. It is simply because the traditional coping mechanism tempers and lessens the more dramatic manifestations of drought and starvation. Eritreans care enough for each other not to let one of their own go hungry to the extent of emaciation or death. This is a national characteristic that is well worth maintaining and strengthening further.

B.9.3.3 Early-warning System and the MoA National Food & Information System (NFIS)

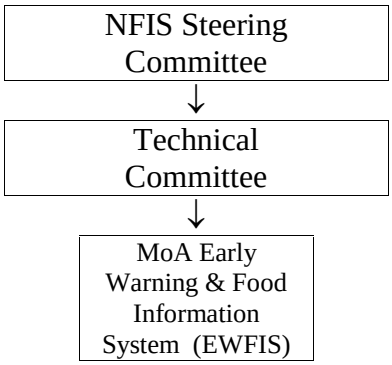
The Government, as part of its formal coping mechanism against drought and starvation, has established a project which aims at strengthening the MoA National Food Information System (NFIS), a part of the MoA Early Warning & Information System (EWFIS). The main intent of NFIS is to make EWFIS fully operational and geared to the needs of decision-makers in terms of the coverage, timeliness, frequency, presentation, and

dissemination of food information.

Although the primary purpose of NFIS is to strengthen EWFIS, once fully established NFIS is also to undertake medium- and long-term data collection and then to organise, process, and interpret those data. This will be done in order to better estimate crop and livestock production, monitor household food security and nutrition, facilitate market transparency, and provide timely inputs for food-relief management. These components will together supply integrated information on *availability* to and *stability* of, access to food. A high-level NFIS Steering Committee is to co-ordinates the system, while the seven institutions represented on the Technical Committee will regularly provide data and information to the system. EWFIS acts as the secretariat of the Technical Committee. It collects and analyses data and information and reports back to the NFIS Steering Committee. EWFIS is also responsible for disseminating relevant information through periodic bulletins: a monthly *Food Information Bulletin* and an annual *Agrometeorological Bulletin*. The Technical Committee is comprised of representatives of the Customs Office, Eritrean Relief & Refugee Commission (ERREC), Eritrean Grain Board (EGB), Ministry of Land, Water, & Environment (MoLWE), Ministry of Agriculture (MoA), Ministry of Health (MoH), and Civil Aviation Authority Department of Meteorology.

The strategy of the GoE project to strengthen NFIS includes three components: (a) cultural monitoring; (b) socio-economic monitoring; and (c) food-relief management. The cultural monitoring component upgrades the capacity to monitor and assess factors affecting planted and harvested crop areas and yields, availability and prices of inputs, crop prices, threat of desert locusts, condition of key food and cash crops, and condition of pastures and livestock. The socio-economic monitoring component establishes systems for monitoring and assessing household food-security strategies, including price of food staples, livestock, and cash crops, and nutrition and population movements. The food-relief monitoring component includes the management of food stocks, flows, and distribution.

Diagram of the present system:



Eritrean Grain Board (EGB):
In Eritrea, large-scale grain storage and distribution are the responsibility of the Eritrean Grain Board (EGB) (see Fact Sheet B.2). The EGB has been established as a public agency with mandates to protect producers and consumers, to stabilise prices, and to establish a national strategic reserve. A further mission of the EGB is to ensure that the staple foods

(primarily wheat and sorghum) are available in all parts of Eritrea at all times at fair and reasonable prices.

The Government of Eritrea has given clear support to the EGB in its mandate to develop the food reserve. It is apparent that GoE considers the development of a food-security reserve under the management of the EGB to be a priority.

The EGB has established a base for the development of a market infrastructure. Warehouses have been built to store supplies in both central and regional locations around Eritrea. A network of agents has been developed to use in the distribution of EGB grain to various areas of Eritrea. Market surveillance has begun, with data on prices now available for all key markets in Eritrea.

In summary, the EGB is entrusted with the following objectives:

- To establish a national grain reserve;
- To intervene in the market when grain prices are exorbitant, so as to stabilise grain prices;
- To give incentives to producers by providing a reasonable and guaranteed price to the producers; and
- To hold emergency food stocks for the prevention of food insecurity in times of drought, flood, pest infestation, and emergencies of human origin.

The EGB also undertakes yearly crop assessment surveys so as to monitor the grain production prospects for Eritrea. Being new, the institutional capacity of the EGB is still in its infancy. To date, this has hindered the EGB from undertaking its mandated operation at full capacity. Hence it is becoming imperative to obtain technical assistance to achieve this goal.

Fact Sheet B.2 The Eritrean Grain Board (EGB)

- ***Establishment and mandate:*** *The EGB was established in 1993 as a public agency with mandates to protect producers and consumers, to stabilise prices, and to establish a national strategic food reserve.*

- ***Business objectives:*** *1. Price and distribute monetised food aid in a manner which maximises the value of this resource in enhancing the food security of all Eritreans. 2. Manage a strategic food-security reserve to ensure that foodstuffs will be available in all parts of Eritrea in the event of emergencies. 3. Ensure fair and reasonable grain prices through time and across* Zobas *by stabilising Eritrean grain prices. 4. Support the enhanced functioning of the Eritrean grain market and development of a food-security policy, through the collection, processing, analysis, and dissemination of market information.*

- ***Warehouses:*** *Warehouses with overall storage capacity of 141 thousand tonnes of grain are available fairly distributed all over Eritrea. Asmara (2 stores),* Adi *Nefas (2* Rub *halls), Dekemehare (1 store), Zigib (13* Rub *halls), Assab (2 stores), Tesseney (2 stores), and Keren (3 stores) are the sites where the warehouses are available with total storage capacity of 9 thousand, 25 thousand, 25 thousand, 75 thousand, 2 thousand, 2 thousand, and 3 thousand tonnes, respectively.*

- ***Importing:*** *The EGB imports from the USA, Canada, & France. The major imported grains are wheat and sorghum.*

- ***Pricing:*** *Market prices in Eritrea are driven by the main variables of local production, commercial imports, EGB sales patterns, and local purchasing power.*

Eritrean Relief & Refugee Commission (ERREC):
The organisation in addition to the EGB with direct linkage to the issue of drought preparedness is the Eritrean Relief & Refugee Commission (ERREC). ERREC is charged and mandated to co-ordinate and implement emergency-programme activities in Eritrea. In responding to humanitarian-emergency needs, ERREC works in co-operation with Local Government institutions, community leaders, local nongovernmental organisations (NGOs), international NGOs, bilateral donors, and the United Nations system.

A key element in the comprehensive emergency-response programme seeks to avoid abnormal mortality and morbidity. At the same time, the programme assists displaced persons in emergency situations to become productive, preventing further deterioration of their condition to stages that might render them permanent dependents.
The overall objective of ERREC is to assist people who are internally displaced, ex-fighters, and those affected by drought. The assistance focuses mainly on the provision of food, nutrition, shelter, water, sanitation, health, emergency education, and agricultural inputs. As it is a member of the MoA Early Warning & Food Information System (EWFIS), ERREC is provided at regular intervals with pertinent information on the food situation, including food prices and weather forecasts.

A food-crisis coping strategy at the household level includes risk minimisation, risk absorption, and risk taking. Risk minimisation and risk absorption include strategies in which households preserve their productive assets in order to be able to recover in another season, after the drought or other emergency is over. Risk taking is a strategy in which households sacrifice future security for present survival. In developing coping mechanisms, the involved institutions such as ERREC and EGB have to consider the situation of the drought-affected people according to this coping strategy.

B.9.3.4 Coping with Insect- or other Pest-infestation Emergencies

Eritrea's coping mechanism against insect infestation, including army worms and desert locusts, needs further strengthening. The MoA Division of Plant Protection carries out various activities in order to avoid crop-failure problems resulting from desert locusts or army worms. The Division's desert-locust and army-worm control programmes are conducted with the close co-operation of different regional and international organisations, including the FAO Desert Locust Emergency Prevention System (EMPRES) and the Desert Locust Control Organisation for Eastern Africa (DLCOEA). EMPRES is involved in all aspects of the desert-locust control programme, including assessment and spraying. DLCOEA assists in the spraying activities by providing aircraft for the desert-locust and army-worm control programmes. In addition, MoA is working actively on early assessment for predicting outbreaks in order to make the necessary preparations for control. The Ministry is assisted in this by monthly meteorological data, monthly desert-locust assessment survey reports, information from scouts (contact farmers), satellite photography, and pheromone-baited army-worm traps.

A draft plant-protection (plant quarantine and pesticide) law has been prepared and submitted to the Government for its consideration.

Drought-resistant varieties:

- ***Crop plants:*** Early-maturing crops with a short life cycle and low water requirements have to be identified and introduced in the drought prone areas. Those crop varieties which have been proved drought resistant and high-yielding in other countries with similar climatic conditions should be tested and disseminated to the farmers in the drought-prone areas.

- ***Forest trees:*** Forest tree species adaptable to dry climatic conditions must be included in the MoA and other afforestation programmes. Special attention should be given to the propagation and planting of particularly suited indigenous forest tree species.

- ***Livestock:*** Livestock species tolerant of arid climatic conditions must be investigated and introduced into Eritrea. In addition, great efforts have to be made by researchers to improve the productivity of local animal breeds, which have been unconsciously tested for centuries for their adaptability to our dryland conditions.

B.9.4 The Drought Preparedness & Mitigation Plan (DPMP)

The national Drought Preparedness & Mitigation Plan (DPMP) must address crop, livestock, forestry, and water-supply issues:

> ***Crops:*** (a) Develop drought-resistant crop varieties; (b) Introduce early-maturing crops; (c) Develop water- and soil-conservation practices; (d) Diversify the economy; and (e) Strengthen early-warning systems.
>
> ***Livestock:*** (a) Develop indigenous drought-resistant fodder; (b) Conserve fodder; (c) Introduce drought-resistant breeds; (d) Develop irrigated fodder production; and (e) Utilise industrial by-product for feeds.
>
> ***Forestry:*** (a) Establish enclosures and grow fodder; (b) Establish fire-control mechanisms; and (c) Introduce drought-resistant multi-purpose trees and shrubs.
>
> ***Water supply:*** (a) Introduce improved water-harvesting techniques; and (b) Develop people's awareness of the proper utilisation of water resources.

Disaster-preparedness:

Disaster-preparedness must take into account such causes as drought, insect pests and other infestations, wind, flood, and fire. The measures to be taken should include:

- Establishing a national grain bank;
- Diversifying the economy;
- Strengthening the early-warning information system;
- Establishing fire-control mechanisms; and
- Widening local coping mechanisms.

Local Drought Preparedness & Mitigation Plans (DPMP-Ls):

Droughts have seriously adverse effects on economic growth and development. A weakened resource and asset base makes households and communities even more vulnerable to future droughts. In the past, the response to drought has been to provide food aid and famine relief. The Drought Preparedness & Mitigation Plan (DPMP) aims at strengthening the capacity of local communities to plan, develop, and manage their own drought-response strategies. Decentralisation of the national DPMP to local Drought Preparedness & Mitigation Plans (DPMP-Ls) is essential for a rapid response. Efforts are also needed to foster greater coherence among local, district, and national institutions as well as to foster regional co-operation amongst governments.

DPMP *vis-à-vis* NAP:

In the context of NAP the following aspects of the national DPMP will have to be dealt with:

- Developing an adequate framework for a drought policy;
- Developing operational guidelines to implement that policy;
- Devising a drought-information system;
- Building capacity for response mechanisms and related institutions; and
- Strengthening local communities to reduce vulnerabilities.

B.10 AWARENESS,EDUCATION, & TRAINING ISSUES

B.10.1 Introduction

Eritrea suffers from a general lack of awareness about desertification issues. Consequently there is little emphasis placed by the general public on controlling land degradation. In response to the chaos of the last few decades, people now tend to exhibit habits they inherited from that anarchic period, and this is especially true with respect to the exploitation of natural resources. A comprehensive programme in environmental awareness will thus be necessary in order to transform those counter-productive attitudes into ones supportive of the reasonable and sustainable use of resources.

Creating environmental awareness is not an easy task, but nonetheless is one that is absolutely essential for the long-term sustainable productivity of Eritrea's land resources. A programme on awareness of land degradation must reach the inhabitants of all of our geographic zones that utilise the land for a living.

Whom are we trying to reach?
A key step in designing an awareness programme on land degradation is to assess the target

audiences, *i.e.* to learn about all the potential recipients. Such knowledge will also help in the planning of the information-dissemination process. Possible audiences include primary-school pupils, secondary-school students, university students, Government officials, rural inhabitants, women, workers, and pastoralists.

What messages do we want to get across?
It is likely that the number of different messages and topics that should be disseminated will be enormous. There must be a system to determine which messages should be disseminated to the different target audiences. Topics worth discussing in any land-degradation awareness programme include: soil conservation, tree planting, tree-nursery establishment, sustainable use of natural resources, and water-catchment establishment.

How do we transmit the messages?
There are a variety of methods that can be used to get messages across to target audiences. Students present a captive audience and can be reached through reading materials or through presentations made by their teachers. The best option for reaching students is to make education on land degradation an integral part of the school curriculum. In order to reach adults, radio programmes are useful to spread information far and wide for relatively little financial input.

The most important audience is the land users themselves, the people who make a living by utilising land resources. Getting a message to such an audience is not likely to be easy. There is a tendency to underestimate the complexity and sensitivity of such an undertaking. Land users are likely to listen to someone who is one of their own, rather than to a stranger making a 'flying' visit to their community. An extension agent who has established a sense of trust could be a good transmitter of the messages. Both in rural Eritrean communities and amongst pastoralists, certain individuals emerge as leaders, opinion makers, and consensus builders. Those individuals can be particularly good transmitters of the message of desertification control. Identifying such individuals and empowering them with new knowledge is likely to be the most efficient way of transmitting knowledge.

Did the message get to the audience?
It is not enough simply to disseminate information and then to hope that people accept it. It is necessary to carry out certain monitoring and evaluation activities in order to see if the methods used have been effective and to see whether people are in fact acting upon the new information. It may be necessary to change tactics or to modify the messages if they have been misinterpreted or not absorbed.

B.10.2 Plan of Action

A plan of action for public awareness, education, and training must be comprised of at least the following six components:

i. **Providing extension agents and reorganising community leaders with new knowledge on land degradation:** If the involved extension agents or community leaders do not have sufficient training in conservation and environmental awareness, they should receive short-course training. Such courses should be especially designed

to meet the needs of particular communities. It is important that the content of any course is relevant to the context of the local land users.

ii. **Assessing the target audience:** This should be done through discussions with the Village/Area Administrator at the *Sub-zoba* (Sub-regional) level, *inter alia*, by determining how many Villages/Areas and *Megebaayas* are to be involved, where they are, and their special characteristics.

iii. **Prioritising the land-degradation messages:** The extension agents and/or community leaders should consult with the *Megebaayas* to find out what their own particular priority messages are. Obviously, each community will have its own set of priorities, and the messages must reflect these in order to be effective.

iv. **Determining the methods of information dissemination:** The extension agent will need to determine what resources are available in order to be able to disseminate information on land degradation. Some information is disseminated appropriately from the national level, because the means of dissemination are located centrally, *e.g.*, radio, and large-circulation newspapers. But there is room for innovative approaches in this regard. Pamphlets or newsletters could be started at the *Sub-zoba*, or even Village/Area-level. A newsletter could be distributed providing general information on land-degradation issues for elementary schools in affected areas.

In a country such as Eritrea, where a tradition of oral literature and folklore are well established, a powerful tool for disseminating information is this informal approach. Community-level theatre could also build upon the notion of extolling good land husbandry. Local poetry and local sayings could be tailored to conveying the message of good stewardship.

v. **Developing a plan for information dissemination:** A plan for information dissemination on land degradation should have the following characteristics:

- It should be simple and straightforward;
- It should have a clear output in terms of the information package that is to be disseminated, *e.g.*, 12 radio programmes per year, 12 issues of a newsletter per year, 6 or 7 community-theatre playlets per year, special pamphlets and posters;
- It should take advantage of visual materials and resource packets, and use these for training and sensitisation;
- It should have stated time-bound objectives, so as to make it possible to determine if the objectives are being met;
- It should build an outreach programme around important and established milestones in desertification control, *e.g.*, the 'World Day to Combat Desertification' (the last Tuesday in October of each year). This day provides a fine opportunity to disseminate a great deal of information; and
- It should review the content of any poster on combating desertification issued by UNDP-UNSO or other organisation in order to adapt it to Eritrean conditions, and should then disseminate it as widely as

possible.

vi. **Monitoring and evaluation:** This is a crucial component in any land-degradation information programme. It is essential to see whether messages get across effectively to the target audiences and, more importantly, to see if they are being interpreted correctly. The extension agent must develop a plan for talking to the various segments of the target audiences. He or she must then implement the plan. This is essential for ascertaining whether money and resources are being allocated successfully and appropriately.

B.10.3 Participation of Local People

The participation of local people in Eritrea's efforts to control desertification is absolutely essential. The local people must be involved in every phase when the aim is to halt the inappropriate exploitation of land resources. The key to success is for the local people to understand and accept why it is necessary to generate new information, and then to use it to arrest land degradation. The needed educational effort is made difficult because land degradation can progress slowly and imperceptibly.

Education and training in land degradation:
Once included, formal education in land degradation is likely to be part of the established system of education, whether in science, geography, or other selected subjects. It is unlikely to be offered as a completely separate subject from other environmental education. However having said that, it is important that education on land degradation be accorded a special and unique niche. And because land degradation is the most critical environmental problem Eritrea faces, it should be given highest priority and prominence in any environmental education programme.

A key institution in education and training in land degradation is the MoA Training Centre. This Centre should be strengthened and its capacity strengthened to initially offer short-term courses, seminars, and workshops on all aspects of the subject. People from areas affected by land degradation should be invited regularly to upgrade their knowledge and understanding of this problem. The Centre should also build its capacity to produce appropriate tools for awareness-raising via, *e.g.*, poster-making, pamphlets, and newsletters. The Centre should do this in collaboration with institutions skilled in training and awareness-raising, *e.g.*, the Ministry of Education (MoE) and the Ministry of Information (MoI).

Taking advantage of experts carrying out fieldwork:
Hands-on experience is often far better than classroom training. Every effort should be made whenever experts (both in-country and from the outside) carry out fieldwork in Eritrea that a trainee accompanies them. In this manner, the trainee can be expected to learn valuable field skills.

The role of the Ministry of Education (MoE) in land degradation:
The Ministry of Education (MoE), an institution that has been playing an important role in combating desertification, is represented on the NAP Technical Committee. The fight against desertification is amongst the main programmes and activities in which the MoE has been

engaged.

B.10.4 Environmental education and Main Interventions

The Ministry of Education believes strongly that the fight against desertification can only be successful if there exists the involvement of strong institutions. Moreover, the execution of various programmes so as to make the public aware of the issue and take part in the process are imperative steps towards combating desertification. Having been increasingly concerned about soil degradation, drought, loss of natural vegetation, and threatened wildlife, the MoE has also been trying to strengthen its efforts to withstand desertification.

The major areas of MoE involvement have been, and shall continue to be, through:

- Curriculum development;
- Adult educational programmes; and
- Student secondary-school vacation work programmes.

B.10.4.1 Curriculum

From the needs-assessment process which has been undertaken for the national curriculum, a strong concern was revealed over environmental awareness. Based upon those findings, and upon national environmental concerns in general, there is seen to be a strong need to introduce environmental education into the school curriculum. However, it remains debatable whether or not environmental education should be made an interdisciplinary subject or multi-disciplinary theme.

Although the national curriculum study has not as yet been completed, it is significant that environmental education has already been placed amongst the top priorities of the needed curriculum work. To date, environmental education has been treated exclusively as a multi-disciplinary theme in Eritrean schools, at all levels from grades 4 to 11. Lessons are included in the various student textbooks, and the content stretches from global environmental concerns at the primary level to national environmental concerns at the secondary level.

B.10.4.2 Adult Education

Many Eritrean adults still lack a positive attitude towards environmental protection and/or lack a systematic way of improving it. Thus, the aim of this programme is to raise environmental awareness of such people – people who are considered amongst the most affected by the consequences of desertification. A considerable contribution is already being made to raising awareness amongst targeted adults in the areas of agriculture, health, family planning, and environmental issues by means of educational broadcasting programmes. This programme has also opened venues for adults to participate effectively in the improvement of their environment.

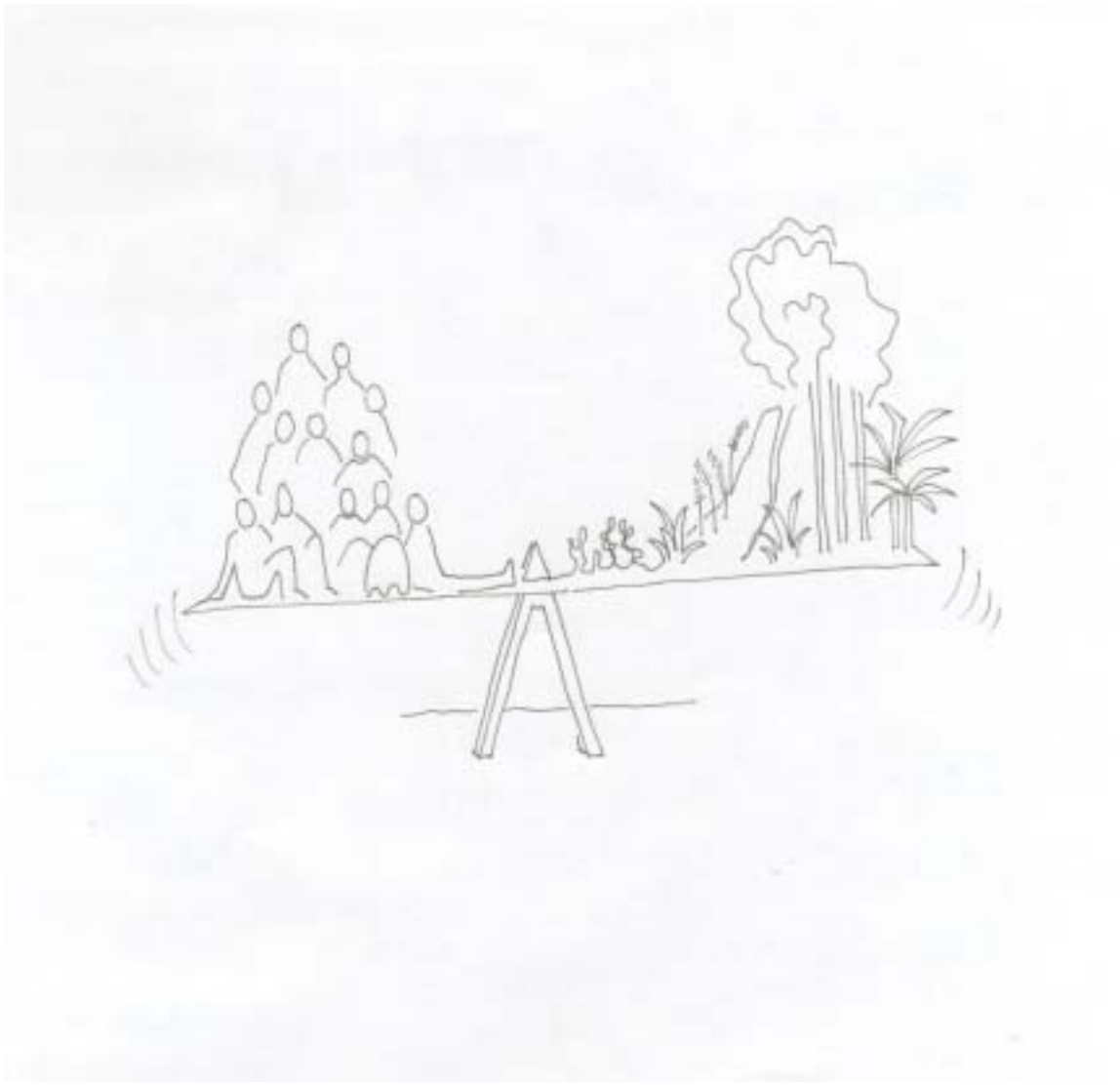
B.10.4.3 Vacation Work Programmes for Secondary-school Students

The vacation work programme for secondary-school students is fully integrated into the educational system, and runs for 45 days during every school vacation (during *Kremti* [June-September]). Well over 60% of the work goes into combating desertification through participation in environmental conservation and development activities.

B.10.4.4 Extra-curricular Activities

Parallel to the existing environmental awareness-raising programmes and activities in the schools (both theoretical and practical), pilot projects have already been introduced into some school (in *Ad* Quala and Tesseney) to engage students in extra-curricular environmental clubs and school afforestation programmes. Such student involvement is potentially significant in environmental education, in part to evaluate whether or not the environmental messages being transmitted by the school are being carried out effectively.

B.11 SOCIO-ECONOMIC ISSUES



B.11.1 Introduction

Perhaps the most challenging task of the NAP process is to articulate clearly and widely the socio-economic aspects of land degradation in Eritrea. To suggest simply that it is too complex to articulate clearly is to suggest that there may be little room for effective action – a sense of defeatism that may further confine and delimit the impact of attempts to reverse land degradation.

How then can we address this challenge? It is clear that the challenge can only be met successfully by aiming to be practical and practicable; to use specific language, and to articulate a concrete prescription for both natural and local action programmes.

In this section we will review the following five elements:

- How to motivate people to act effectively to arrest land degradation;
- How to reduce poverty;
- How to deal with population pressures; and
- How to improve the quality of life for women and pastoralists.

Perception of land degradation
People in the rural areas tend to think that land degradation is inevitable, that drought and aridity are supernaturally ordained, that infestations such as those of the desert locust occur as acts of God, and that God's wisdom cannot be fully understand, let alone questioned. In the circumstance, the rural people tend to seek the capacity for forbearance, the capacity to suffer without bitterness, and the capacity to accept that which is perceived as inevitable.

Thus, the notion that much of land degradation is the result of human action, that it is the result of wrong practices, or that land productivity is directly related to the right combination of inputs is not as yet widely accepted. The NAP process faces a major challenge in addressing this issue, and in eventually establishing the perception that land degradation can be arrested and even reversed, and that the key factor for success is the 'people'.

B.11.2 The Shifting Balance between Land and People

The NAP process must pose a fundamental question: Is it the Eritrean land or the Eritrean people that produce food? If the answer to this question is 'Land', then limits are being approached. We can now discern a shifting balance between land and people. Historically, food production kept pace with population growth. Now key trends suggest important reasons for concern:

- Every year Eritrea needs to feed at least 117 thousand more people (see Table A.3), while at the same time continuing to lose *circa* 12 tonnes/ha/year of rich topsoil from our arable land through erosion (see Table A.2).

- There never was an abundance of land in Eritrea, and even less of water. Key indicators to demonstrate these points have already been presented in earlier sections.

- The notion that Eritrea can bring an extra 1 million ha of new land under rain-fed agriculture because that many hectares receive 400 mm/year of rain is too simplistic at best. At worst, such action would be unsustainable as more and more pastureland unsuitable for agriculture is converted to grain production.

- We are moving towards natural-resources scarcity. In 1941 the amount of cultivable land supporting the food needs of each Eritrean was 0.58 ha. By 2015 population projections suggest it will be 0.07 ha (see Table A.3). This projection suggests that this could be the year that Eritrea will have reached **arable-land scarcity,** a conditions in which the population of Eritrea will on average have no more than 0.07 ha/*capita*. This is the lowest authoritative

estimate of the minimum amount of arable land required to feed one person without intensive use of chemical fertilisers.

- Cereal production, which was *circa* 52 kg/*capita* in 2001 (*i.e.*, 203 thousand tonnes/3,924 thousand people – see Table A.3), appears to be declining slightly. Similarly, *per capita* livestock production may be declining as well.

- As deforestation has increased, soil moisture has been reduced. Deteriorating soil quality has meant declining land productivity. Average yield in 2001 was *circa* 462 kg/ha (*i.e.*, 203 thousand tonnes/439 thousand ha – see Table A.1).

Collectively, these trends make a powerful case for conserving land as well as on easing the increasing pressures on the resources needed for food production.

B.11.3 Empowering People to Take Action

The case for conserving land can be presented powerfully. But beyond a powerful presentation there is need to empower people to take action, because it is only through empowered people that effective action can be taken. As stated earlier, perceptions need to change. The NAP process must develop the necessary mechanisms to bring about such change. An improved flow of information tailored to the needs and comprehensions of the people in the rural areas will be a key factor.

A proper legal framework, which assures security of tenure, is another key factor. The new Land Reform Proclamation (No. 58/1994), if implemented forcefully and comprehensively, can become an effective means to bring about appropriate changes in perception. People who work the land need to experience tangible benefits from any effort in land conservation. Without such beneficial experience, there is little chance that land-conservation efforts can be sustained over the long term. But when they perceive tangible benefits and experience them in practical ways, commitment expands and the resourcefulness of farmers rises to new levels.

But it is clear there is no 'magic' to be invoked here. Experience from other countries – *e.g.*, from Machakos, Kenya – demonstrates that without additional inputs and concerted efforts, positive change will not result. In Machakos, the key to success was that many farmers were able to diversify their income by finding non-farm jobs and then applying their additional income to land conservation. In Machakos, success appears to have been achieved through a combination of:

- Improved education and public awareness;
- Improved security of tenure;
- An improved community-government partnership; and
- A prominent leadership role for women.

B.11.4 Poverty Profile

Poverty is widespread in Eritrea. According to a recent poverty assessment of Eritrea by the World Bank, 53% of the population (distributed proportionally between urban and rural inhabitants) lives permanently below the poverty line (World Bank, 1996). This proportion of poverty might well rise to 70% during the not infrequent years of poor rainfall and thus poor harvests. As a consequence of the disruptions brought about by our War of Liberation of 1961-1991 and our Ethiopian War of 1999-2000, female-headed households are now numerous (*circa* 30%), but owing to inter-family assistance at the Village level those households are not poorer than the rest, at least in the rural areas.

Apart from the widowed and orphaned, the invalids, the internally displaced persons, and the demobilised ex-fighters (male and female), many of the spontaneous returnees from the Sudan also count amongst the poor. It is not only the war-affected displaced or shattered families which are poor. Many farmers are structurally poor, in particular in the larger part of the Central highlands Zone where land holdings (with precarious rainfall) amount to less than 1 ha/family of rain-fed land. Elsewhere in Africa, the poor rely upon diversified survival strategies. The raising of small livestock, off-farm activities (petty trade etc.), wage-earning family members, and the receipt of remittances are all important augmenters of income in rural and urban families alike.

Educational standards and health services have also plummeted as a consequence of our War of Liberation of 1961-1991 and our Ethiopian War of 1999-2000. A few 1995 social and economic indicators comparing Eritrea with Sub-saharan Africa as a whole will be useful in the present context (see Table B.27).

Table B.27 Key Social Indicators for Eritrea and Sub-saharan Africa (1995)

	Eritrea	**Sub-saharan Africa**
GDP *per capita* (US$)	160-190	520
Illiteracy (% of those over 15 years)	80	50
Female illiteracy (% of those over 15 years)	90	62
Life expectancy (years)	46	52
Infant mortality (per 1000 live births)	135	93
Gross primary-school enrolment (% of those of school age)	47	67
Gross secondary-school enrolment (% of those of school age)	14	18

Source: World Bank (1996).

To simplify a bit, it can be said that poverty in Eritrea – in terms of insufficient and insecure

income (whether subsistence or monetary) – is more acute than elsewhere in the Central Highlands Zone. In the CHZ, land holdings are smaller, livestock ownership more limited, and rainfall more erratic than in major portions of the Lowlands Zones. Conversely, people in the Lowlands Zones are worse off with respect to educational and health services, owing to the more severe damages from our War of Liberation of 1961-1991 and our Ethiopian War of 1999-2000 in those areas as well as to the dispersion of the population (part of which is nomadic or semi-nomadic) over vast areas, often of difficult access.

B.11.5 Development and Poverty-alleviation Policies

The GoE Macro-policy Document of November 1994 spells out the Government's basic orientations and objectives, which are a private-sector-based and export-oriented economy, exploiting Eritrea's advantages (its location and the energy and entrepreneurial talents of its people) and resource potentials (marine resources, tourism, possibly energy). It hopes to achieve these objectives by:

a) Creating an open environment in which its private sector can develop in partnership with foreign investors;
b) Rebuilding and modernising its economic infrastructure;
c) Investing in its human capital (through education and health programmes); and
d) Developing its social-welfare services and creating a safety net.

Poverty-alleviation:
Notwithstanding Item (d) above, with respect to poverty-alleviation, GoE is opposed to departmentalising poverty issues, *i.e.,* to separate them from overall development tasks and issues. This implies an opposition to specific poverty-oriented projects. In GoE's view, poverty-alleviation and social equity must be – and already is – built into each and every government programme. This argument gains particular force in a country where there is relatively little differentiation in wealth and income levels in the rural areas, and where more than half the population is below the poverty line.

Significantly, there is no separate chapter on poverty or poverty-alleviation in the GoE Macro-policy Document of November 1994. The issue is dealt with under Social Welfare (Section 13.3), where it is stated that employment safety nets will be introduced through labour-intensive public works programmes in areas and periods of major economic distress (Paragraph 13.3.2.d). In a similar spirit, the GoE Regulation on Food Aid Monetisation of January 1996 provides that able-bodied persons expecting to be assisted with food, will henceforth have to earn it through 'cash-for-work'.

Population issues:
Projections of population growth in relation to arable land *per capita* were presented earlier (see Tables A.3 & B.1). As previously stated, Eritrea has to feed at least 117 thousand additional people every year even as the pressures on the resources needed for food production increase. Eritrea's population is likely to increase to almost 6 million by 2015. The necessary increases in food production would require as much as a tripling, assuming improved diets aimed at the moral imperative to end to end malnutrition.

Is there room for the national motivation that would be needed to influence the size of Eritrea's population in the next few decades and beyond? Unfortunately, the answer is not entirely clear, as evidenced, *e.g.*, by Eritrea's position at the 1994 United Nations International Conference on Population & Development (ICPD) in Cairo.

Whatever the reason for national ambivalence on the issue of population, it cannot be denied that population growth diminishes each Eritrean's share of our nation's finite arable land, increasing the pressures to increase food production on each hectare suitable to the task.

We have suggested on the basis of sound evidence and reasoning that Eritrea will begin to face arable-land scarcity by the year 2015 or earlier (see Table A.3). International experience seems to indicate that countries with less than 0.07 ha/*capita* of arable land cannot feed their population sustainably (even on an essentially vegetarian diet) without the use of chemical fertilisers. The 0.07 ha benchmark would need to be much higher if a USA-style meat-based diet were to become the norm for Eritrea.

Despite a number of conceptual shortcomings, the 0.07 ha benchmark is a crossing, a transition to the vulnerability of dependence on intensive modern inputs. Moreover, experts have suggested that the transition is permanent, not affected by later expansion of arable land or decreases in population size. Given the generally thin and acid agricultural soils of Eritrea, it may simply not be possible to attain a sustainable output of sufficient food even by turning to intensive agriculture. Thus, there is considerable reason for concern in light of the 0.07 ha benchmark of arable-land scarcity in Eritrea and its likely attainment by 2015.

The NAP process will not be able to come up with a quick-fix policy option. What the process can do is keep under review the linked challenges of population growth and resource sustainability. To this end a proposed Project Profile is being submitted for early implementation (see Appendix 1.2, PP No. K1-1/1).

B.11.6 Economic Issues

B.11.6.1 Significance of the Agricultural Sector

Agriculture is the most important sector of the Eritrean economy. It accounts for *circa* 50% of the GDP, and for most of the exports. Roughly 80% of the population earn their living from crop and livestock production. In view of this, the Government has made agriculture its top priority. All Eritreans, regardless of sex, above the age of 18 years have the right to land based on the usufruct principle. The Land Reform Proclamation (No. 58/194) enacted in 1994 guarantees this (see Fact Sheet B.1).

Agricultural production in Eritrea is in essence based on rainfall and traditional methods of production. The agricultural technologies in use are still very crude and inefficient. Average yields of most crops do not exceed 1 tonne/ha – and the average yield is less than half that (462 kg/ha in 2001). Because of this, poverty and food insecurity reign in much of rural Eritrea.

Smallholders account for most of agricultural production: units of 1-2 ha/family on average.

In the Central Highlands Zone (CHZ) it is usually less than 1 ha/family, whereas in the Western Lowlands Zone (WLZ) it is often *circa* 2 ha/family. In addition to much agro-pastoralism in the Lowlands Zones, there are also nomadic pastoralists inhabiting the southern Danakil Depression, *Zoba* Semenawi Keyih Bahri, and the northern part of *Zoba* Gash-Barka. Land holdings are fairly equally distributed within each of the agricultural zones. Differences in income and wealth result more from differences in access to draught animals, to irrigation water (from wells or from spate or river diversions) or to sources of non-agricultural income.

Production in the Central Highlands Zone consists overwhelmingly of cereals: barley (*Hordeum vulgare*), wheat (*Triticum* spp), teff (*Taf*), finger-millet (*Eleusine coracana*), and sorghum (*Sorghum bicolor*). Production in the Lowlands Zones consists mainly of sorghum and pearl-millet (*Pennisetum glaucum*). Where water is available in the Lowlands Zones, cash income is derived from horticulture or from rain-fed cultivation of sesame (*Sesamum indicum*). Livestock products provide an important income complement. Especially in the Eastern Lowlands Zone, income from livestock products outweighs that from smallholder crop production.

B.11.6.2 The National Economic Situation

GDP *per capita* for Eritrea was estimated to be US$ 160–US$ 190 (see Table B.27). Using the mid-point, total GDP would thus currently be *circa* US$ 707 million (*i.e.*, US$ 175 x 4,038 thousand people – see Table A.3). A remarkable contributor to total GDP is the substantial remittances being sent home by Eritreans abroad.

Eritrea does not have a large debt burden and so the alleviation of debt by the international community would not have a significant impact on the countering of land degradation, either in the short- or long-term.

Having said this, it is clear that there are important factors to be considered as far as trade and desertification are concerned:

- Increasingly, the Eritrean pastoralist system is being monetised and incorporated with the regional market:

- Nevertheless land, particularly arable land, will remain the most important ‘natural capital’. As such, its care and appropriate use are the most reliable – indeed, the only basis for economic growth.

- Pastoral lands are looked upon as under-utilised potential farmland where large-scale mechanised enterprises and resettlements could be initiated.

- Livestock – cattle and particularly small ruminants (goats, sheep) – are likely to become important export items for Eritrea. Here trade measures that encourage fair value to this important product of pastoralists needs to be put in place. Some very straightforward trade measures must be included in NAP.

B.11.6.3 Rural Credit

The issue of rural credit deserves special attention because of its role in many development projects. Several points must be made:

- MoA distributes credits worth some US$ 2 million/year to farmers. *Circa* 75% of this is medium-term (mostly for draught animals) and 25% is long-term (mostly for pumps, water pipes, or tractors). Credit terms are below market rates (which are 14%–16%): 12% for medium-term credit, and as low as 8% for long-term credit. Repayment rates are claimed to be in the range of 60%–70% (although a NAP mission was unable to obtain documents in support of this claim). Credit is distributed through the network of extension agents. The fact that extension agents thus also have to look after the repayment of credit is bound to be detrimental either to the effective discharge of their extension tasks or to the collection of debts, or to both.

- The most promising initiative in Eritrea is the development by the Associates for Co-operation & Research in Development (ACORD) of savings & loan associations, evolving into farmer-owned rural banks, in *Zoba* Debub. Owing to the careful approach used, the realistic lending rates, and the excellent repayment record (group liability), these savings & loan associations could, with appropriate further support, become self-supporting in the not too distant future.

- Various NGOs (and also bilateral donors, such as the German Technical Co-operation Agency [GTZ]) operate other credit schemes – for pumps, draught animals, etc. – but without the ambition of setting up self-sustaining rural financial institutions, which characterises the ACORD scheme. Most of those NGO schemes would now presumably be either phased out or taken over by GoE.

- The micro-credit component of the MoLG Eritrean Community Development Fund (ECDF) seems to follow an approach similar to that of ACORD, *i.e.*, group liability and the combining of savings mobilisation with lending. However, as ECDF is under the Ministry of Local Government, there appears to be somewhat more emphasis on social needs, and therefore also a somewhat more pro-active attitude towards making credit available to Village populations.

B.11.7 Improving the Quality of Life of Vulnerable Groups

NAP recognises that women and pastoralists are two important groups that are particularly vulnerable to the deleterious effects of land degradation.

- Women perform most of Eritrea's subsistence farming; and their workload

grows as men leave rural areas to find paid employment elsewhere. A new direct focus on women in agriculture in order to improve nutrition and resource conservation is essential.

- Pastoralists are another group significantly affected by land degradation. NAP must address such issues as:

    (a) The growth of export-oriented plantation agriculture in areas traditionally used by pastoralists for grazing;

    (b) The increasing tendency for herding communities to no longer be able to earn a living from their animals; and

    (c) Formal restrictions on the mobility of pastoralists.

B.12 PUBLIC PARTICIPATION ISSUES

B.12.1 Role of the Chamber of Commerce

B.12.1.1 Background

If desertification is not combated at an early stage, the consequences can be significant, leading to poor productivity and a lowering of the Eritrean standard of living. Nonetheless it can be said that desertification is little known within the business community.

The Eritrean National Chamber of Commerce, as a private-sector organisation, play a central role in the development of the national economy. It must therefore also play a leading role in creating awareness in the business community about the impact of desertification on agricultural productivity and the economic growth of Eritrea. Therefore, it is the task and responsibility of the Chamber of Commerce to create an awareness of the effects of desertification amongst its members so that they can participate effectively in combating it.

B.12.1.2 Role the Chamber of Commerce Can Play

There are several roles the Chamber of Commerce can play in the NAP process: (a) creating awareness; (b) technology transfer; (c) fund-raising; and (d) tree planting.

Creating awareness:
As the creation of awareness is the cornerstone for the effective and efficient implementation of any development programme, the Chamber of Commerce has to make every effort to increase the awareness amongst its members about desertification and land degradation. To that end, the Chamber should organise seminars and/or workshops and publish appropriate articles in its newsletters and other publications.

Technology transfer:
The Chamber of Commerce has to seize every opportunity to advise the business community to invest in or import appropriate technology that is environmentally friendly and does not exacerbate desertification or land degradation. The Chamber should encourage the business community to invest in the manufacturing of environmentally friendly cooking appliances, such as gas, kerosene, and electric stoves, instead of using those dependent on wood for their fuel. Such appropriate technology helps to preserve Eritrea's trees.

Fund-raising:
Fund-raising is one of the critical areas in which the role of the private sector is urgently needed. In this regard, the private sector is to take an active role in the governance structure of ENDF. The Chamber of Commerce is to be represented on the board of ENDF. The active participation of all major stakeholders in the governance of ENDFs will enhance the process of mobilising resources for the initial financing of this key programme. Seeking voluntary contributions would be one means of ensuring initial funds.

Tree planting:
The Chamber of Commerce, in co-operation with other major groups, should organise seminar and/or workshops, and should take the necessary effort to raise the awareness of the private sector to the need of planting trees on their premises and surrounding areas. If possible, the Chamber should additionally undertake an annual planting project of tree seedlings in an area selected by the NAP Steering Committee.

Condemning harmful business practices:
Unfortunately, not all businesses are sensitive to land-degradation issues. For example, there are cases in Eritrea where investors in commercial agricultural enterprises have contributed to the acceleration of land degradation. An agricultural entrepreneur in Hagaz who had been assigned large areas of land for raising crops, removed all of the trees and shrubs for charcoal and then abandoned the site. In doing this, he exposed the fragile land to destructive wind erosion, and the area now appears to be slowly turning into desert.

This example can be used to illustrate the role that the Chamber of Commerce should assume in such cases, bringing pressure to bear on entrepreneurs who are insensitive to land-degradation issues. Thus, the Chamber should consider several options in addressing the issue of entrepreneurs who vandalise the environment:

(a) Organising a well-publicised boycott of an entrepreneur who vandalises the environment. This could be a powerful tool for persuading entrepreneurs to evaluate their business practices in terms of environmental impact; and

(b) Black-listing a company or business that has vandalised the environment, again together with a well-publicised boycott of its services and products. Companies and business cannot be permitted to consider themselves immune to taking responsibility for the results of their actions upon the environment.

Of course, an entrepreneur, business, or company should always be given an opportunity by the Chamber of Commerce to change its anti-environmental and anti-social ways before it is boycotted or black-listed.

Consumers can make a difference because if they decide that a particular business is insensitive to land-degradation or other environmental issues, they can decide not to purchase its products or utilise its services. A well-known historical example of the power of boycotts is the one organised by Mohandas Gandhi in British-ruled India in 1930. Gandhi organised huge numbers of Indians to march to the sea so they could prepare their own salt by boiling seawater, in a successful move to have the British colonial rulers eliminate a tax they had imposed on the purchase of salt. His next step was to boycott the British monopoly on cotton products, which he did by getting people to spin their own cotton and to wear simple *Otis* a traditional garb in India.

B.12.2 Role of the National Union of Eritrean Youth & Students (NUEYS)

The National Union of Eritrean Youth & Students (NUEYS) is one of the biggest and most effective national NGOs in Eritrea. Its power lies in its vast membership of more than 130 thousand. Many of the members can offer their labour on a voluntary basis. Moreover, it has a wide network all over Eritrea that enables it to implement different projects smoothly.

In September 1997, NUEYS drew up a 5-year 'Strategic Plan' which includes a section on 'Environmental issues'. NUEYS's implementation of desertification issues, particularly in assisting in the implementation of NAP, could be accommodated within that rubric.

NUEYS has rich experience in implementing projects related to the protection and well-being of the environment. Every year, NUEYS organises national campaigns and mass activities. For example, in 1998, *circa* 20 thousand youth and children from all over Eritrea participated in such NUEYS-sponsored activities as planting seedlings, digging wells, terracing hillsides, and cleaning up their surroundings.

Here are some specific activities which have been performed by NUEYS to combat desertification, and which they should be encouraged to continue:

- Under the guidance of MoA, organising campaigns to increase awareness about land degradation. Awareness campaigns can take a variety of forms, amongst them organising competitions that test general knowledge of land degradation issues, designing and distributing of posters, and organising

seminars.

- Working on activities that require mass participation, *e.g.*, planting seedlings and terracing hillsides;

- Since NUEYS has offices in all *Zobas* and most *Sub-zobas*, participating in the committees relevant to the environment which exist at the grassroots level; and

- Assisting in the wide dissemination of information necessary to the success of implementing NAP.

B.12.3 Role of the National Union of Eritrean Women (NUEW)

B.12.3.1 Background

Desertification is a problem that affects the entire population in general and women in particular. It is of prime concern to the women of Eritrea, especially in the rural areas, where they play a significant role in environmental issues.

The NAP process will be addressing the following issues related to women:

- Targeting all pastoralist communities through public campaigns in an effort to reverse the trivialisation of women's activities, which now limit them largely to the domestic arena.

- Ensuring that incomes generated from women's dairying activities attract as much attention as men's livestock exchanges.

- Addressing the challenges and opportunities created for women as more and more men move to the expanding urban job markets. The women and children are left behind to look after the farms and livestock. Women are then confronted with heavier workloads, often without the right of ownership over the animals left to their care. Women's involvement in farming and livestock care must not be constrained by the customary land-tenure rules and land-registration laws that favour men, and they should not have to face difficulties in selling their goods. They must be helped to overcome the existing barriers or moral codes that constrain female mobility.

- Addressing the issue of women in pastoralist communities contributing heavily without payment to the labour-intensive tasks of caring for young animals, while their male relations dominate the livestock market and control the income from sales.

Bearing in mind the meaning of 'desertification' in UNCCD as revised for NAP (see Section B.2.2), and recognising the critical role that the National Union of Eritrean Women (NUEW)

could play as a mass women's organisation in combating desertification, NUEW should:

1. Integrate a long-term strategy to combat desertification, as already called for by the NUEW constitution.
2. Develop a short-term strategy and operational outline that will involve all of NUEW's members throughout Eritrea to implement its desertification plan of action.
3. Ensure that women become part in the NAP planning, implementation, and evaluation process.
4. Co-operate with the NAP Secretariat in drawing up programmes for environmental protection and to combat desertification.

B.12.3.2 Recommended NUEW Activities

NUEW, in co-operation with relevant stakeholders (Ministries and other authorities) should undertake the following activities to combat desertification.

Prevention and reversal of desertification:

- NUEW should introduce solar panels, fuel-efficient stoves, kerosene stoves, and other appropriate technologies at the grassroots level, in co-operation with the Ministry of Energy & Mines (MoEM). For the last 50 years, countless trees have been cut by local communities for cooking and heating purposes, something that this will counter.

- NUEW should identify areas subject to the expansion of desertification, and plant trees there, especially in the month of June when rainfall is likely to be assured, in co-operation with the Ministry of Agriculture (MoA).

- NUEW should make sure that young schoolgirls participate effectively in the school-vacation programme of afforestation, and conduct awareness campaigns directed toward youngsters on the dangers of desertification during *Hagay* (the October-February dry season).

Use of water and land:

- NUEW should make sure that women enjoy the rights provided to them by the Land Reform Proclamation (No. 58/1994) regarding access to land ownership.

- NUEW should make sure that women are involved in the management of land and water use in the Village, especially those who take care of their family alone (woman-headed households).

- NUEW should encourage women to get involved in horticultural activities and other land-related income-generating programmes, in order to help secure their food requirements.

- NUEW should increase the existing active involvement of women in the annual national green-up and clean-up day.

- NUEW should mobilise individual women to plant at least 2 or 3 trees or shrubs per year wherever they live, and then to protect them until they reach maturity.

- NUEW should enable women to protect their sources of drinking water from contamination.

- NUEW should encourage families to build proper latrines, and to oppose to improper waste disposal.

- NUEW should train women in the technical handling of water pumps.

- NUEW should devise mechanisms for separating safe drinking water for human consumption from water meant for livestock.

Training and the dissemination of information:

- NUEW should raise the awareness of women in the protection of the environment and in the negative impacts of desertification.

- NUEW should prepare elementary training manuals in the local languages, which could be easily understood by women in the Villages, in order to address the physical, biological, and socio-economic aspects of drought and desertification, doing so in co-operation with the Ministry of Agriculture.

- NUEW should identify and select women animators from the 57 *Sub-zobas* of Eritrea who would be given training to establish programmes to combat desertification, so that they, in turn, would be able to train others in their respective *Sub-zobas*.

- NUEW should integrate the issue of combating desertification into all of its skills training programmes (including literacy).

B.12.4 Role of Local Government

B.12.4.1 Background

Environmental protection and management were not properly addressed during our protracted War of Liberation of 1961-1991, although some efforts were made in areas liberated by the Eritrean People's Liberation Front (EPLF). The Ethiopian regime had, for various reasons, speeded up environmental degradation in Eritrea. Under Ethiopian rule, inappropriate farming practices, deforestation, poor management of natural resources, development of new settlements, and expanded urbanisation all contributed to Eritrean desertification and land degradation.

Following independence in 1991, the Government of Eritrea instituted various efforts to reverse the situation. It began to work hard to increase community awareness of the cause,

effects, and remedies of desertification and of the need for environmental protection. GoE also induced various grassroots organisations to encourage the participation of communities in environmental protection and management. Many of those early efforts were based on experience acquired during our War of Liberation of 1961-1991. However, environmental protection and management were again interrupted for a time during our Ethiopian War of 1999-2000.

Those post-liberation efforts have contributed to improving the environment of Eritrea. The introduction of new farming practices, rehabilitation of the environment, conservation of water and soil resources, etc. have, indeed, proved to be very encouraging. As the main actors, Local Governments have gained a great deal of credibility because they played a significant role in the implementation of the national programme of environment rehabilitation.

B.12.4.2 A New Policy Orientation for Regionalisation

A decentralised regional approach to all development initiatives is an important policy orientation of the Government of Eritrea. This policy orientation is cogently encapsulated in the Proclamation for the Establishment of Regional Administrations (No. 86/1996). A decentralised regional approach is the key to combating desertification and land degradation. The Proclamation provides a basis for such an approach (see Fact Sheet B.3). That approach recognises the following major points:

- People at the local level most closely affected by land degradation are able to articulate the problem and to create solutions that are practical and effective.

- Decisions on the type of solutions to address pressing problems such as land degradation are best defined at the lowest level of the decision-making hierarchy. The Proclamation allows for this.

- In its introduction, the Proclamation states that Eritrea is committed to lay a foundation whereby people can administer their own affairs.

- Local knowledge on land degradation is likely to be most effectively used when there is a decentralised regional approach in place. Local knowledge and local empowerment through decentralisation can create a dynamic synergy.

- It is self-evident that local knowledge is most effectively and optimally utilised at the local level. Thus the legal and administrative structures provided by the Proclamation facilitate the free play and growth of local autonomous action.

B.12.4.3 Role of Local Government in Combating Desertification

To consolidate the development efforts of the grassroots and to increase community participation in development matters, the Local Governments have been restructured into 6 *Zoba* (Regional), 57 *Sub-zoba* (Sub-regional), and 654 Village Administrations. The Proclamation for the Establishment of Regional Administrations (No. 86/1996) has been promulgated to facilitate such restructuring (see Fact Sheet B.3). The Proclamation makes the line ministries as well as mass organisations such as the National Union of Eritrean Women (NUEW) and National Union of Eritrean Youth & Students (NUEYS) accountable to the *Zoba* Administrations.

Fact Sheet B.3 Proclamation for the Establishment of Regional Administrations (No. 86/1996)

- Adopted (published) in the Gazette of Eritrean Laws on 15 April 1996.

- Establishes 6 Regional Administrations (*Zobas*) and determines the modalities for establishing Sub-regions (*Sub-zobas*) and Village/Area Councils (*Megebaayas*).

- Delineates powers of Regional Administrations (*Zobas*). These are limited to 'conclude administrative contracts...when approved by the Minister of Local Government' (Article 7.2.a). Sub-regional (*Sub-zoba*) and Village/Area Administrations are also given the power to 'conclude administrative contracts...when approved by the Regional Administration'.

- Three levels of Regional Administration are recognised: (a) Regional (*Zoba*) Administrations (6 in number); (b) Sub-regional Administrations (57 in number); and (c) Village/Area Administrations (654 in number).

- Towns are classified into three categories:
  Category (i) Towns are administered as Sub-regions (3 in number);
  Category (ii) Towns and their outskirts are administered as Sub-regions (5 in number);
  Category (iii) Towns are administered as centres of Sub-regions (9 in number).
  [There is no mention of Asmara in this scheme.]

- The Minister of Local Government has the sole power to ratify boundaries of Regions, Sub-regions, and Villages/Areas.

- Each level of Regional (*Zoba*) Administration shall have the following bodies:

Regions (and Towns)	Sub-regions	Villages/Areas
Baito (Legislative)	Administration (Eritrea)	*Megebaaya*
Administration (Executive)	Judiciary	
Judiciary		

Baito members are elected by direct secret ballot: 1 representative for 3500-8500 residents of a *Zoba*; and 1 representative for every 1000-2000 residents of a Town. 30% of the seats are reserved for women and access to the remaining 70% is guaranteed.

- *Megebaaya*, *i.e.*, the Village-level *Baito*, is open all Village residents 18 and over.

Powers and duties of the *Baito* include:

- To collect local revenues, based on the central Governments' local duty and taxation directives (Article 13.6).
- To assess information on the people's needs, and to pass this on to the Regional Administration with recommended solutions (Article 13.4).
- To prepare Regional development programmes; to pass resolutions in harmony with central Government policies; and to implement the same when approved by the Minister of Local Government (Article 13.1).
- *Baito* members are accountable to their constituency; *Baito* reports are submitted to the Minister of Local Government (Article 14).
- *Baito* terms of office are 12 months, but the Minister of Local Government can prolong these by up to 6 months.
- The *Baito* prepares the recurrent *Zoba* budget, and implements it upon approval by the Minister of Local Government.

Powers and duties of the several Administrators:

- The *Zoba* Administrator is the highest administrative authority (Article 20.1). He or she plans, controls, and implements directives on behalf of the central Government (via MoLG) (Articles 20.2, 20.3, & 20.4).
- The *Zoba* Administrator has the power to suspend *Baito* resolutions and recommendations until the Minister of Local Government decides upon them, if he or she thinks that policies of the central Government are being violated.
- The *Zoba* Administrator chairs all *Baito* meetings.
- The *Sub-zoba* Administrator is answerable to the Zo*ba* Administrator.
- The Village/Area Administrator is answerable to the *Sub*-zoba Administrator.
- The Village/Area Administrator chairs all *Megebaaya* meetings (Article 30.1). He or she has the power to 'punish' those that do not fulfil their duty.

Powers of the Regional (*Zoba*) Administrations

- To prepare the Regional recurrent budget and allocate the same upon approval of the MoLG (Article 37.3

Powers of Central Government bodies:

- To formulate plans and develop budgets, and supervise their implementation (Article 36.1).
- To establish and administer banks and related matters (Article 35.6).
- The Regional Administrator shall comply with the central Government in collecting revenues at the Regional level (Article 38).
- Regional and Sub-regional Administrators, Regional Executives, Department Heads, and Village/Area Administrators are all appointed by either the President or by the Minister of Local Government (Article 39).

Decentralisation and devolution of power to the local level:
Currently, the Regional (*Zoba*) Administrations – as executive bodies and the highest echelon of the Regions – are responsible for integrating the plans of the line ministries and mass organisations. They are also responsible for co-ordinating and implementing the planned activities after the approval of the legislative body, the *Baito*.

Regional (*Zoba*) Administrators are made responsible to:

1. Execute administrative and social services as well as development programmes;
2. Prepare the Regional development plan and budget, and implement it upon its approval, integrated with the national plan of the central Government;
3. Prepare the Regional recurrent budget, and allocate to the Sub-regional Administrators the same power, upon approval of the line ministry;
4. Control compliance with, and proper implementation of, the central Government's policies, standards, and directives;
5. Undertake research and studies, collect statistical data, and pass the results on to the Minister of Local Government;
6. Recruit and take other necessary measures to strengthen and improve the quality of the Regional human resources, in accordance with established

rules and the provisions of the Proclamation for the Establishment of Regional Administrations (No. 86/1996);

7. Submit brief monthly progress reports and semi-annual evaluations to the Minister of Local Government; and

8. Perform other tasks provided for by the Proclamation.

The Regional Administrations also play a vital role in:

- Ensuring the even distribution of socio-economic developments;
- Ensuring the active participation of communities in local affairs; and
- Encouraging local initiatives, that guarantee a gradual decentralisation as one of the bases for sustainable development.

Establishment of the new structure has primarily encouraged the participation of local communities in the identification, preparation, implementation, and management of development programmes. In particular, the new organisational set-up of the Sub-regional and Village Administrations has laid a good foundation for the concerted action of local communities not only in environmental protection, but also in other development endeavours. In the prevailing administrative structure, there are committees made up of Village representatives responsible for overlooking the implementation of sectoral plans, at the lowest level of the Administration, although their establishment has not as yet been fully realised in all Village Administrations. The participation of the local communities and the commitment of the elected committees are so far proving to be crucial in the development process of Eritrea.

For instance, performance by the committees already established in some parts of Eritrea to look after the protection and management of the environment can be measured in terms of concrete results. However, there is still a need to increase the awareness of the established committees, and to assist them in properly carrying out their responsibilities. There is also a need to strengthen their capacity.

B.12.4.4 Role of Local Government in Land Allocation for Urbanisation

Among the major factors related to desertification are the establishment of new settlement areas and urbanisation. Local Governments, as institutions responsible for land management and allocation, can play a substantial role in properly managing available land and subsequently mitigating the harm that can be inflicted upon the environment, or controlling desertification and its consequences. The issues of urbanisation and desertification being outlined here have been dealt with earlier in some detail (see Section B.8).

Local Government and the environment:
The role of Local Governments in protecting and managing the environment consists largely of:

- Increasing the awareness of local communities regarding the need for environmental protection and management;
- Encouraging communities to protect their environment; and
- Mobilising the efforts and resources of local communities.

The Proclamation for the Establishment of Regional Administrations (No. 86/1996) has bestowed responsibility for environmental protection upon the Regional Administrations.

- 'Environmental protection' is made one of the four bodies of 'Economic development' of the Regional structures, the others being 'Agriculture', 'Marine resources', and 'Land' (Article 19.b.1.1).

- However, the above structure does not carry forth to the Sub-regional level (see Article 25). The power of the Administrator of the Sub-region includes, 'The necessary measures to consume and develop the natural environment' (Article 26.10).

- The power of the Village/Area Administrator includes 'the necessary measures to consume and develop the natural environment' (Article 30.10). The Proclamation allows for committees to be established at the Village/Area level) 'to execute programmes and directives of the Administrator' (Article 30.d).

Here there is good opportunity to establish a 'Land-degradation Committee' under the leadership of the Administrator at the Village/Area level. Such a committee would work closely with the Administrator to address issues of direct concern to the community, as developed in some of the proposed Project Profiles (see Appendix 1.2, PP Nos. I1-1/2 & L1-1/1).

Awareness by the local community:
Awareness is the cornerstone for the effective and efficient implementation of any development programme, both in general and for the protection of the environment in particular. The efforts exerted so far to increase environmental awareness at the local-community level have been encouraging. However, those efforts should continue in order to ensure sustainability. People need to be educated continuously, both formally and informally. Additionally indispensable for ensuring a sustainable and successful package of environmental protection are efforts by the mass media, local training, workshops, tours to countries with substantial experience, etc. These approaches are especially important for *Baito* executives, leaders of mass organisations such as NUEW and NUEYS, and community representatives.

As mentioned earlier, Local Governments have since independence in 1991 taken various initiatives to ensure the awareness of the local communities about environmental issues, and thereby to implement successful environmental rehabilitation programmes. However, to

carry on those efforts, the capacity of the Local Governments will have to be strengthened.

Community participation in environmental protection:
Community participation in the choice and execution of development interventions is the *sine qua non* of achieving sustainable development. The main idea behind the need for participation – *i.e.,* in terms of labour, materials, and cash – is to increase the effectiveness and sustainability of development interventions. With community participation, programmes are based on better information. Local people are more likely to contribute to the programme and sustain it after outside support has been phased out. In fact, it has now become the general consensus that grassroots participation in development is a necessary pre-condition for communities to be able to manage their affairs, control their environment, and enhance their well-being.

In Eritrea, the prevailing local frameworks or grassroots organisations – the Council (*Baito*) at the Regional (*Zoba*) level and the Assembly (*Megebaaya*) at the Village level – serve to bolster community participation. Indeed, the *Baitos*, NUEW, and NUEYS are some of the most precious heritages to have emerged from our War of Liberation of 1961-1991, having proved most worthy in the ongoing post-war development process. Similarly, their role in environmental protection and management is also becoming significant. These community organisations are facilitating participation by the local people, mobilising their efforts and resources. Owing to their crucial roles in ensuring community participation, the need has become essential for strengthening the administrative capacities of Local Governments, NUEW, and NUEYS, as well as their capacity for implementing and managing environmental projects.

Some policy options:
Decentralisation is recognised as an important policy instrument in combating desertification. This is because local people are best able to address the issues inasmuch as they are closest to the problems of land degradation. The Eritrean perception towards decentralisation is still evolving. That perception is moulded by the existing central political and social concept that a nation must maintain a unitary and unified state, although one that at the same time recognises the diversity of its cultures and peoples. '**Unity in diversity**' is a central message enshrined in the Eritrean constitution.

The evolution of decentralisation took a major leap in 1996 when the Proclamation for the Establishment of Regional Administrations (No. 86/1996) was adopted. That Proclamation establishes the initial steps towards decentralisation. But as summarised above, the Proclamation does not provide for full decentralisation (see Fact Sheet B.3). It continues to vest most local power with the central Government authorities, who are not directly responsible to the people. The Minister of Local Government must approve all important decisions.

Local authorities do not have the power to raise revenues and utilise them as they see fit. Their power in this regard is limited to preparing a recurrent budget. Even the execution of those budgets is subject to approval by the central Government.

B.12.4.4 Conclusion

In short, it is clearly important to strengthen the technical and managerial capacities of the Local Governments, and to enable them to operate and maintain their development interventions. Thus, in order to ensure the strengthening of their capacity, Local Governments should be assisted as necessary, financially, technically, and administratively.

PART C: THE NATIONAL ACTION PROGRAMME (NAP)

C.1 The Five Pillars of the National Action Programme (NAP)

NAP recognises five important steps to be taken. These steps should be taken sequentially, although in some cases two or more steps could be taken simultaneously:

i. **Improving knowledge;**
ii. **Empowering people and institutions;**
iii. **Addressing the concerns of vulnerable groups (women and pastoralists);**
iv. **Reducing poverty through income-generation;** and
v. **Arresting land degradation and controlling desertification.**

i. Improving knowledge:
Actions aimed at improving knowledge should include:

- Better data collection and analysis through the establishment of monitoring and assessment networks on land degradation;
- Improved understand of the carrying capacity of land;
- Improved measures and indicators of land degradation, particularly a better understanding of the nature and scope of loss of productivity in farmland and grazing land; and
- Improved understanding of drought and its impact on desertification.

ii. Empowering people and institutions:
Actions aimed at empowering people and institutions should include:

- Establishment of an effective emergency-response mechanism to mitigate the effects of drought;
- Establishment of effective local action groups (community-based organisations) to address land-degradation issues, as envisaged in the Proclamation for the Establishment of Regional Administrations (No. 86/1996);
- Accelerating implementation of the Land Reform Proclamation (No. 58/1994).
- Providing an opportunity for the affected population to periodically assess its progress (or lack thereof) in arresting land degradation and in reducing poverty. This is to be carried out through the periodic assemblies of the NAP National Forum on Land Degradation;
- Involvement by youth and women;
- Development of a community tool box.
- Networking through the use of radio, television, etc.
- Advertising; and
- Fund-raising.

iii. Addressing the concerns of vulnerable groups (women and pastoralists):
Actions aimed at addressing the concerns of vulnerable groups (women and pastoralists) should include:

- Establishment of special programmes for female-headed farming households; and
- Establishment of special programmes for pastoralists.

iv. Reducing poverty through income-generation:
Actions aimed at reducing poverty through income-generation should include:

- Developing marketing strategies and establishing effective marketing mechanisms for the products of people in the arid and semi-arid areas of Eritrea.

v. Arresting land degradation and controlling desertification:
Actions aimed at arresting land degradation and controlling desertification, particularly of productive agricultural lands, should include:

- Controlling and, where possible, completely eliminating, excessive nutrient losses from productive agricultural lands;
- Expanding enclosure systems;
- Expanding systems for the protection of productive land from erosion;
- Expanding systems for the retention of soil moisture; and
- Expanding ground cover by planting appropriate vegetation.

C.2 The Proposed Project Profiles (PPs)

The National Action Programme (NAP) will in time propose concrete actions addressing each of the five pillars upon which it rests, as identified above (see Section C.1). This is being done in the light of the various major factors contributing to desertification, as identified and explained earlier under the headings of 12 issue areas (sectors) (see Part B).

The 23 Project Profiles (PPs) being offered below for action (see Appendix 1) can be sorted out into a matrix of 60 cells that distinguishes among the five pillars of NAP in light of the 12 issue areas (sectors) (see Table C.1). Each PP is assigned to at least one cell, and perhaps also secondarily (parenthetically) to an additional cell.

As to the funding of the 23 proposed Project Profiles (PPs), it is suggested that a total of US$ 37.890 million will be needed in order to carry them out, of which US$ 3.815 million (10%) is to come from local sources, and the remaining US$ 34.075 million (90%) from external sources (see Appendix 1.2, each PP Row No. 6). The funding being assigned to each of the PPs has also been sorted out as above into 60 cells (see Table C.2). If the PP falls under more than one of the five pillars of NAP (see Appendix 1.2, each PP Row No. 1), it will be entered into more than one cell. In such cases, the primary cell is assigned two-thirds of the funding, and the secondary cell the remaining one-third.

Table C.1 Proposed Measures to Address Desertification

Factors contributing to desertification	The five pillars of NAP					
	i.	**ii.**	**iii.**	**iv.**	**v.**	**No. of projects**
B.1	A1-1/3	A3-3/3			A2-2/3	**3**
B.2				B1-1/1	(B1-1/1)	**1**
B.3	C1-1/2 (C2-2/2)	C2-2/2				**2**
B.4			(D1-1/2)	D2-2/2	D1-1/2 (D2-2/2)	**2**
B.5					E1-1/1	**1**
B.6	F3-3/4	F1-1/4 F4-4/4			(F1-1/4) F2-2/4 (F4-4/4)	**4**
B.7	G1-1/5 G3-3/5	(G1-1/5) G2-2/5		G4-4/5	G5-5/5	**5**
B.8					H1-1/1	**1**
B.9	(I1-1/2)	I1-1/2			I2-2/2	**2**
B.10						**0**
B.11	K1-1/1				(K1-1/1)	**1**
B.12		L1-1/1				**1**
No. of projects	**8**	**8**	**1**	**3**	**12**	**23**

Notes: (a) The **five pillars of NAP** are: i. Improving knowledge; ii. Empowering people and institutions; iii. Addressing the concerns of vulnerable groups (women and pastoralists); iv. Reducing poverty through income-generation; and v. Arresting land degradation and controlling desertification.

(b) The **12 issue areas (sectors)** are: B.1 Land issues; B.2 Agricultural issues; B.3 Water issues; B.4 Energy issues; B.5 Biodiversity issues; B.6 Forestry issues; B.7 Livestock and rangeland issues; B.8 Human-settlement issues; B.9 Drought-preparedness issues; B.10 Awareness, education, & training issues; B.11 Socio-economic issues; and B.12 Public-participation issues.

(c) The **Project Profile (PP) numbers** assigned to the 60 cells of the matrix refer to the 23 PPs presented in Appendix 1.2. Note that a proposed project can apply to more than one of the five pillars of NAP (see Appendix 1.2, each PP Row No. 1), *i.e.*, be entered into more than one cell. If it appears in a second cell, then the second entry is in parentheses in order to indicate its subsidiary character.

Table C.2 Proposed Budget to Address Desertification

Factors contributing to desertification	The five pillars of NAP						
	i.	**ii.**	**iii.**	**iv.**	**v.**	**Total (US$ thousand)**	**%**
B.1	1,500	100			100	**1,700**	**4.5**
B.2				4,667	2,333	**7,000**	**18.5**
B.3	542	433				**975**	**2.6**
B.4			450	1,467	1,633	**3,550**	**9.4**
B.5					1,700	**1,700**	**4.5**
B.6	5,500	6,000			8,000	**19,500**	**51.5**
B.7	380	340		50	225	**995**	**2.6**
B.8					400	**400**	**1.1**
B.9	117	233			700	**1,050**	**2.8**
B.10						**0**	**0**
B.11		200			100	**300**	**0.8**
B.12		720				**720**	**1.9**
Total (US$ thousand)	**8,039**	**8,026**	**450**	**6,184**	**15,191**	**37,890**	
%	**21.2**	**21.2**	**1.2**	**16.3**	**40.1**		**100**

Notes: (a) The **five pillars of NAP** are: i. Improving knowledge; ii. Empowering people and institutions; iii. Addressing the concerns of vulnerable groups (women and pastoralists); iv. Reducing poverty through income-generation; and v. Arresting land degradation and controlling desertification.

(b) The **12 issue areas (sectors)** are: B.1 Land issues; B.2 Agricultural issues; B.3 Water issues; B.4 Energy issues; B.5 Biodiversity issues; B.6 Forestry issues; B.7 Livestock and rangeland issues; B.8 Human-settlement issues; B.9 Drought-preparedness issues; B.10 Awareness, education, & training issues; B.11 Socio-economic issues; and B.12 Public-participation issues.

(c) The proposed **Project Profile (PP) funding** assigned to the 60 cells of the matrix has been summarised from Row 6 of the 23 PPs presented in Appendix 1.2. When a project applies to more than one of the five pillars of NAP, *i.e.*, has been entered into more than one cell on the basis of Row No. 1 of the 23 PPs (see Table C.1), then two-thirds of its funding is assigned to its primary cell, and the remaining one-third to its secondary (subsidiary) cell.

C.3 Conclusion

The 23 projects being proposed to implement NAP at the outset can be examined in two ways: in terms of the five pillars of NAP presented above (see Section C.1); and in terms of the 12 issue areas (sectors) presented earlier (see Part B). An examination in terms of the five pillars of NAP (see Tables C.1 & C.2) makes it clear that major emphasis in the initial pursuit of NAP is to be with arresting land degradation and controlling desertification (the fifth pillar). Indeed, 12 of the 23 proposed projects and 40% of the proposed budget address that pillar. Tied for second place are improving knowledge (the first pillar) and empowering people and institutions (the second pillar), each with 8 projects and 21% of the funding. By contrast, addressing the concerns of vulnerable groups (women and pastoralists) (the third pillar) is hardly being addressed at the outset, with only 1 project and a mere 1% of the funding. Reducing poverty through income-generation (the fourth pillar) is initially being accorded intermediate attention, with 3 projects and 16% of the funding.

An examination of the proposed early emphasis of NAP in terms of the 12 issue areas (sectors) (see Tables C.1 & C.2) reveals a major initial emphasis on forestry issues (the sixth issue, B.6), to which is being allocated 52% of the proposed budget (via four projects). In second place is agricultural issues (the second issue, B.2), with 18% of the proposed budget (via two projects). The largest number of projects (five) is being proposed for livestock and rangeland issues (the seventh issue, B.7), although that sector is being allocated only 3% of the proposed budget. At the low end, no direct financial support is being initially planned for awareness, education, and training issues (the tenth issue, B.10); and quite little to human-settlement issues (the eleventh issue, B.11).

The initial priorities being suggested here should be subjected to detailed scrutiny at the next NAP National Forum on Land Degradation (see Section D.2).

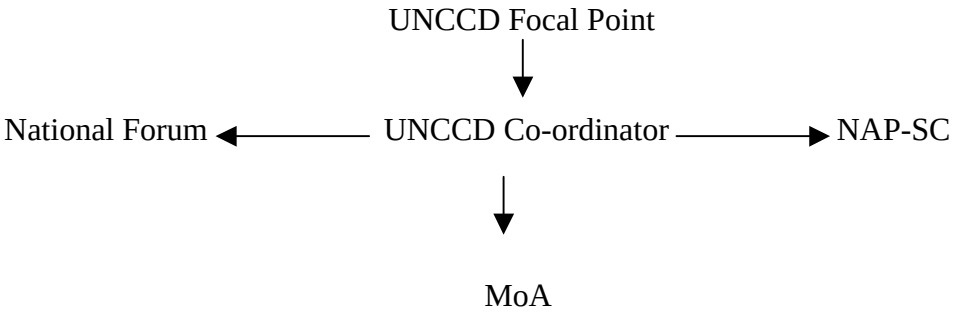
PART D: IMPLEMENTING THE NATIONAL ACTION PROGRAMME (NAP)

D.1 Institutional Measures for Implementing NAP

D.1.1 Instituting NAP at the National Level

The lead institution responsible for implementing NAP is the Ministry of Agriculture (MoA). However, because land degradation is a cross-cutting issue, many other institutions must also become actively involved in implementing NAP, particularly the Ministry of Local Government (MoLG) and the Ministry of Land, Water, & Environment (MoLWE).

NAP is to be implemented at the national level in accordance with the following structure:



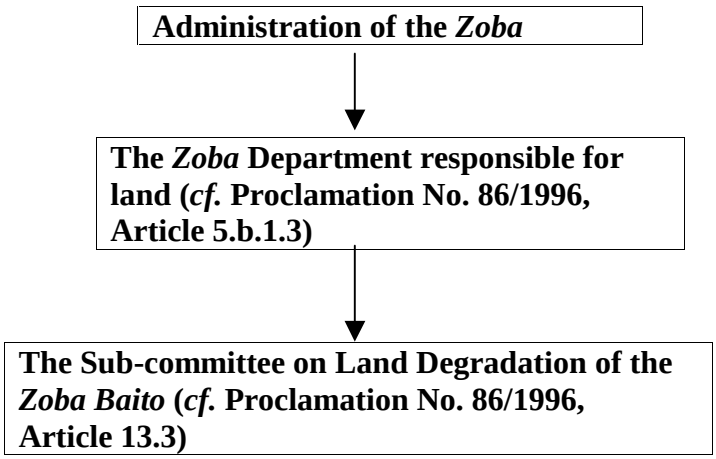
The terms of reference for the NAP Steering Committee (NAP-SC) are:

- To keep NAP under review, and to monitor its implementation at the national level;
- To identify gaps in action or knowledge, and to specify modalities for addressing them;
- To formulate policy on land degradation;
- To revise the NAP document as appropriate in light of changing circumstances, new information, and recommendations of the NAP National Forum on Land Degradation, which is to be held every 3 years;
- To co-ordinate the actions of all the stakeholders on land degradation, and to suggest ways and means of harmonising these; and
- To suggest ways and means of mobilising resources, both locally and externally.

The members of the NAP Steering Committee (NAP-SC) will be selected by the Ministry or other agency they represent, subject to confirmation by MoA. The NAP-SC will formulate its own rules of procedure, including length of tenure of its members, review of its mandate, and means of decision-making. As to the Chairperson of the NAP-SC, this could be either the designated Eritrean UNCCD National Focal Point, or else be an independent person not in the civil service who is recognised for his or her knowledge and experience in land degradation.

D.1.2 NAP at the *Zoba* Level

NAP is to be implemented at the *Zoba* level in accordance with the following structure:



***Baito* Sub-committee on Land Degradation:**
A key mechanism for implementing NAP at the *Zoba* level is the Sub-committee on Land Degradation of the *Zoba Baito*. This body is formed in accordance with the Proclamation for the Establishment of Regional Administrations (No. 86/1996), via which the *Baito* has the power to 'form various committees comprising members and non-members' of the *Baito* (Article 13.3).

Members of the Sub-committee shall serve for a minimum period of 3 years. The Sub-committee shall consist of 12 members, of which 6 will be sitting members of the *Baito* and the other 6 will be non-members. 30% of the membership shall be reserved for women, and they shall have equal opportunity for the remaining 70% of the seats (Article 10.3.a). The rules of procedure of the *Baito* apply equally to the Sub-committee (*e.g.*, Articles 10.30 & 15).

The Sub-committee shall have broad powers to deal with land-degradation issues, *inter alia*:

- To prepare Regional programmes relating to the arresting of land degradation, and to pass resolutions and issue directives thereupon in harmony with central Government policies, and to implement same in consultation with the Ministry of Agriculture and the Ministry of Local Government;

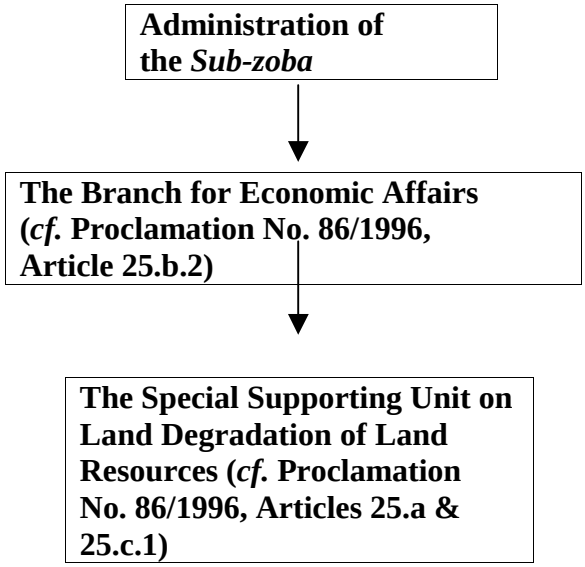
- To gather and assess information on the people's felt needs, problems, and views pertaining to land degradation, and to recommend solutions for implementation by the Regional Administrator;

- To review social and economic programmes related to land degradation prior to their approval by the full *Zoba Baito*; and

- To participate fully in the NAP National Forum on Land Degradation.

D.1.3 NAP at the *Sub-zoba* Level

NAP is to be implemented at the *Sub-zoba* level in accordance with the following structure:
:



The Proclamation for the Establishment of Regional Administrations (No. 86/1996) specifically empowers the *Sub-zoba* Administrator to 'take the necessary measures to conserve and develop the nation' (Article 36.10). The Proclamation also provides for Branches of the *Sub-zoba* Administration to assume administrative responsibility for sectors including land.

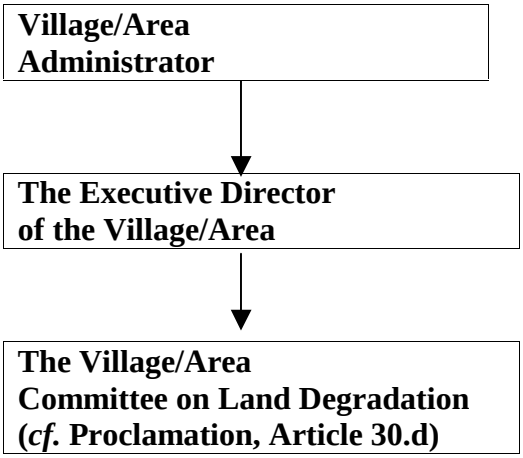
Insofar as land degradation and NAP implementation at the *Sub-zoba* level are concerned, a Special Supporting Unit on Land Degradation may be created as and when the necessary human-resources capacity is in place and as the scope of land-degradation services are expanded (Proclamation, Article 25.c.1).

One of the ways by which the Administrator of the *Sub-zoba* 'takes the necessary measures to conserve' land resources is to establish a Special Supporting Unit on Land Degradation. Such unit could be headed by a specially trained co-ordinator and facilitator designated by the Administrator of the *Sub-zoba*. The duties and responsibilities of the Special Supporting Unit on Land Degradation might be the following:

- To gather and assess information on the people's felt needs, problems, and views pertaining to land degradation at the *Sub-zoba* level, and to recommend solutions for implementation by the Administrator of the *Sub-zoba*.

D.1.4 NAP at the Village/Area Level

A key mechanism for implementing NAP at the grassroots level is the *Megebaaya*, the free 'Assembly' of all Village or Area inhabitants 18 years or older. NAP is to be implemented at the Village/Area level in accordance with the following structure:



The persons responsible for implementing NAP at the grassroots level are the Village/Area Administrator and the Executive Director. The Proclamation for the Establishment of Regional Administrations (No. 86/1996) defines their relevant powers and duties (Chapter 7, Article 29).

The Village/Area Administrator and the Executive Director will work closely with a committee of Villagers and area inhabitants specifically designated to address land-degradation issues of the locality. The committee shall be chaired by a person elected from amongst its members. The Proclamation defines the powers and duties of Village/Area-level committees (Article 29.d). These include:

- Executing the programmes and directives of the Administrator. It formulates its own local programme on land degradation, and defines modalities for implementing it through the administrative mechanism of the Village/Area;

- Mobilising co-operative self-help projects and programmes, including small-scale enterprises related to improving livelihoods through making the land more productive;

- Addressing the problems of poverty through income-generating activities;

- Addressing the problems of vulnerable groups, especially of women; and

- Improving the welfare of women farmers, especially the welfare of female-headed households working on the land.

Finally, two or more Villages might join forces in their NAP endeavours. The Proclamation for the Establishment of Regional Administrations (No. 86/1996) provides for this: 'A centre of Administration shall be established to serve more than two Villages...the number of Villages being determined by geographic conditions' (Article 3.iii).

D.2 Role of the NAP National Forum on Land Degradation

The NAP National Forum on Land Degradation is the principal platform for discussing policy issues on land degradation. The National Forum will bring together all the stakeholders concerned with land degradation from all levels. The National Forum will be held every 3 years. It will:

- Review and evaluate progress being made in addressing land degradation at all levels;
- Recommend policy changes where these are deemed necessary; and
- Focus national attention on land degradation and thereby increase national awareness and commitment to address land degradation more effectively.

The potential participants of the National Forum are:

- Village/Area Administrator and Village/Area Executive Directors;
- Chairperson of the Village/Area Sub-committee on Land Degradation;
- Administrators of *Sub-zobas*;
- Head of the *Sub-zoba* branch responsible for land-related questions;
- Head of the *Sub-zoba* Special Supporting Unit on Land Degradation;
- Heads of *Zoba* Departments responsible for land questions;
- All members of the *Baito* Land Degradation Sub-committee;
- Representatives of the line ministries at the *Zoba* level;
- All members of the UNCCD-SC;
- Representatives of the line ministries;
- Representatives of NGOs (both national and international);
- Representatives of civic organisations;
- The UNCCD Focal Point; and
- The UNCCD Co-ordinator.

D.3 Legal measures to implement NAP

Two GoE Proclamations provide the necessary legal basis for implementing NAP. These are:

- The Land Reform Proclamation (No. 58/1994); and

- The Proclamation for the Establishment of Regional Administrations (No. 86/1996).

At present it is considered that those two proclamations provide sufficient legal basis for implementing NAP. Additional legislation, still in draft form (*e.g.*, a Forestry & Wildlife Act) would provide added legal capacity to implement NAP, once they are adopted.

The Land Reform Proclamation (No. 58/1994):
This Proclamation has been described earlier (see, *e.g.*, Fact Sheet B.1). The Proclamation provides:

- A good basis for security of land tenure. That in turn provides an incentive for better land husbandry and for increased long-term investment in land improvement;
- An equitable and fair distribution of land resources amongst men and women; and
- Improved access to land for those groups which had been traditionally denied such access.

The Proclamation for the Establishment of Regional Administrations (No. 86/1996):
This Proclamation has also been described earlier (see, *e.g.*, Fact Sheet B.3). Despite some shortcomings, the Proclamation provides:

- An empowering framework for action at the *Zoba*, *Sub-zoba*, and Village/Area levels;
- A clear mandate to local-level officials – especially *Zoba*, *Sub-zoba*, and Village/Area Administrators – to take action in protecting and preserving land resources; and
- A framework for the evolution of grassroots action against land degradation.

D.4 Financial Measures for Implementing NAP

Sector-specific financial resources:
As the NAP process becomes more and more institutionalised, each Ministry or other Government agency will have begun to report on the portion of its financial resources allocated to land-degradation issues. The NAP National Forum on Land Degradation will provide an appropriate opportunity to hear and discuss the financial reports of all the stakeholders. The UNCCD Co-ordinator's office will be required to present a consolidated analytical report analysing what resources each Ministry allocate to land-degradation issues.

An important agenda item for discussion at the NAP National Forum on Land Degradation will be the scope and level of resources each Ministry provides or allocates to land-degradation issues. That discussion will be based in part upon the report of the UNCCD Co-ordinator. It is clear that some financial resources will be mobilised from the different stakeholders themselves, either as part of their budgetary allocation or else raised by them from other sources, both domestic and external. By way of example, the following five Ministries should certainly be able to make funding available for projects in the areas

suggested for them:

- *Ministry of Agriculture (MoA):* B.2 Agricultural issues; B.6 Forestry issues; B.7 Livestock and rangeland issues; and B.9 Drought-preparedness issues.

- *Ministry of Land, Water, & Environment (MoLWE):* B.1 Land issues; B.3 Water issues; and B.5 Biodiversity issues.

- *Ministry of Energy & Mining (MoEM):* B.4 Energy issues.

- *Ministry of Education (MoE):* B.10 Awareness, education, & training issues.

Financial resources for cross-cutting issues:
To at least some extent, all land-degradation issues can be perceived of as cross-cutting issues. Nonetheless, one can focus here on some aspects of land degradation that are especially, even uniquely, cross-cutting, amongst them:

- Socio-economic issues (see Section B.11);
- Public-participation issues (see Section B.12);
- Vulnerable-group issues, particularly regarding women and pastoralists (see Sections B.11.7 & B.12.3); and
- Poverty-reduction issues (see Sections B.11.4 & B.11.5).

The 1994 Convention to Combat Desertification [UNTS 33480] (UNCCD) recognises the central role of financing for achieving its objectives, and for that matter includes a number of provisions on financial resources and mechanisms (Articles 20 & 21).

Eritrean National Desertification Fund (ENDF):
At the national level, the establishment of the Eritrean National Desertification Fund (ENDF) is the principal mechanism which will be used 'to channel financial resources rapidly and efficiently to the local level' (Article 21.1.d). The mandate and mission of ENDF can be summarised as follows:

- ENDF is the primary financial mechanism for supporting community-level anti-desertification and drought-mitigation activities;

- ENDF may be linked to the Eritrean Community Development Fund (ECDF), either formally or informally. The modalities for such a linkage are still to be determined by appropriate legislation; and

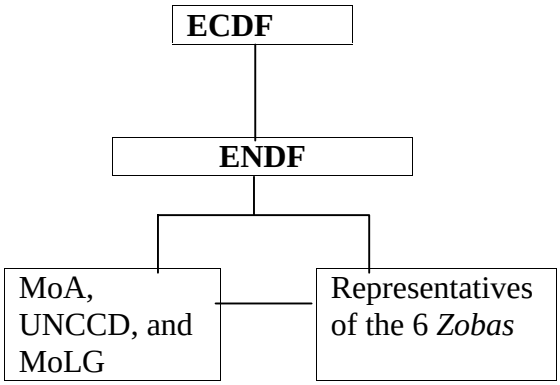
- Notwithstanding its possible link with ECDF, ENDF shall have a Board of its own, to be composed of representatives from MoA, from MoLG, and from each of the six *Zoba Baitos*.

Thus it can be seen that although ENDF is being created by Government decree and is to be linked to a Government structure, it will have a governing body of its own that will have

members from all the stakeholders, particularly from the local communities. ENDF may receive some funding from the Government, but its main source of funds is to be external to the central Government Treasury. Thus, ENDF may receive funds from:

- The GoE National Treasury;
- International multilateral or bilateral sources, including nongovernmental organisations (NGOs); and
- Any other voluntary organisation.

ENDF is to be implemented in accordance with the following structure:



Finally, ENDF moneys are expected to be used according to the following guidelines:

- ENDF shall be used for projects designed to promote good land husbandry at the *Zoba*, *Sub-zoba*, and Village/Area levels;
- Projects submitted by Village/Area-level representatives shall be given priority consideration;
- Eritrean NGOs may submit for consideration projects related to land degradation; and
- MoA, in consultation with ECDF, shall prepare detailed regulations for the administration of ENDF.

APPENDIX 1
PROJECT PROFILES (PPs)

Appendix 1.1 Explanatory Note

Each of the 23 proposed Project Profiles (PPs) has a summary sheet. The following offers a guide to those summaries.

Project Profile No.: This number has four components, in the format 'A1-1/1', as follows:

First component: One of 12 letters, A through L, each signifying a sectoral programme (corresponding to the 12 sections presented in Part B of this report):
A = Land issues; B = Agricultural issues; C = Water issues; D = Energy issues; E = Biodiversity issues; F = Forestry issues; G = Livestock and rangeland issues; H = Human-settlement issues; I = Drought-preparedness issues; J = Awareness, education, and training issues (although no project begins as yet with this letter); K = Socio-economic issues; and L = Public-participation issues (*cf.* '2. Issue', below).

Second component: One of several numbers, simply the sequential project number within its programme.

Third component: One of several numbers, indicating that project's priority within its program, 1 signifying the highest relative priority, and subsequent numbers signifying ever lower relative priorities (*cf.* '13. Priority' below.)

Fourth component: One of several numbers, simply giving the total number of projects within its programme.

1. Basis for action: Pinpointed here is where within the NAP text the specific issue to which this project proposal responds is located.

2. Issue; Sub-issue: Provided here under ***Issue*** is reference to the section in the text that deals with the sector within which the project falls. It is equivalent to the first component of the Project Profile number. Also provided here is which of the **five pillars of NAP** this project helps to address: **i.** Improving knowledge; **ii.** Empowering people and institutions; **iii.** Addressing the concerns of vulnerable groups (women and pastoralists); **iv.** Reducing poverty through income-generation; and **v.** Arresting land degradation and controlling desertification. ***Sub-issue*** narrows the Issue focus in words.

3. Project title: Major land-degradation issues appear in NAP under 12 headings (sectors), *i.e.*, Land issues; Agricultural issues; Energy issues; Water issues; Biodiversity issues; Forestry issues; Livestock and rangeland issues; Human-settlement issues; Drought-preparedness issues; Awareness, education, and training issues; Socio-economic issues; and Public-participation issues. Within each of these sectors there are sub-sectors

(sub-headings). Each project has a title which falls under one of these sectors or sub-sectors.

4. Ministry, institution, or agency responsible: The body or group responsible for implementation of the project is identified. An indication of the level of participation may be given.

5. Participation of communities & NGOs: Any expected community or NGO participation is noted here.

6. Financial requirements: Given here are the ***local***, ***external***, and ***total*** figures needed to complete the project, all in US dollars (US$).

7. Duration; Start; Completion: The anticipated timeline for each project is identified here.

8. Potential partner(s): Given here are both the ***local*** and ***external*** groups that are perceived as potential stakeholders and joint players in implementing the project (*cf.* 13. 'Potential linkages' below). The inclusion of the name of any such partner here does **not** imply a firm commitment by that partner.

9. Scope: The scope of the project refers to whether it is nationwide or restricted to a specific area.

10. Objective(s): Project objectives are provided here (quantifiable, to the extent feasible), in order to make it possible to assess the success of the project after its completion.

11. Description: Given here is a brief account of the project and its organisation.

12. Management requirements: Details of expected management and personnel requirements are given here.

13. Priority accorded within the sector; Potential linkage(s): Listed under ***Priority...*** is the project's numerical priority within its programme, with '1' signifying the highest priority within its programme. It is equivalent to the third and fourth components of the Project Profile number. Listed under ***Potential linkage(s)*** are groups pursuing similar or complementary projects and with which it would be useful to co-operate (*cf.* '8. Potential partner[s]'above). The inclusion of the name of any linkage here does **not** imply a firm commitment by that linkage.

14. Prerequisites & advance preparations: Any required forward planning is detailed here.

15. Other observations: This is reserved for important information not otherwise presented earlier.

Appendix 1.2 23 Project Profiles (PPs)

A1-1/3: Mapping & land classification for resource assessment.
A2-2/3: Application of land-tenure system in pilot areas.
A3-3/3: Introduction of community land-use planning in pilot areas.
B1-1/1: Assistance to farmers for *in situ* conservation of indigenous crops & landraces.
C1-1/2: Soil-moisture assessment.
C2-2/2: Community awareness-raising.
D1-1/2: Dissemination of improved traditional wood stoves.
D2-2/2: Promotion of renewable-energy technologies for rural community benefits.
E1-1/1: Establishment of gazetted protected areas.
F1-1/4: Fuelwood plantations.
F2-2/4: Enclosure development & conservation activities.
F3-3/4: Woody biomass survey.
F4-4/4: Development of agro-forestry in farm forestry.
G1-1/5: Identification of useful grasses & forbs of Eritrea.
G2-2/5: Reviewing & revising existing customary (traditional) law on the management & utilisation of communal grazing lands.
G3-3/5: Comparative analysis of livestock *versus* crop production.
G4-4/5: Livestock marketing through the establishment of marketing outlets.
G5-5/5: Establishment of shelterbelts in areas prone to dust storms.
H1-1/1: Conversion of land use from agriculture to housing: the case of 13 Villages incorporated into Asmara municipality.
I1-1/2: Understanding & strengthening traditional coping mechanisms, strengthening the capacity of local communities, & the Local Drought Preparedness & Mitigation Plan (DPMP-L).
I2-2/2: Developing a national Drought-preparedness & Mitigation Plan (DPMP) in the context of NAP.
K1-1/1: Population, development, & land interactions: evaluating alternative possibilities for future development in Eritrea.
L1-1/1: Establishing local Land Degradation Committees.

Note: There is no Project Profile number beginning with 'J'.

Factors Contributing to Desertification

Land Issues

1. Basis for action: Section B.1.2. ***Project Profile No.*** **A1-1/3**

2. Issue: Section B.1. ***NAP Pillar No.*** i.
Sub-issue: Assessment of natural resources.

3. Project title: **Mapping & land classification for resource assessment.**

4. Ministry, institution, or agency responsible: MoLWE Department of Land.

5. Participation of communities & NGOs: Participation of communities vital.

6. Financial requirements: External: US$ 1,500,000.

7. Duration: 4 years ***Start:*** ***Completion:***

8. Potential partner(s): Local: MoA.

9. Scope: National.

10. Objective(s): To produce aerial photos of the whole country. To develop a national capability for land-use planning, & to produce a land classification which provides an effective basis for overall rural & urban development.

11. Description: A 1:25,000 scale aerial photo of the whole country is to be produced. Various data are to be collected from aerial-photo interpretations & field observations. Land classification is to be carried out with the collected information, & a number of further maps might also be produced. The project is to be carried out in 4 phases, covering specific *Zobas* in each phase. The completion of the project would strengthen the MoLWE Department of Land, & hence facilitate the implementation of the recent Land Reform Proclamation (No. 58/1994).

12. Management requirements: Managed under the MoLWE Division of Land Use & Cartography.

13. Priority accorded within the sector: Priority 1 out of 3.
Potential linkage(s): Close co-operation important with MoA & Eritrean Civil Aviation Authority.

14. Prerequisites & advance preparations: Recruitment &/or training of the necessary staff.

15. Other observations: None.

Factors Contributing to Desertification

Land Issues

1. Basis for action: Section B.1.2. ***Project Profile No. A2-2/3***

2. Issue: Section B.1. ***NAP Pillar No.*** v.
Sub-issue: Land tenure.

3. Project title: **Application of land-tenure system in pilot areas.**

4. Ministry, institution, or agency responsible: MoLWE Department of Land.

5. Participation of communities & NGOs: The communities in the project area are expected to co-operate.

6. Financial requirements: External: US$ 100,000.

7. Duration: 1 year ***Start:*** 2003 ***Completion:*** 2003

8. Potential partner(s): Local: MoLG & MoA.

9. Scope: National.

10. Objective(s): To test the new land-tenure system on Villages around Asmara.

11. Description: The new land-tenure system is to be implemented in 20 Villages around Asmara. This would be an experimental process, & the experience gained would help in the implementation of the land tenure system in a wider area.

12. Management requirements: Managed by the MoLWE Department of Land in co-operation with MoLG & MoA.

13. Priority accorded within the sector: Priority 2 out of 3.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: Intensive sensitisation of the local community is required before the implementation of this project.

15. Other observations: The MoLWE Department of Land has already carried out a land-capability classification & socio-economic survey of the area.

Factors Contributing to Desertification

Land issues

1. Basis for action: Section B.1.2. ***Project Profile No. A3-3/3***

2. Issue: Section B.1. ***NAP Pillar No.*** ii.
Sub-issue: Land-use planning.

3. Project title: **Introduction of community land-use planning in pilot areas.**

4. Ministry, institution, or agency responsible: MoLWE Department of Land.

5. Participation of communities & NGOs: Community participation is part of the project.

6. Financial requirements: External: US$ 100,000.

7. Duration: 1 year ***Start:*** 2003 ***Completion:*** 2003

8. Potential partner(s): Local: MoLG & MoA.

9. Scope: National.

10. Objective(s): To prepare a land-use plan, with community participation, which designates areas according to their resource potential.

11. Description: Planning is to be implemented in 20 Villages around Asmara. The process is to be accomplished through full participation of the involved local communities (*i.e.*, participatory land-use planning).

12. Management requirements: Managed by MoLWE Department of Land in co-operation with MoLG & MoA.

13. Priority accorded within the sector: Priority 3 out of 3.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: This project could be implemented only if the new-land tenure system is implemented as expected in these Villages. The necessary procedures & guidelines have to be worked out before the start of the implementation.

15. Other observations: This project should encourage community participation in combating desertification.

Factors Contributing to Desertification

Agricultural Issues

1. Basis for action: Section B.2.5. ***Project Profile No. B1-1/1***

2. Issue: Section B.2. ***NAP Pillar No.*** iv (also No. v).
Sub-issue: None.

3. Project title: **Assistance to farmers for *in situ* conservation of indigenous crops & landraces.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: Farmers, especially the selected ones, necessary.

6. Financial requirements: Local: US$ 2,000,000. ***External:*** US$ 5,000,000. ***Total:*** US$ 7,000,000.

7. Duration: 4 years ***Start:*** 2002 ***Completion:*** 2006

8. Potential partner(s): Local: MoLG & the 6 the *Zoba* Administrations.

9. Scope: National.

10. Objective(s): To provide a back-up for existing *ex situ* conservation efforts in case they are struck by unexpected calamities. In addition, the *in situ* conservation efforts would allow for better utilisation of landraces through enhancing yield capability.

11. Description: It is anticipated that some farmers in selected areas & for selected landraces will be given an incentive in the form of financial &/or technical assistance for a certain period of time, say *circa* 5 years, to continue to grow the endangered landraces. After such time, the landraces would have become enhanced through breeding & selection. From then on, farmers could presumably grow them profitably.

12. Management requirements: The assistance to farmers is an ongoing activity of MoA, but it needs to be expanded to include additional areas & landraces. For this reason additional staff & materials may be needed.

13. Priority accorded within the sector: Priority 1 out of 1. This is a priority area in certain places & for those landraces, which are on the verge of extinction.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: None.

15. Other observations: None.

Factors Contributing to Desertification

Water Issues

1. Basis for action: Section B.3.5. ***Project Profile No. C1-1/2***

2. Issue: Section B.3. ***NAP Pillar No.*** i.
Sub-issue: Climate, water resources, & desertification.

3. Project title: **Soil-moisture assessment.**

4. Ministry, institution, or agency responsible: MoLWE Department of Water Resources & MoA.

5. Participation of communities & NGOs: Community & NGO participation desired.

6. Financial requirements: Local: US$ 75,000. ***External:*** US$ 250,000. ***Total:*** US$ 325,000.

7. Duration: 1½ years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): Local: MoA & MoLG.
External: UNEP, CIDA, SIDA, DANIDA, FINNIDA, WMO, & UNESCO.

9. Scope: National.

10. Objective(s): To assess the quantity of water stored as soil moisture in Eritrea, the rapidity with which this supply is renewed, & the length of time it remains available for use by plants. To establish the seasonal variations in soil moisture.

11. Description: Establishment of soil-evaporation monitoring stations. Estimating the amount of water evaporated from the soil from selected monitoring sites. Mapping the soil moisture & evaporation rate. Assessing the variations of soil moisture based on the local geography, climate, geology, & soil type. Calculating the available soil-moisture supply for crop growth during an average year.

12. Management requirements: Appointing a soil expert to co-ordinate the project & act as team leader. Progress reporting at every stage & submission of a final report. The Hydrology Unit & Soil Laboratory of the MoLWE Department of Water Resources would support the assessment of soil evaporation in the established monitoring sites.

13. Priority accorded within the sector: Priority 1 out of 2. Soil-moisture assessment is a priority concern for agriculture, soil degradation, canal sedimentation, & water conservation structures.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: Purchase & installation of soil-evaporation monitoring instruments; employing the requisite labour; & the purchase & installation of the necessary equipment, office furniture, computers, stationery, & means of transportation.

15. Other observations: None.

Factors Contributing to Desertification

Water Issues

1. Basis for action: Section B.3.6. ***Project Profile No. C2-2/2***

2. Issue: Section B.3. ***NAP Pillar No.*** ii (also No. i).
Sub-issue: Community, climate, water resources, & desertification.

3. Project title: **Community awareness-raising.**

4. Ministry, institution, or agency responsible: MoLWE Department of Water Resources, MoA, MoEM Department of Energy, MoE, & MoLG.

5. Participation of communities & NGOs: Community & NGO participation desired.

6. Financial requirements: Local: US$ 150,000. ***External:*** US$ 500,000. ***Total:*** US$ 650,000.

7. Duration: 1½ years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): Local: MoA & MoLG.
External: UNEP, CIDA, SIDA, DANIDA, FINNIDA, WHOM & UNESCO.

9. Scope: National.

10. Objective(s): To evaluate the existing 'knowledge-attitude-practice' (KAP) in Eritrea. Also to create awareness amongst the people in nature appreciation & conservation, & to safeguard the environment by better utilisation of water & other natural resources.

11. Description: Establishing a mechanism to reach & educate the public. Preparing the necessary publicity materials for an awareness campaign that explains the fragile nature of Eritrea. Evaluating the impact on the public of the activities in behavioural change.

12. Management requirements: A UNESCO expert would be required to co-ordinate the project & act as team leader. Progress reporting at every stage & submission of a final report. The MoLWE Division of Water Use & Management is to support the implementation of the project.

13. Priority accorded within the sector: Priority 2 out of 2. Awareness of water & environmental issues, & water-conservation attitudes are a high priority for the entire population.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: Purchase & installation of media technology; employing the requisite labour; & the purchase & installation of the necessary equipment, office furniture, computers, stationery, & means of transportation.

15. Other observations: None.

Factors Contributing to Desertification

Energy Issues

1. Basis for action: Section B.4.7. ***Project Profile No. D1-1/2***

2. Issue: Section B.4. ***NAP Pillar No.*** v (also No. iii).
Sub-issue: Conserving fuelwood resources through improved traditional stoves.

3. Project title: **Dissemination of improved traditional wood stoves.**

4. Ministry, institution, or agency responsible: MoEM Department of Energy.

5. Participation of communities & NGOs: All wood-stove owners, NUEW, NUEYS, Local Governments, local & international NGOs, & private rural & urban entrepreneurs desired.

6. Financial requirements: Local: US$ 100,000. ***External:*** US$ 1,250,000. ***Total:*** US$ 1,350,000.
Operational: US$ 250,000/year + Nakfa 160,000/year.

7. Duration: 5 years ***Start:*** 2002 ***Completion:*** 2007

8. Potential partner(s): Local: MoA.
External: DANIDA, GEF, UNCCD, & other donors.

9. Scope: National.

10. Objective(s): Through research efforts, the MoEM Energy Research & Training Centre has managed to improve the efficiency of traditional stoves from <10% to >20%. Moreover, these improved stoves are designed to have chimneys, thereby protecting women & children from smoke-induced health hazards. These stoves have been amply demonstrated to interested partners, stakeholders, & selected rural communities. Their popularity & acceptability have been established & ensured. The main objective of this project is to disseminate these improved stoves, as it would contribute directly to combating desertification & to protecting women from respiratory & eye diseases. This project would also offer substantial income-generating potentials for manufacturers of stove components.

11. Description: Together with its partners & the participation of communities, local artisans, & private developers, the MoEM Department of Energy intends to co-ordinate the production of all the improved stove components & to disseminate them to the rural & interested urban communities. It is to be the responsibility of the stove owners to prepare an acceptable space & background construction for these stoves as well as to provide free labour & associated local construction materials. It is planned to construct these stoves at the rate of 10 thousand/year, at an estimated cost of US$ 25/stove. Artisans are to be trained from each Village, or neighbouring Village, to construct the system. Artisans from Medeber or elsewhere are to participate in the production of chimney structures. Brick manufacturers are to produce fire-holders centrally for inside the stove.

12. Management requirements: Under the auspices of the MoEM Department of Energy, national, zonal, & sub-zonal *ad hoc* committees shall be establishment whose members are to be from the mainly involved Government- or community-based organisations.

13. Priority accorded within the sector: Priority 1 out of 2. Of high priority owing to its linkage with forest resources.

14. Potential linkage(s): None expected.

14. Prerequisites & advance preparations: The conducting of a successful pilot project, strong community participation, & availability of funds.

15. Other observations: None.

Factors Contributing to Desertification

Energy Issues

1. Basis for action: Section B.4.4. ***Project Profile No. D2-2/2***

2. Issue: Section B.4. ***NAP Pillar No.*** iv (also No. v).
Sub-issue: Energy resources.

3. Project title: **Promotion of renewable-energy technologies for rural community benefits.**

4. Ministry, institution, or agency responsible: MoEM Department of Energy.

5. Participation of communities & NGOs: Community & NGO participation highly desirable & generally available.

6. Financial requirements: Local: US$ 200,000. ***External:*** US$ 2,000,000. ***Total:*** US$ 2,200,000.
Operational: US$ 400,000/year + Nakfa 300,000/year.

7. Duration: 5 years ***Start:*** 2002 ***Completion:*** 2007

8. Potential partner(s): Local: MoA, MoH, MoLWE, & MoLG.
External: GEF, UNCCD, & other donors.

9. Scope: National.

10. Objective(s): To equip health centres, health stations, schools, & Village water sources with solar-powered systems. To equip rural households which could contribute to capital costs with solar-home systems, solar PV, & diesel-hybrid systems.

11. Description: The solar systems are to be supplied by donors. Technicians from the MoEM Energy Research & Training Centre, MoE, MoH, & MoLG are to take the responsibility in installing the systems. Locations of the power systems shall be determined in co-operation with the concerned authorities. The benefiting communities shall be responsible for protecting & maintaining the systems.

12. Management requirements: None.

13. Priority accorded within the sector: Priority 2 out of 2. Of high priority owing to its linkage with water, environment, education, health, & income-generating activities.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: Community participation. The project would have to take advantage of the good experience gained by the technicians & workshop facilities established at the MoEM Energy Research & Training Centre & elsewhere.

15. Other observations: None.

Factors Contributing to Desertification

Biodiversity Issues

1. Basis for action: Section B.5.3. ***Project Profile No. E1-1/1***

2. Issue: Section B.5. ***NAP Pillar No.*** v.
Sub-issue: None.

3. Project title: **Establishment of gazetted protected areas.**

4. Ministry, institution, or agency responsible: MoA, MoT, & MoLWE.

5. Participation of communities & NGOs: Community & NGO participation absolutely necessary.

6. Financial requirements: ***Local:*** US$ 500,000. ***External:*** US$ 1,200,000. ***Total:*** US$ 1,700,000.

7. Duration: 5 years ***Start:*** 2003 ***Completion:*** 2008

8. Potential partner(s): Several because this is a cross-cutting activity amongst various sectors.

9. Scope: National.

10. Objective(s): Eritrea does not as yet have a formal protected-area system. To protect the threatened biological diversity of Eritrea, it is high time that formally gazetted areas be identified & properly established as soon as possible. The question of which institution should be responsible for establishing the protected areas should also be identified at the earliest possible time.

11. Description: Historically, protected areas established under past colonial regimes have not been maintained & no longer have any legal status. A number of new sites have been prioritised for increased conservation & management, but no legislation exists as yet under which a protected area can be gazetted. There is some ambiguity over which ministries have the mandate for creating protected areas. The responsibility for management of protected areas is also not as yet clearly defined in law. This lack of legal authority has slowed progress towards establishing protected areas & should be clarified as soon as possible.

12. Management requirements: The gazetted protected areas would have their own management unit under the overall control & supervision of the responsible Government institution.

13. Priority accorded within the sector: Priority 1 out of 1. The establishment of gazetted protected areas should be given a high priority in order to conserve those landraces which are being endangered from genetic erosion &, hence, are in danger of extinction.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: Certain places have already been identified as possible areas for the establishment of protected areas, but these should be studied further to verify or determine their suitability.

15. Other observations: None.

Factors Contributing to Desertification

Forestry Issues

1. Basis for action: Section B.6.4. ***Project Profile No. F1-1/4***

2. Issue: Section B.6. ***NAP Pillar No.*** ii (also No. v).
Sub-issue: Development of fuelwood plantations.

3. Project title: **Fuelwood plantations.**

4. Ministry, institution, or agency responsible: MoA Division of Forestry & Wildlife.

5. Participation of communities & NGOs: Community participation vital.

6. Financial requirements: External: US$ 4,500,000.

7. Duration: 4 years ***Start:*** 2002 ***Completion:*** 2006

8. Potential partner(s): Local: Communities.

9. Scope: National.

10. Objective(s): To establish fuelwood plantations in selected sites so as to alleviate the acute shortage of energy.

11. Description: This project is to be sited in selected sites of *Zobas* Maekel, Debub, & Anseba. This can help to alleviate the shortage of fuelwood in those areas, & would save the indigenous species by decreasing the pressures of encroachment into the remaining natural forest & woodland.

12. Management requirements: Managed under the MoA Division of Forestry & Wildlife.

13. Priority accorded within the sector: Priority 1 out of 4.
Potential linkage(s): Close co-operation with Village Administrations & farm communities is of high priority.

14. Prerequisites & advance preparations: This is to be an extension of the nationwide afforestation efforts which already take place every year.

15. Other observations: Soil & water conservation benefits & cash supplements to the community could be derived from the establishment of fuelwood plantations.

Factors Contributing to Desertification

Forestry Issues

1. Basis for action: Section B.6.4. ***Project Profile No. F2-2/4***

2. Issue: Section B.6. ***NAP Pillar No.*** v.
Sub-issue: Development & conservation of enclosures.

3. Project title: **Enclosure development & conservation activities.**

4. Ministry, institution, or agency responsible: MoA Division of Forestry & Wildlife.

5. Participation of communities & NGOs: Community participation vital.

6. Financial requirements: External: US$ 5,000,000.

7. Duration: 4 years ***Start:*** 2002 ***Completion:*** 2006

8. Potential partner(s): Local: Communities.

9. Scope: National.

10. Objective(s): To establish enclosures throughout Eritrea in order to create favourable conditions for vegetational recovery through natural regeneration. These would provide pastoral reserves for the growing livestock numbers & woody biomass for local people.

11. Description: This project is to be situated in selected sites of all 6 of Eritrea's *Zobas*. This can help to protect endangered tree & wildlife species from extinction, control runoff & loss of arable land by erosion, & increase infiltration for water conservation & for better soil-moisture retention.

12. Management requirements: Managed under the MoA Division of Forestry & Wildlife.

13. Priority accorded within the sector Priority 2 out of 4.
Potential linkage(s): Close co-operation with Village Administrations & farm communities is of high priority.

14. Prerequisites & advance preparations: A survey of existing & potential enclosures was completed by the recent FAO Pre-investment Study mission to MoA, providing the first comprehensive assessment of the extent of the existing enclosure system in Eritrea.

15. Other observations: (a) The current MoA enclosure policy was initiated in the Central Highlands Zone, & has been based to some extent upon a traditional system of land management used by agriculturists in the highlands for many years. (b) The term 'forest (or woodland) enclosure' applies to any area put under full or partial protection by implementing a number of measures intended to halt or at least limit human pressures placed on existing resources.

Factors Contributing to Desertification

Forestry Issues

1. Basis for action: Section B.6.4. ***Project Profile No. F3-3/4***

2. Issue: Section B.6. ***NAP Pillar No.*** i.
Sub-issue: Assessment of natural resources.

3. Project title: **Woody biomass survey.**

4. Ministry, institution, or agency responsible: MoA Division of Forestry & Wildlife.

5. Participation of communities & NGOs: Community participation vital.

6. Financial requirements: External: US$ 5,500,000.

7. Duration: 4 years ***Start:*** 2002 ***Completion:*** 2006

8. Potential partner(s): Local: MoEM Department of Energy.

9. Scope: National.

10. Objective(s): To assess the woody biomass capacity of Eritrea in order to provides a basis for energy planning. Also to assess the environmental impact of harvesting of forest resources, animal dung, & agri-residues.

11. Description: This nationwide project is to assess the use of biomass at both the household & national levels.

12. Management requirements: Managed under the MoA Division of Forestry & Wildlife.

13. Priority accorded within the sector: Priority 3 out of 4.
Potential linkage(s): Close co-operation with the MoEM Department of Energy, Local Administrations, & some communities is of high priority.

14. Prerequisites & advance preparations: A survey was carried out by the MoEM Department of Energy during 1996-1997 with the primary aim of strengthening the management capacity & development of the personnel in the MoEM Department of Energy as to energy policy, planning, analysis, & modelling systems.

15. Other observations: A socio-economic study was conducted by the FAO-TCP together with MoA in 1997 with the aim of improving the level of available data regarding socio-economic interactions with forest & wildlife with respect to selected specific interventions.

Factors Contributing to Desertification

Forestry issues

1. Basis for action: Section B.6.4. ***Project Profile No. F4-4/4***

2. Issue: Section B.6. ***NAP Pillar No.*** ii (also No. v).
Sub-issue: Development of natural resources.

3. Project title: **Development of agro-forestry in farm forestry.**

4. Ministry, institution, or agency responsible: MoA Division of Forestry & Wildlife.

5. Participation of communities & NGOs: Community participation vital.

6. Financial requirements: External: US$ 4,500,000.

7. Duration: 4 years ***Start:*** 2002 ***Completion:*** 2006

8. Potential partner(s): Local: Communities.

9. Scope: National.

10. Objective(s): To identify appropriate agro-forestry practices for farmers' fields based on observations of traditional in-country practices, & lessons on the subject from other countries with agro-ecological characteristics similar to those of Eritrea. To introduce & extend selected agro-forestry technologies to farmers' fields. To evaluate the impact of agro-forestry practices on crop & livestock productivity, energy supply, soil restoration, & farm income.

11. Description: This project would expand agro-forestry practices to farmlands throughout Eritrea. This project is meant to help alleviate the shortage of fuelwood, which (together with charcoal) accounts for *circa* 55% of energy national requirements. It would additionally improve soil fertility, conserve land, increase the availability of building materials, & lower a farmer's need for cash.

12. Management requirements: Managed under the MoA Division of Forestry & Wildlife.

13. Priority accorded within the sector: Priority 4 out of 4.
Potential linkage(s): Close co-operation with Village Administrations & farm communities is of high priority.

14. Prerequisites & advance preparations: 3 sites for the demonstration of agro-forestry practices have already been established.

15. Other observations: The traditional system of associating trees with crops is still widely practised in the Western Lowlands Zone. Tree stands are observed amongst pearl-millet (*Pennisetum glaucum*) & sorghum (*Sorghum bicolor*) crops.

Factors Contributing to Desertification

Livestock & Rangeland Issues

1. Basis for action: Section B.7.2. ***Project Profile No. G1-1/5***

2. Issue: Section B.7. ***NAP Pillar No.*** i (also No. ii).
Sub-issue: Rangeland management.

3. Project title: **Identification of useful grasses & forbs of Eritrea.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: None expected.

6. Financial requirements: Local: US$ 20,000. ***External:*** US$ 400,000. ***Total:*** US$ 420,000.

7. Duration: 1 year ***Start:*** 2002 ***Completion:*** 2002

8. Potential partner(s): Local: MoA, MoLG, & MoLWE.
External: DANIDA & FAO.

9. Scope: National.

10. Objective(s): To document the economically, ecologically, & socially important native grasses & forbs. To collect the seeds of those species for over-sowing on degraded grazing lands. Also to ensure that the over-sown grasses & forbs are not replaced by alien invasive species which have low feeding value.

11. Description: This project is to produce a detailed document on the taxonomic classification of the native grasses & forbs & their main uses by conducting field trips to all *Zobas*. After completing the preparation of this document, concerned institutions & ministries are to be asked to give their feedback. Based on this survey, interventions would be carried out to multiply seeds of grasses & forbs which are on the way to extinction. Measures are also to be taken to improve the vegetational cover of deteriorated rangelands through over-sowing.

12. Management requirements: A working group composed of the MoA Department of Animal Resources, FAO, UoA, & MoA Department of Agricultural Research & Human Resources Development is to be established to handle this project.

13. Priority accorded within the sector: Priority 1 out of 5.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: A Memorandum of Understanding would be needed among MoLG, DANIDA, & FAO.

15. Other observations: None.

Factors Contributing to Desertification

Livestock & Rangeland Issues

1. Basis for action: Section B.7.7. ***Project Profile No. G2-2/5***

2. Issue: Section B.7. ***NAP Pillar No.*** ii.
Sub-issue: Rangeland management

3. Project title: **Reviewing & revising existing customary (traditional) law on the management & utilisation of communal grazing lands.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: None expected.

6. Financial requirements: Local: US$ 50,000. ***External:*** US$ 150,000. ***Total:*** U$ 200,000.

7. Duration: 1 year ***Start:*** 2002 ***Completion:*** 2002

8. Potential partner(s): Local: MoA, MoLG, & MoLWE.

9. Scope: National.

10. Objective(s): To document existing customary (traditional) laws & practices in rangeland management & livestock ownership in different *Zobas*, including detailed descriptions of traditional enclosure systems & the use of communal grazing lands. To assess the strengths & weaknesses of such customary laws & practices in light of changing social habits, & of growing populations of both people & livestock. To examine the links between customary laws & practices & modern ones, & to propose where synergy could be enhanced. To propose ways & means of revising customary laws & practices on the basis of dialogue & inputs from local pastoralist communities & other livestock keepers.

11. Description: This project is to establish a set of concise documents on customary (traditional) laws & practices in rangeland management & livestock keeping through a series of 'participatory-rapid-assessment' (PRA) exercises. PRAs are to be carried out in the 3 *Zobas* described, 1 each in the CHZ (which accounts for 23% of Eritrea's livestock), the CPZ (which accounts for 28%), & the WLZ (which accounts for 49%). The record on customary (traditional) laws & practices is to be based almost exclusively on information provided by representatives of the communities which keep livestock. Following the completion of the documents on customary laws & practices, workshops & dialogue sessions are planned with the people in order to identify any weaknesses & means of improving them.

12. Management requirements: The project is to be implemented jointly by the MoA Department of Animal Resources & MoA Department of Agricultural Research & Human Resources Development. In view of the need to generate the information from local people, both the MoLG & the UoA Faculties of Law, Sociology, & Anthropology are to be involved. A working group is to be established composed of representatives from the mentioned institutions.

13. ***Priority accorded within the sector:*** Priority 2 out of 5.

14.Potential linkage(s): None expected.

15. Prerequisites & advance preparations: A Memorandum of Understanding would be needed amongst MoA, MoLG, & MoLWE.
16. Other observations: None.

Factors Contributing to Desertification

Livestock & Rangeland

1. Basis for action: Section B.7.6. ***Project Profile No. G3-3/5***

2. Issue: Section B.7. ***NAP Pillar No.*** i.
Sub-issue: Rangeland.

3. Project title: **Comparative analysis of livestock *versus* crop production.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: None expected.

6. Financial requirements: Local: US$ 25,000. ***External:*** US$ 75,000. ***Total:*** US$ 100,000.

7. Duration: 2 years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): Local: None.
External: AfDB & DANIDA.

9. Scope: National.

10. Objective(s): To carry out economic analyses of crop & livestock production on a given area of land. To ensure food self-sufficiency & food security through improved livestock production. To identify a production system that would change the standards of living of the rural population, avoid land degradation, generate hard currency, & ensure the supply of raw materials & other commodities to domestic industries & the urban population.

11. Description: The project is to acquire a defined area of land in each of the 6 *Zobas*. At least 2 ha of land are to be fenced & developed. 1 ha is to be allocated for livestock production & the remaining 1 ha for crop production. The project is to commence its work in a rainy season. The land allocated for livestock production is to accommodate either male shoats or cattle, based on the recommended carrying capacity needed for at least 4 months for fattening. At the beginning of the dry season the animals are to be sold. The 1 ha of land allocated for crop production are to be ploughed & sown with crops that are adapted to the area. All appropriate farming practices are to be applied. Yield is to be determined after the crops are harvested & threshed, shelled, or otherwise collected. The income accrued from the animals & crops is then to be compared for determining the production system that best suits farmers on such a site.

12. Management requirements: The project is to be managed by the MoA Department of Animal Resources & MoA Department of Land Resources & Crop Production.

13. Priority accorded within the sector: Priority 3 out of 5.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: The identification, fencing, & development of the said land would be needed.

15. Other observations: None.

Factors Contributing to Desertification

Livestock & Rangeland Issues

1. Basis for action: Section B.7.5. ***Project Profile No. G4-4/5***

2. Issue: Section B.7. ***NAP Pillar No.*** iv.
Sub-issue: Livestock.

3. Project title: **Livestock marketing through the establishment of marketing outlets.**

4. Ministry, institution, or agency responsible: MoA & MoLG.

5. Participation of communities & NGOs: A low level of community & NGO participation expected.

6. Financial requirements: Local: US$ 50,000.

7. Duration: No limit. ***Start:*** [na] ***Completion:*** [na]

8. Potential partner(s): Local: MoA & MoLG.

9. Scope: National & international.

10. Objective(s): To secure markets for livestock during times of drought. To reduce the illegal marketing of livestock, *i.e.*, of illegal cross-border trading. To improve the income & standards of living of livestock owners. To assure an adequate supply of livestock in all marketplaces at any time. To ensure better environmental conservation & grazing-land management.

11. Description: The establishment of an efficient livestock market network, marketing places, & efficient abattoirs in strategic locations of livestock raising zones is indispensable to livestock owners in particular as well as to the whole of Eritrea in general. Such a system would enable the people to destock their livestock, whether in times of drought or in good years when the environment favours a fast rate of reproduction. The system would also permit livestock owners to restock their small herds when decimated by natural calamities such as drought or flood. The availability of both destocking & restocking opportunities would not only help livestock owners maintain manageable herd sizes, but would additionally minimise land degradation.

12. Management requirements: The project is to be implemented jointly by the MoA Department of Animal Resources & MoLG.

13. Priority accorded within the sector: Priority 4 out of 5.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: None.

15. Other observations: None.

Factors Contributing to Desertification

Livestock & Rangeland Issues

1. Basis for action: Section B.7.5. ***Project Profile No.*** **G5-5/5**

2. Issue: Section B.7. ***NAP Pillar No.*** v.
Sub-issue: Rangeland management.

3. Project title: **Establishment of shelterbelts in areas prone to dust storms.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: None expected.

6. Financial requirements: ***Local:*** US$ 25,000. ***External:*** US$ 200,000. ***Total:*** US$ 225,000.

7. Duration: 3 years ***Start:*** 2002 ***Completion:*** 2005

8. Potential partner(s): ***Local:*** MoLG.
External: DANIDA.

9. Scope: National.

10. Objective(s): To minimise wind erosion & sand-dune formation. To reduce the harsh effects of wind to a tolerable level. To create a healthy micro-climate. To provide cover & shade to wildlife & domestic animals.

11. Description: 6 decades ago *circa* 30% of the total land surface area of Eritrea was covered by highland forest. But owing to the indiscriminate felling of trees since then by colonialists & local communities for construction, military, & fuelwood purposes, highland-forest cover has dropped down to *circa* 0.4%. Today, this forest is confined primarily to the Green Belt Zone (eastern escarpment). Because of this, the micro-climate has changed & animals have been faced with shortages of food & cover. With the land bare, most of the wildlife has disappeared from Eritrea. The planting of various types of trees in shelterbelts could reduce the now highly destructive wind velocity to a tolerable level & help in halting further land degradation. Besides, the ongoing afforestation activities in the country need to be strengthened.

12. Management requirements: The project is to be implemented jointly by the MoA Department of Animal Resources & MoA Department of Land Resources & Crop Production. The co-operation of FAO, DANIDA, & MoLG would be needed in order to make the project implementable & fruitful.

13. Priority accorded within the sector: Priority 5 out of 5.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: A Memorandum of Understanding would be needed between MoLG & DANIDA.

15. Other observations: None.

Factors contributing to Desertification

Human-settlement Issues

1. Basis for action: Section B.8.1. ***Project Profile No. H1-1/1***

2. Issue: Section B.8. ***NAP Pillar No.*** v.
Sub-issue: Conversion of agricultural land to urbanisation.

3. Project title: **Conversion of land use from agriculture to housing: the case of 13 Villages incorporated into Asmara municipality.**

4. Ministry, institution, or agency responsible: MoLWE Department of Land.

5. Participation of communities & NGOs: Community & NGO participation highly expected.

6. Financial requirements: ***Local:*** US$ 100,000. ***External:*** US$ 300,000. ***Total:*** US$ 400,000.

7. Duration: 3 years ***Start:*** 2002 ***Completion:*** 2005

8. Potential partner(s): ***Local:*** Municipalities, MoLWE, MoA, & MoLG.
External: UNDP, DANIDA, & FAO.

9. Scope: National.

10. Objective(s): To determine the extent to which conversion of agricultural land results in loss of livelihood. As a related objective, to show how affected populations, especially women, are able to cope with such conversion.

11. Description: Describing & analysing tenure transformation & assessing the nature & scope of loss of livelihood. In 13 Villages, examining the opportunities for alternative livelihoods when faced with the loss of land for farming, to be carried out with special emphasis on women & their coping mechanisms.

12. Management requirements: The project is to be implemented by the MoLWE Department of Land together with Moa (an Asmara Municipality).

13. Priority accorded within the sector: Priority 1 out of 1.
Potential linkage(s): Close linkage with Asmara municipality in all phases of the study is of high priority.

14. Prerequisites & advance preparations: Advance preparation of the project document would be needed, prepared jointly by MoLWE & MoA, with close consultation with Asmara municipality.

15. Other observations: None.

Factors Contributing to Desertification

Drought-preparedness Issues

1. Basis for action: Section B.9.3. ***Project Profile No. I1-1/2***

2. Issue: Section B.9. ***NAP Pillar No.*** ii (also No. i).
Sub-issue: Local coping mechanisms.

3. Project title: **Understanding & strengthening traditional coping mechanisms, strengthening the capacity of local communities, & the Local Drought Preparedness & Mitigation Plan (DPMP-L).**

4. Ministry, institution, or agency responsible: MoA & ERREC.

5. Participation of communities & NGOs: Local communities from 6 *Zobas*.

6. Financial requirements: Local: US$ 100,000. ***External:*** US$ 250,000. ***Total:*** US$ 350,000.

7. Duration: 2 years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): Local: MoLG & ERREC.
External: UNDP-UNSO & DANIDA.

9. Scope: National.

10. Objective(s): To review traditional drought-coping mechanisms & to analyse their strengths & weaknesses. To strengthen the capacity of local communities to plan, develop, & manage their own drought-response mechanisms.

11. Description: Investigating the existing traditional drought-coping mechanisms, & the role of Government organisations in developing & strengthening those mechanisms. Developing improved participatory strategies for the formulation & strengthening of local drought-preparedness mechanisms.

12. Management requirements: MoA & ERREC are to be responsible for planning & implementing this project.

13. Priority accorded within the sector: Priority 1 out of 2.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: The existing drought-preparedness mechanism of Eritrea would have to be investigated & documented.

15. Other observations: None

Factors Contributing to Desertification

Drought-preparedness Issues

1. Basis for action: Section B.9.4. ***Project Profile No.*** ***I2-2/2***

2. Issue: Section B.9. ***NAP Pillar No.*** v.
Sub-issue: Drought preparedness & mitigation.

3. Project title: **Developing a national Drought-preparedness & Mitigation Plan (DPMP) in the context of NAP.**

4. Ministry, institution, or agency responsible: MoA, ERREC, MoLG, & Civil Aviation Authority.

5. Participation of communities & NGOs: None expected.

6. Financial requirements: ***Local:*** US$ 250,000. ***External:*** US$ 450,000. ***Total:*** US$ 700,000.

7. Duration: 2 years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): ***Local:*** ERREC, MoA, MoLG, & Civil Aviation Authority Dept of Meteorology.
External: UNDP, FAO, & DANIDA.

9. Scope: National.

10. Objective(s): To develop an adequate drought-policy framework, & to develop operational guidelines to implement that policy.

11. Description: Devising a drought-information system as part of the early warning & food security system. Developing capacity-building for the necessary response mechanisms.

12. Management requirements: The project should be managed by ERREC.

13. Priority accorded within the sector: Priority 2 out of 2.
Potential linkage(s): This project is of high priority because of its linkage with ERREC, EGB, & EWFIS.

14. Prerequisites & advance preparations: It would be required to analyse the existing DPMP & to identify any gaps.

15. Other observations: None.

Factors Contributing to Desertification

Socio-economic Issues

1. Basis for action: Section B.11.2. ***Project Profile No. K1-1/1***

2. Issue: Section B.11. ***NAP Pillar No.*** i (also No. v).
Sub-issue: Population issues.

3. Project title: **Population, development, & land interactions: evaluating alternative possibilities for future development in Eritrea.**

4. Ministry, institution, or agency responsible: MoA.

5. Participation of communities & NGOs: Limited community & NGO participation expected.

6. Financial requirements: ***Local:*** US$ 50,000. ***External:*** US$ 250,000. ***Total:*** US$ 300,000.

7. Duration: 2 years ***Start:*** 2002 ***Completion:*** 2004

8. Potential partner(s): ***Local:*** MoLG & UoA.
External: UNFPA, IIASA, UNEP, NEERI (India), & Suzhou Institute for Planning & Environmental Protection China).

9. Scope: National.

10. Objective(s): To understand the interactions among population, development, & environment in Eritrea through historical & interdisciplinary modelling, based, *inter alia*, on the 'population-development-environment' (PDE) model, in order to indicate policy directions for population, environment, & development.

11. Description: Mathematical modelling should be used to better understand the possible future development alternatives for Eritrea. The Eritrean model should be an adaptation of the general PDE model. 4 or 5 modules may be determined. Being sought is a reliable predictive tool for the expected interactions among population, development, & environment. The model should give some objective indications concerning food security, sustainable economic growth, equity, & policy issues.

12. Management requirements: Establishment of a task force to define detailed objectives & specifications. Potential task force members would include UoA, MoLWE Department of Environment, Office of the President for Macro-policy & International Co-operation, IIASA, & NEERI (India).

14. ***Priority accorded within the sector:*** Priority 1 out of 1. Of high priority because it provides insight into the capacity of Eritrea.

14.Potential linkage(s): None expected.

15. Prerequisites & advance preparations: A project proposal would need to be prepared by the CCD secretariat

15. Other observations: Provisional assistance (PA) of 3 'person-months' would be required from IIASA &/or UNEP.

Factors Contributing to Desertification

Public-participation Issues

1. Basis for action: Section B.12.4. ***Project Profile No. L1-1/1***

2. Issue: Section B.12. ***NAP Pillar No.*** ii.
Sub-issue: Empowering local committees to take action.

3. Project title: **Establishing local Land Degradation Committees.**

4. Ministry, institution, or agency responsible: MoLG in co-operation with MoA.

5. Participation of communities & NGOs: Local *Megebaayas* from 6 *Zobas.*

6. Financial requirements: ***Local:*** US$ 120,000. ***External:*** US$ 600,000. ***Total:*** US$ 720,000.

7. Duration: 3 years ***Start:*** 2002 ***Completion:*** 2005

8. Potential partner(s): ***Local:*** The 6 *Zobas* Administrations.
External: UNDP-UNSO.

9. Scope: National.

10. Objective(s): To empower the office of the *Sub-zoba* Administrator to carry out his or her important responsibility – vested in it by virtue of the Proclamation for the Establishment of Regional Administrations (No. 86/1996) (Article 30.9.d) – to create a Village/Area-level community-based Committee on Land Degradation in each *Zoba*. There should be 6 pilot efforts of this sort, 1 in each *Zoba*. The project is to provide all the necessary facilitation & incentives for the Village/Area-level Committees thus established to operate effectively. To develop the modalities for expanding the Village/Area-level Committees on Land Degradation to other areas.

11. Description: Examined here are establishment & functioning of the local Land Degradation Committees. The Proclamation for the Establishment of Regional Administrations (No. 86/1996) assigns responsibility for land degradation to the *Zobas* (Article 19.b.1.1) The Administrator of a *Sub-zoba* is empowered to take the necessary measures to conserve & develop the national environment (Article 19.b.1.1).

12. Management requirements: A joint steering committee consisting of MoA & MoLG is to be established to oversee implementation of this project.

13. Priority accorded within the sector : Priority 1 out of 1.
Potential linkage(s): None expected.

14. Prerequisites & advance preparations: None.

15. Other observations: None.

APPENDIX 2
REFERENCES

Bein, E., Habte, B., Jaber, A., Birnie, Anne, & Tengnaes, Bo. (1996) *Useful Trees and Shrubs in Eritrea*. Nairobi: Regional Soil Conservation Unit (RSCU) Technical Handbook No. 12.

Bojö, Jan (1996) *Land Degradation and Rehabilitation in Eritrea: Working Paper 1*.

*Dalal-Clayton, B., & Dent, D. (1993) *Surveys, Plans and People: a Review of Land Resource Information and its Use in Developing Countries*. London: International Institute for Environment & Development, Environmental Planning Group.

*DoE (1997) *National Report on Implementation of Article 6 of the Convention on Biological Diversity*. Asmara: MoLWE Department of Environment.

DoE (1998) *Eritrea Biodiversity Stocking Assessment*. Asmara: MoLWE Department of Environment.

*DoE (1999) *National Biodiversity Strategy and Action Plan Draft Report*. Asmara: MoLWE Department of Environment.

FAO (1992) *Food and Nutrition: Creating a Well-fed World*. Rome: FAO.

FAO (1994) *Agriculture Sector Review and Project Identification for Eritrea*. Rome: FAO, 126 pp.

*FAO (1995) *Crop Production System Zones of the IGADD Sub-region*. Rome: FAO.

FAO (1996) *National Livestock Development Project for Eritrea*. Rome: FAO, 32 pp.

FAO (1997) *Pre-investment Study on Forestry and Wildlife Sub-sector of Eritrea*. Rome: FAO.

*FAO & UNDP (1985) *Ethiopia: Guidelines for Land Use Planning*. Rome: FAO.

*GoE (1994) *Gazette of Eritrean Laws, Form 4/1994, No. 6, Tigrigna Version*. Asmara: GoE.

*GoE (1997) *Gazette of Eritrean Laws, Form 7/1997, No. 2, Tigrigna Version*. Asmara: GoE.

*Haile, Azbaha, *et al.* (1998) *Rehabilitation of Degraded Land in Eritrea*. 2nd ed. Asmara: MoA & UoA.

Hardwood, C., & Boland, D. (1994) *CSIRO-ICRAF Advisory Visit to Eritrea*. Monrovia, California, USA: World Vision International.

Jepma, C.J. (1995) *Tropical Deforestation: a Socio-economic Approach*. London: Earthscan Publications, 316 pp.

*Kifle, G., & Radcliff, (1997) *Agro-ecological Zones Map of Eritrea*. Asmara: MoLWE.

MoA (1993) *Agricultural Development Potentials and Constraints*. Asmara: MoA.

MoA (1994) *Evaluation of Current Forestry Situation and Future Viable Methodical Appliances*. Asmara: MoA, Afforestation Committee.

*MoLWE (1997) *State of Environment: Eritrea: Pilot Report*. Asmara: MoLWE

MoLWE (1998) *Study Sector Water Demand and Quality Component Stage 1 Report*. Asmara: MoLWE???.

Morris, W. (ed.) (1992) *American Heritage Dictionary of the English Language*. 3rd ed. Boston: Houghton Mifflin, 2140 pp.

NEMP-E (1995) *National Environmental Management Plan for Eritrea*. Asmara: GoE.

Sabadell, J.E., Risley, E.M., Jorgenson, H.T., & Thornton, B.S. (1982) *Desertification in the United States: Status and Issues*. Washington: US Department of the Interior, Bureau of Land Management.

UNDP-UNSO (1997) *Aridity Zones and Dryland Populations*. New York: UNDP Office to Combat Desertification & Drought (UNDP-UNSO).

Vavilov, N.I. (1997) *Five Continents* [transl. from the Russian by D. Löve from the author's unpublished memoirs]. Rome: International Plant Genetic Resources Institute.

World Bank (1994) *Eritrean Options and Strategies for Growth*. Washington: International Bank for Reconstruction & Development (World Bank) East Africa Department Report No. 12930-ER.

World Bank (1996) *Eritrea: Poverty Assessment*. Washington: International Bank for Reconstruction & Development (World Bank) Report No. 15595-ER.

*These entries are not cited in the text, but are included here for further reference.

Appendix 3.1
Acronyms and other Initials

ACORD	Associates for Co-operation & Research in Development (London).
AfDB	African Development Bank (Abidjan).
CBD	1992 Convention on Biological Diversity [UNTS 30619] (Secretariat: Montreal)
CHZ	Central Highlands Zone.
CIDA	Canadian International Development Agency (Ottawa).
CPZ	Coastal Plains Zone.
CITES	1973 Convention on International Trade in Endangered Species of Wild Fauna & Flora [UNTS 14537] (Secretariat: Geneva).
CSIRO	Commonwealth Scientific & Industrial Research Organisation (Canberra).
DANIDA	Danish International Development Agency (Copenhagen).
DFSC	Danish Forest Seed Centre (Humlebaek, Denmark).
DLCOEA	Desert Locust Control Organisation for Eastern Africa (Addis Ababa).
DPMP	Drought Preparedness & Mitigation Plan [national].
DPMP-L	Local Drought Preparedness & Mitigation Plan.
ECDF	MoLG Eritrean Community Development Fund.
EEA	Eritrean Electric Authority.
EGB	Eritrean Grain Board.
ELZ	Eastern Lowlands Zone.
EMPRES	FAO Desert Locust Emergency Prevention System (Rome).
ENDF	Eritrean National Desertification Fund.
EPLF	Eritrean People's Liberation Front.
ERA	Eritrean Relief Agency, now ERREC, *q.v.*
ERREC	Eritrean Relief & Refugee Commission
EU	European Union (Brussels)
EWFIS	MoA Early Warning & Food Information System (*cf.* NFIS).
FAO	Food & Agriculture Organisation of the United Nations (Rome).
FAO-TCP	FAO Technical Co-operation Programme (Rome).
FINNIDA	Finnish International Development Agency (Helsinki).
FFW	Food-for-work assistance.
GAIL	Gross annual immediate crop loss.
GDCL	Gross discounted cumulative loss.
GDP	Gross domestic product.
GEF	United Nations Global Environment Facility (Washington).
GoE	Government of Eritrea.
GTZ	German Technical Co-operation Agency [Deutsche Gesellschaft für Technische Zusammenarbeit] (Eschborn, Germany).
ICPD	1994 United Nations International Conference on Population & Development (Cairo).
ICRAF	International Centre for Research in Agroforestry (Nairobi)
IGAD	Inter-governmental Authority on Development [formerly: Inter-governmental

	Authority on Drought & Development] (Djibouti).
IIASA	International Institute for Applied Systems Analysis (Laxenburg, Austria).
KAP	Knowledge-attitude-practice.
LPG	Liquified petroleum gas.
MoA	Ministry of Agriculture.
MoC	Ministry of Construction.
MoE	Ministry of Education.
MoEM	Ministry of Energy & Mines.
MoF	Ministry of Fisheries.
MoH	Ministry of Health.
MoI	Ministry of Information.
MoLG	Ministry of Local Government.
MoLWE	Ministry of Land, Water, & Environment.
MoT	Ministry of Tourism.
N	Nitrogen.
na	Not available.
NAP	The National Action Programme for Eritrea to Combat Desertification & Mitigate the Effects of Drought.
NAP-SC	The NAP Steering Committee.
NBSAP	National Biodiversity Strategy & Action Plan.
NEERI	National Environmental Engineering Research Institute-India (Nagpur, India).
NEMP-E	National Environmental Management Plan for Eritrea.
NFIS	MoA National Food & Information System (a part of EWFIS, *q.v.*).
NGO(s)	Nongovernmental organisation(s).
No.	Number
NTSC	MoA National Tree Seed Centre.
NUEW	National Union of Eritrean Women.
NUEYS	National Union of Eritrean Youth & Students.
NWLZ	North-western Lowlands Zone, a subdivision of WLZ.
P	Phosphorus.
PA	Provisional assistance.
PDE	Population-development-environment.
PGRU-ER	MoA Plant Genetic Research Unit for Eritrea.
PP(s)	Project Profile(s)
PRA	Participatory rapid assessment.
Ppm	Parts per million.
PV	Photo-voltaic.
RMRS	Regional Office for Mapping & Remote Sensing (Nairobi).
RSCU	Regional Soil Conservation Unit (Nairobi).
SIDA	Swedish International Development Authority (Stockholm).
SWLZ	South-western Lowlands Zone, a subdivision of WLZ.
TFES	Total final energy supply.
UNCCD	1994 United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa [UNTS 33480] (Secretariat: Geneva).
UNDP	United Nations Development Programme (New York).
UNDP-UNSO	UNDP Office to Combat Desertification & Drought [United Nations Sudano-sahelian Organisation] (New York).

UNEP	United Nations Environmental Programme (Nairobi).
UNESCO	United Nations Educational, Scientific & Cultural Organisation (Paris).
UNFPA	United Nations Population Fund [formerly: United Nations Fund for Population Activities] (New York).
UNSO	*Cf.* UNDP-UNSO.
UNTS	*United Nations Treaty Series* (New York).
UoA	University of Asmara.
UAG	Urban area growth.
UPG	Urban population growth.
US$	United States dollar(s). (*Circa* 7.5 Nakfa/US$; *circa* US$ 0.133/Nakfa.)
WLZ	Western Lowlands Zone (*cf.* NWLZ & SWLZ).
WMO	World Meteorological Organisation (Geneva).

Appendix 3.2
Standard International (SI) Units of Measure

^{o}C	Degree Celsius
cm	centimeter
dL	deciliter
g	gram
GWh	Gigawatt-hour (1 GWh = 3.6 x 10^{12} J)
ha	hectare (100 ha = 1 km^2) (1 ha = 10,000 m^2)
J	Joule
kg	kilogram (1 kg = 100 quintals)
km	kilometer
km^2	square kilometer (1 km^2 = 100 ha)
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour (1 kWh = 3.6 x 10^6 J)
L	liter
m	meter
m^2	square meter
m^3	cubic meter (1 m^3 = 1000 L)
mm	millimeter
PJ	Petajoule (1 PJ = 10^{15} J) (1 PJ = *circa* 23,815 t of oil equivalent)
t	tonne (1 t = 1000 kg)

Appendix 3.3
Eritrean (Tigrigna) Terms

Adi: Village. Eritrea has 654 *Adis*.

Akeza: The short rainy season (March-May). One of the 3 main Eritrean seasons (*cf. Hagay* & *Kremti*).

Bahri: Sea; or sea coast.

Baito: Council, referring to a Regional *Baito* (the *Baito* of a *Zoba*). The *Baito* is an elected legislative (governing) body (*cf. Megebaaya* & *Zoba*).

Diessa: Land in Village ownership. The Village land is periodically redistributed amongst the Village inhabitants by the Village *Baito* (*q.v.*), generally every 5-7 years.

Fanya juu: Hillside terrace or contour ditch. (This is a Swahili term [literal meaning: thrown upward].)

Hagay: The dry season (October-February). One of the 3 main Eritrean seasons (*cf. Akeza* & *Kremti*).

Hidmo: Traditional rural Eritrean house.

Injera: Traditional unleavened Eritrean bread made from *Taf* (*q.v.*) flour. Also known as *Taita*.

Kremti: The long rainy season (June-September). One of the 3 main Eritrean seasons (*cf. Akeza* & *Hagay*).

Mai: Water; or watering place.

Megebaaya: Assembly, referring to the Assembly of a Village. It is the equivalent of a *Baito* of a *Zoba* (*cf. Baito* & *Zoba*). The Village *Megebaaya* is open to all Village inhabitants age 18 and over.

Mogogo: A stove for preparing *Injera* (*q.v.*).

Nakfa: Eritrean unit of currency. *Circa* 7.5 *Nakfa*/US$; *circa* US$ 0.133/*Nakfa*.

Resti: Land in family (kinship) ownership.

Rub: A structure meant for temporary use.

Ruba: River.

Stalla: Dairy farm.

Sub-zoba: Sub-region (*cf. Zoba*). Eritrea has 57 *Sub-zobas*.

Suwa: Traditional Eritrean beer-like alcoholic beverage.

Taf: Teff (*Eragrostis tef*).

Tiesa: Land traditionally given by a Village to its inhabitants for residential purposes.

Wadi: Bed or channel of an intermittent watercourse. (This is an Arabic term.)

Zoba: Administrative Region. A *Zoba* is comprised of a number of Villages. The *Zoba* can be divided into two or more *Sub-zobas* (Sub-regions). Eritrea is divided into 6 *Zobas* (Anseba [containing Keren], Debub, Gash-Barka, Maekel [containing Asmara], Semenawi Keyih Bahri [containing Massawa], and Debubawi Keyih Bahri [containing Assab]), and 57 *Sub-zobas*.

Appendix 3.4
Technical Terms

Sources: Adapted primarily from FAO (1992) & Morris (1992).

Agricultural inputs: Substances (such as fertilisers and pesticides), technologies, or labour applied to cultivated land in order to increase crop yield.

Agricultural intensification: The process of increasing inputs and yields.

Alley cropping: The agro-forestry practice of planting parallel rows of trees or shrubs in a field (in order to counter wind erosion and to produce wood) and to plant agricultural crops in the intervening strips, the 'alleys'.

Aquaclude: An underground stratum or bed (*e.g.*, of packed clay or shale) that inhibits or even precludes the passage of groundwater (*cf.* aquifer & aquitard).

Aquifer: An underground stratum or bed (*e.g.*, of gravel or porous stone) that collects & stores groundwater (*cf.* aquaclude & aquitard).

Aquitard: An underground stratum or bed (*e.g.*, of semi-porous stone) that collects & stores groundwater, but the permeability of which is low, limiting the flow of its contained groundwater (*cf.* aquaclude & aquifer).

Arable land: Cropland, or land cultivated with crops. Land that is fallow or used for pasture for less than 5 years is also considered to be arable land.

Area: Reliable land areas are not as yet available for Eritrea. In this report, Eritrea's total land area is taken be 124,340 km^2 (12,434,000 ha). The separate land-use areas being used in this report are presented in Table A.1. For the areas of Eritrea's six *Zobas*, see Table B.21.

Arable-land scarcity: As used in this report, a condition in which the population of a country has on average less than 0.07 ha/*capita* of arable land available. This is the authoritative estimate of the minimum amount of arable land required to feed one person without intensive use of synthetic fertilisers.

Aridity index: Calculated as 'mean annual precipitation' divided by 'mean annual potential evapo-transpiration', both expressed in the same units, *e.g.*, mm/year.

Bund: An artificial embankment (often made of soil or stone).

Cultivable land: Land with the potential to be converted to arable land.

Fallow: The process of temporarily leaving land unseeded and without crops in order to restore its suitability for cultivation.

Food security: The condition in which all people at all times have access to the food they need for a healthy and active life. Food security requires stable food supplies, whether produced domestically or imported, that are physically and economically accessible to all.

Forb: Plants are divisible into woody and non-woody (herbaceous) plants. Those non-woody plants which are not grasses are referred to as forbs.

Gabion: A cage (often of wickerwork or iron) filled with earth for constructing fieldworks.

Grains: The fruit of cereal grasses, including wheat (*Triticum*), rice (*Oryza*), maize (*Zea*), rye (*Secale*), pearl-millet (*Pennisetum*), finger-millet (*Eleusine*), barley (*Hordeum*), oats (*Avena*), teff (*Taf*) (*Eragrostis*), and sorghum (*Sorghum*).

Green revolution: A shift in food production, beginning in the 1960s, that dramatically increased yields through development of varieties of grains with greater resistance to disease and pests, together with the use of improved management techniques and the use of chemical inputs such as improved pesticides and fertilisers.

Land degradation: A natural or anthropogenic (human-induced) process that decreases the current or future capacity of soil to support life-sustaining crops. The productivity of land can be reduced by wind or water erosion, which strips away nutrient-rich topsoil, or by physical and chemical processes such as compaction, waterlogging, salinisation, or acidification.

Population: Reliable population numbers are not as yet available for Eritrea. In this report, Eritrea's 1997 population is taken to have been 3,500,000, and a subsequent growth rate of 2.9%/year is assumed (a rate that leads to a doubling time of 24 years). This makes Eritrea's 2002 population *circa* 4,038,000. Eritrea's 1997 urban population is taken to have been 20% of its total population of that time, *i.e.*, *circa* 700,000, and here a subsequent growth rate of 5.0% is assumed (a rate that leads to a doubling time of 14 years). This makes Eritrea's 2002 urban population *circa* 893,000 (or 22% of total 2002 population). All *per capita* values in this report are calculated on the basis of 2002 values unless otherwise specified.

Salinisation: An increase in the concentration of salts in topsoil that results from inappropriate irrigation practices, potentially rendering land unfit for cultivation.

Spate: A sudden heavy downpour of rain (for which provision can be made to capture the water for irrigation).

Yield: The amount of a crop produced per unit of land.

APPENDIX 4
TABLES, FIGURES, MAPS, & FACT SHEETS

Appendix 4.1 Tables

Appendix 4.2
Figures

Appendix 4.3
Fact Sheets

APPENDIX 5
THE NAP TECHNICAL COMMITTEE

Mebrahtu Iyassu	MoA Department of Land Resources & Crop Production (UNCCD Focal Point)
Estifanos Bein	MoA Department of Land Resources & Crop Production
Kahsay Negash	MoA Department of Animal Resources
Eyob Zemichael	MoA Department of Land Resources & Crop Production
Mulugeta Asmelash	MoLWE Department of Land
Misghina Gebresellasie	MoLG
Teclemariam Berhane	MoLWE Department of Environment
Dr. Semere Habtetsion	MoEM Department of Energy
Paulos Negassi	National Union of Eritrean Youth & Students (NUEYS)
Mohammed Sifaf	Chamber of Commerce
Dehab Suleiman	National Union of Eritrean Women (NUEW)
Ghezae Kibreab	UNCCD Assistant Co-ordinator
Yergalem Taages	UNCCD National Co-ordinator.
Naigzy Gebremedhin	NAP Senior Advisor