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THE USE OF ETHNOPEDOLOGY AS A TOOL FOR PARTICIPATORY LAND USE PLANNING IN THE ERITREAN HIGHLANDS

BY

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Submitted in partial fulfillment of the requirements for the degree M Inst. Agrar. Land Use Planning
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November 2003

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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my supervisor Mr. Johan van der Waals and my co-supervisor Prof. Sylvain Perret, who encouraged me and gave me their expert advice and assistance.

I also express my special thanks to the Government of Eritrea for financing my studies.

I owe a vote of thanks to the staff of the Ministry of Land, Water and Environment, and Ministry of Agriculture, Eritrea, for their support and assistance during data collection in Eritrea.

I also convey my special word of appreciation to my friends Tekle Yemane and Asmerom Fishazion for their support in GIS and the production of the different maps.

Last, but not least, I thank my wife Himan and our daughter Sosna for their support, love and sacrifice during my stay in South Africa.

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SUMMARY

Land use planning is a new practice in Eritrea. It was introduced with the promulgation of the new land law and the establishment of the Department of Land after the Eritrean independence. The detailed policies, rules, regulations and guidelines for implementation of the land proclamation are not yet worked out. Similarly, the institutions responsible for the implementation are not well developed in their material and manpower. To this end, indigenous knowledge and practices on land use in rural areas have not properly been studied and integrated into the new process.

Ethnopedology has proven to be of great help in development activities, especially in rural areas where farmers have an in depth knowledge of their land and where scientific investigation of land resources became difficult or impossible. As over time communities in the Eritrean highlands have managed their land, they have developed methods and institutions of land management. These are valuable resources, which have to be exploited properly.

The study describes the local land classification in two Eritrean highland villages and explores methods of using it as a tool for participatory land use planning in natural resource management. It pays particular attention to investigating local soil knowledge, the logic behind the farmers' soil categorization and their traditional institutions using participatory methods.

The main finding of this investigation is that farmers have strong local institutions at village level and they classify their land based on the problems and potentials of their environment. The study has also shown that local soil knowledge in the study area can be used as a gateway to participation, as a means for data collection and as a means of communication between local communities and the planning experts during land use planning.

The study concludes that ethnopedology in the study area is well adapted to the given environment and has a practical use as a tool for village-level participatory land use planning. It recommends that development agents in the area use this knowledge for planning and implementation of different activities, especially in natural resource management. The study proposes a rough structural outline of basic stages in the planning process based on the outcome of the investigation.

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ABBREVIATIONS

CIA	Central Intelligence Agency
DOL	Department of Land
WRD	Water Resource Department
FAO	Food and Agricultural Organization
GIS	Geographic Information System
GOE	Government Of Eritrea
GTZ	German Agency for Technical Cooperation
LRCPD	Land Resources and Crop production Department
MLWE	Ministry of Land Water and Environment
MOA	Ministry Of Agriculture

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The evaluation of land resources and other land use studies involve a complex and laborious process. This process typically requires large sets of data as inputs, including biophysical variables as well as socio-economic determinants (Dent and Young, 1981). However, the implementation of land use studies in developing countries is faced with the problem of data availability. The information base is poor, unreliable and often inappropriate for the modern land evaluation frameworks. There is, therefore, a pressing need for an adapted framework for land use studies that is appropriate for data-poor environments, and that lends itself readily to stakeholder participation (Zurayk et al., 2001).

Consequently, involving the local community in participatory studies offers the possibility of generating complementary data by tapping into indigenous knowledge and practices. It also helps to establish partnerships and dialogue among stakeholders and builds confidence. Given the central role of soil resources in agriculture, and the fact that soil, as a resource, is a major concern in sustainable agriculture, the indigenous knowledge of soils, or ethnopedology, has recently received more attention (Pawluk, et al., 1992).

The focus of this study will be on the local land classification in two Eritrean highland villages and on exploring methods of integrating it as a tool for participatory land use planning for natural resource management. The study pays particular attention to investigating local soil knowledge, the logic behind the farmers' soil categorization and their traditional institutions using participatory methods.

1.2 FORMULATION OF THE RESEARCH PROBLEM

Mismanagement, drought and neglect by the past colonial regimes have exacerbated the problem of land degradation in the Eritrean highlands. Pressing Eritrean environmental problems are directly related to land degradation, deforestation, soil loss and desertification, especially in the critical areas where agricultural output is vital (Government of Eritrea (GOE), 1995). According to University of Asmara and Ministry of Agriculture (1998), the main contributing factors for land degradation are physical factors like location, topography and climate, and socio economic factors such as over cultivation, overgrazing, deforestation, the legacy of war and demographic pressure. This is clearly reflected in the high rate of soil erosion in the country particularly in the highlands (Bojo, 1996).

Safeguarding the productivity of land is a major concern. Towards this end, the government of Eritrea has promulgated a Land Reform Proclamation, No. 58/1994 (Government of Eritrea, 1994). This new land law replaces the traditional land tenure system that was based on a periodic redistribution of land every five to seven years, which caused tenure insecurity and discouraged permanent improvement of land (University of Asmara and Ministry of Agriculture, 1998). It guarantees security of tenure based on the usufruct principles and permits the classification and allocation of land, avoiding excessive fragmentation, and encouraging introduction of land use planning, especially in rural areas.

Since its promulgation, substantial steps have been taken to implement the new land law. The implementing body, the Department of Land (DoL), has been established and the Land Use Planning unit of the Department is working towards the implementation of the new land law all over the country. However, its activities are limited to urban and peri-urban areas, where there is high demand for land for different development activities (Ministry of Agriculture, 2001). Meanwhile, as 80% of the Eritrean population lives in rural areas, land use planning activities should focus also on these areas. However, lack of trained personnel and necessary data in rural areas are some of the main problems facing the Department of Land in implementing land use planning activities.

The Eritrean environmental management plan considers public participation in the process as fundamental to the success of environmental and developmental planning (Government of Eritrea, 1995). The relevance of a given plan and its acceptance by the population is greatly affected by the degree of participation. Jackson (2002) found that people who participate in making decisions that affect their lives are more likely to accept decisions and to feel that they are just than if they had no part in the decision making process.

In addition to this, one of the main advantages of involving the local community is to benefit from the available indigenous knowledge. Local knowledge and experience gathered and refined during generations is worth tapping and should be incorporated into the planning process. *"Indigenous knowledge is an end solution, which has been developed to fit well with all aspects of a particular farming situation. ... Respect and understanding of local wisdom can then be useful for sustainable land use particularly in developing countries"* (Petersmann and Jilg, 1996).

As the communities in the Eritrean highlands have managed their land for centuries, they have developed methods and institutions of land management over generations. This is a valuable resource, which has to be exploited properly. In his planning exercise, Araya (2001) observed that farmers know their land better than any expert from outside and hence; the indigenous knowledge of farmers should be used to facilitate the classification of land based on their potential. Since the use of indigenous knowledge motivates the involvement of communities, it could help as a platform for local participation in land use planning. Furthermore, in the data-poor rural areas, using local experts and knowledge to generate important data for the planning saves time and resources.

To this end, indigenous knowledge and practices on land use in rural areas have not properly been studied and integrated into the new process. Specifically, the ethnopedologic knowledge of the rural areas in the highlands of Eritrea has not been investigated and its vast knowledge resource has not been properly tapped for land use planning purposes.

1.3 OBJECTIVE OF THE STUDY

The objective of this study is to investigate the indigenous knowledge and practices in land management, with special emphasis on ethnopedological knowledge in the Eritrean highlands to:

1. identify if indigenous knowledge in the study area exists, is comprehensive and accurate, and is worth tapping and usable in land use planning
2. find out if such knowledge forms a background for further participation in land use planning and
3. identify methodologies that would enable the use of these practices as a tool in participatory land use planning.

1.4 DELIMITATION

This study is limited to a village level scale. Though the results could reflect the existing situation in the central highlands and especially in the *Debub* region, care should be taken to avoid any generalizations as conditions might differ from village to village.

CHAPTER TWO

LITERATURE REVIEW

2.1 DEFINITIONS

The discipline of Land use planning is complex. Over the past many years, different scholars have tried to define it in different ways. The most commonly used, however, is the FAO definition which defines land use planning as *"... the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use option"* (Food and Agricultural Organization (FAO), 1993). This definition emphasizes the importance of the development of alternative uses for a given land. It considers not only the physical condition of land but also the social and economic conditions as the main determining factors for suitability.

Moreover, depending on the purpose and location, land use planning is defined in greater detail. Nnkya (1998) has defined it as *"... a program of state intervention in land use and environmental change to mediate conflicts of interests over how land should be used, developed, and coordinate individual activities"*. This definition attempts to explain the planning process as a state intervention in different land related issues. According to this source, the state is the main role player in the planning and implementation of activities.

There are others who still view land use planning as a rational decision-making process involving predetermined steps designed to bring about the adoption of objectives and appropriate measures for attaining them, while taking environmental constraints into account. In this case land use planning is considered a technical process entrusted to professionals - planners, urban planners and developers - who are familiar with the generally accepted planning practices presented in textbooks and taught by institutions of higher learning (Chabot and Dunhaime, 1998).

An integrated approach to planning is another way of explaining land use planning. In this instance, land use planning has input from the public about their preferences as well as technical inputs and analysis about physical, engineering, environmental, economic, administrative and legal considerations (Vlasin and Bronstain, 1979). Similarly, Dykeman (1988) stated that planning could not be a one-way flow of information. Rather it must be *"a mutual education process and a generally cooperative attempt at finding solutions to a problem"*. In other words, the top down planning process expressed in goals, guidelines, and regulations must be matched by the bottom-up process of involvement by local residents and appropriate incentives for management of land resources.

Sustainability may also be the main target in land use planning. In this sense, land use planning is an instrument to systematically address problems related to the sustainable use of natural resources. It describes the process of developing options of alternative land use type which best meet the need of the present population, whilst safeguarding the natural resources for the future (Petersmann and Jilg, 1996). This means that land use planning may become a tool for sustainable development giving emphasis to the sustainable use of resources with the future generation in mind.

The Government of Eritrea (1995) considers public participation as fundamental to the success of environmental and developmental planning. It advocates very substantial public participation or involvement in land use planning. Involving the local population in the planning process is important to ensure effective management plans and an equitable pattern of socio-economic development.

2.2 LEVELS OR TYPES OF PLANNING

There are different levels of planning depending on the objective and size of the planning area and level of decision makers at which decisions about land use are taken. The level of planning also affects the approach and outcome of a planning exercise. Based on the government structure, different levels are identified in different countries. For example, the FAO (1985) identified four levels of planning in the Ethiopian case. The smallest scale being the global or international at a scale of 1:10 million, and the largest scale identified is 1:5 000 for village or farm level.

Similarly four different levels are used in Germany (The Federal Ministry of Environment, Natural Protection and Nuclear Safety, 1994), but the details and map scale are different from that of Ethiopia. In this case the real land use plan is done at the community level while at higher levels, state and regional plans are done at relatively small scale. Hence it is evident that different countries use different details and map scale. This reflects the existing geographic, socio-political and economic condition of the nation playing a role in the planning exercise. Meanwhile, the FAO (1993) tried to identify three general levels of planning as a guide especially to developing countries. These are national level, district level, and local level.

2.3 TRENDS IN LAND USE PLANNING

2.3.1. EARLIER STAGES

In the past, land use planning activities were concerned with zoning plans. This is physical planning relating to land areas. It defines the essential elements of physical development like streets, parks, sites for public buildings, public reservations, and routes for public utilities and zoning districts for private lands. As traditionally practiced, zoning essentially consists of dividing an area into districts. Within each district type, only certain land uses are permitted. It is the most familiar exercise of police power.

Zoning was aimed at protection than at guiding development. For example, according to Singer, et al. (1979), the main aim of zoning in California was:

- To preserve a maximum amount of the limited supply of agricultural land,
- To discourage premature and unnecessary conversion of agricultural land to urban use and discourage discontinuous urban development patterns which necessarily increase the cost of community services to community residents, and
- To preserve open spaces and preservation of agricultural production of such land.

Zoning is one of the earliest practices in land use planning. As Loew (1979) explained, before the Second World War, planning was entirely local in that there were no statutory plans covering anything but specific areas of limited size. Local authorities were entitled to prepare planning schemes indicating merely the land use zoning of these areas. The first comprehensive attempt to regulate land use as well as building characteristics was made by New York City in 1916. The role of the local authorities changed with the rise in the 1950s of the civil rights movement and in the 1960s the environmental movements (Urban Land Institute, 1985).

2.3.2 CURRENT TRENDS

Kaiser and Goldschalk (1995) developed a planning family tree concept to explain the evolution of the planning process. The earlier practices are represented as the roots of the tree. The general plan, constituting consensus practice at mid century, is represented by the main trunk. Then several branches - the verbal policy plan, the land classification plan, and the development management plan, join this traditional land use plan. These branches combine into the contemporary, hybrid comprehensive plan integrating design, policy, classification and management represented by the foliage at the top of the tree.

In addition to these branches, the technological advances made in different fields also affect land use planning. Remote sensing and GIS are the most prominent ones that revolutionized the planning process. Mathews, et al. (1999) explained that GIS, which include thematic and infrastructure digital maps, and remotely sensed images from satellite, are becoming more common in the planning process. They indicated that land managers increasingly wish to look beyond the use of GIS for inventory purpose and to add value to their investment in GIS by using it as a land use-planning tool. Church (2002) also mentioned that there is a big potential of using GIS in different land use related activities. These include the fields of forestry, transportation, environmental protection and landscape planning.

The issue of sustainability is becoming a key concern in the planning process. Sustainable land use planning is understood as *"a decision making process that facilitates the allocation of land to uses that provide the greatest sustainable benefit in terms of production, efficiency and equal access to resources"* (Petersmann and Jilg, 1996). They further explained that the main criteria for sustainability are equity, social mobility, social cohesion, participation, empowerment and institutional development. Similarly, Pannel and Schiliazzi (1999) mentioned protection of ecological systems, equity and fairness over generations and efficiency of resource use as the most essential elements of sustainability that must be considered in the planning process.

It is evident that land use planning is becoming a more participatory practice. Karl (2001) indicated that the involvement of citizens in planning was viewed as a potential remedy when the post World War II programs of social improvement through planning and urban renewal proved to be unproductive by the 1960's. Another example is the statement by the Ministry of Housing and Local Government (1969) of Scotland, that the Town and Country Planning Act (of England) of 1969 provides the citizen of England with a statutory guarantee that he must be given information about the given situation and opportunity to make his views known to his local planning authority.

2.3.3 SUMMARY

Starting from its inception the planning practice in land use has passed through different stages and has shown some trends in its development. It has changed tremendously in its scope and approach over the past century. An exercise, which started as a means of state control over resources, is now a means to manage and develop resources. It has generally shifted from a top-down approach to a more participatory bottom-up approach.

2.4 PARTICIPATION IN LAND USE PLANNING

2.4.1 WHY PARTICIPATION?

The Ministry of Housing and Local government (1969), of Scotland elaborately defined participation in the planning process as *"... the act of sharing in the formulation of policies and proposals. ...Participation involves doing as well as talking and there will be full participation only where the public are able to take an active part through the plan making process"*. It further explains that the plan produced with out the participation of the community could be best suited to the need of the community. However, the reasons for decision do not emerge, nor are people told why superficially attractive alternatives have been put aside. The failure to communicate has meant that preparation of the plan instead of being a bridge between the authority and the public has become a barrier, reinforcing the separation between the authority and the public.

Different reasons are mentioned why citizens should be involved in the development and implementation of plans regarding land resources. For example, Vlasin and Bronstain (1979) stated that land resources plans might not effectively meet resident's needs unless they are involved. The community residents must be involved from the beginning so that the plans address their problems, preferences and priorities to the greatest extent possible. They further stated that public involvement is a crucial addition to, not a substitute for, analytic ability and technical information. The community can provide precise information on the nature, location, magnitude and severity of problems, how they actually feel about the problems and opportunities and their preferences concerning the future use of resources.

Therefore, it can be argued that acceptance of a given plan is greatly affected by the degree of participation. Jackson (2002) found that people who participate in making decisions that affect their lives are more likely to accept decisions and to feel that they are just than if they had no part in the decision making process. A number of countries have started to implement policies which allow a certain amount of local decision-making, and accept the fact that planning has to be done with local people and not for them by other authorities. It can be hoped that if people have been involved with the plan right from the beginning, their awareness and interest should be greater than it has been in the past, and they should have achieved a good level of communication with planners. The argument that public participation takes time and complicates the life of planners should not be an excuse for not trying (Loew, 1979).

2.4.2 TRENDS IN PARTICIPATION

There is a general consensus that involvement of the land user and other concerned local people and institutions should be ensured at different stages of planning and implementation. However, in practice, there are different types of participation where the degree of involvement varies to a great extent. Petersmann and Jilg (1996) identified seven general stages based on the degree of public participation. The last step is the self-mobilization step whereby people participate by taking initiative independently of external institutions. They develop contacts with institutions for resources and technical advice, but retain control over how resources are used. This is the ideal situation for the bottom up approach where planning is initiated at the local level and involves active participation by local people and technical staff who are mobilized to identify development priorities and to draw up and implement plans.

Similarly, Arstain (1969) attempted to explain trends in participation using the ladder of citizen involvement. As is explained in Figure 2.1, the lowest two rungs of non-participation are manipulation and therapy. Climbing up the ladder one reaches tokenism: the rung of information and consultation. Here the citizen can be heard but decisions are made without any regard to their voice. The next steps are placation where citizens have an advisory position and partnership where tradeoffs are made between citizens of different interest. Only on the top of the ladder does the citizen role reach the rung of delegated power and citizen's control, where citizens have a major role in the decision-making process.

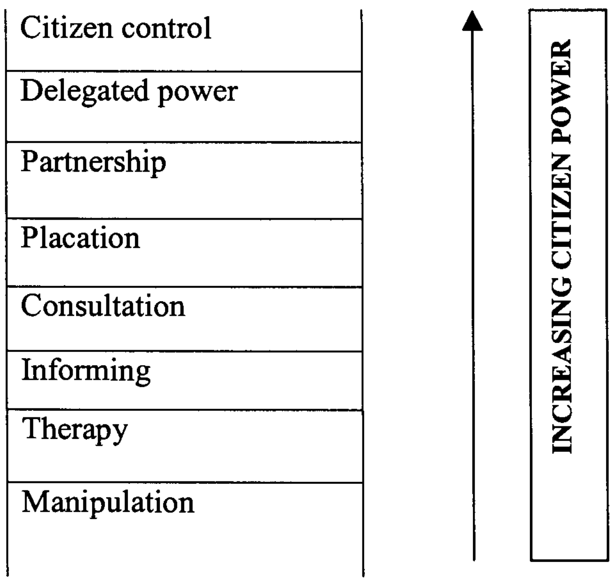

Figure 2.1 Ladder of participation (From Arstain, 1969)

In like manner, Jackson (2002) explained that in the 1960s and 1970s the public began to be consulted; today they are demanding shared power with decision-makers. She found that all levels of public involvement might be appropriate under certain circumstances and for specific stakeholders. According to her, there is firstly a need to identify and analyse stakeholders, and secondly to set the appropriate objectives before determining the most appropriate level. Figure 2.2 explains the whole process diagrammatically.

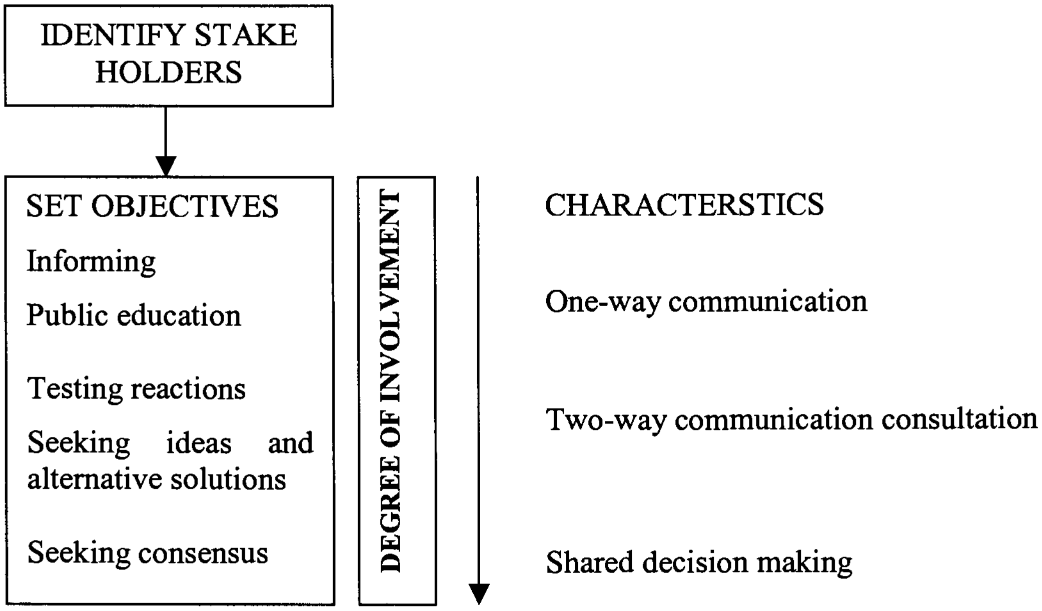

Figure 2.2 Level of participation according to Jackson (2002)

2.4.3 SUMMARY

Participation in land use planning is becoming an essential part of the planning process. There is a demand for greater involvement of the stakeholders or communities in the whole planning process. The level of involvement is changing from the lowest level of information sharing to the highest stage of power sharing by the local communities. This would lead to the empowerment of land users through the shared decision-making and the drawing of plans that address the real problem of stakeholders.

2.5 INDIGENOUS KNOWLEDGE IN LAND USE PLANNING

2.5.1 GENERAL

One of the main advantages of participatory planning is to benefit from the indigenous knowledge of the local community. The knowledge that people in a given community have developed over time and continue to develop is defined in literature as 'indigenous', 'local', 'traditional' or 'indigenous technical' knowledge (Cools, et al., 2003). Similarly, Altieri (1990) explained it as accumulated knowledge, skill and technology of local people derived from their direct interaction with the environment.

It includes the complex of practices and decisions made by local people. It is based on experience passed from one generation to the next, but nevertheless, it changes, adapts and assimilates new ideas (Martin and Oudwater, 2003).

Local knowledge can be of a wide range and could encompass many subjects related to and affecting the local population's day-to-day life. As communities' life in rural areas is mainly related to agriculture, their knowledge in agriculture related fields are of paramount importance. Local people are knowledgeable about their soils, lands, plants and environment and well qualified to define their own problems (Barrera-Bassols and Zinck, 2003). Similarly, Chambers, et al. (1989) explained that over generations farmers have developed land use systems that are well adapted to the potentials and constraints of their land. To achieve this adaptation, they have developed informal systems of land quality appraisal based on observation and experimentation both of which are often very sophisticated and accurate.

For a long time, agricultural and natural resource related development projects were often based on a top-down approach where 'experts' transferred their knowledge to the 'target group'. Often these approaches were not successful in achieving the intended goal. Nowadays, it has become clear that local knowledge is a valuable resource for sustainable development and it should play a central role in any development program (Martin and Oudwater, 2003). In general, it is found that land use decisions made by local people are more accurate and better adapted to local conditions than the technical recommendations forwarded by extensionists (Barrera-Bassols and Zinck, 2003).

The implementation of land use studies in most developing nations is often faced with the lack of data. Participatory studies offer the possibility of complementing data sets by tapping into indigenous knowledge. They also encourage the adoption of sustainable land management practices by establishing partnerships and dialogue among stakeholders (Zurayk et al., 2001). Ericksen and Ardo (2003) explained that collaboration between development agents and local farmers can result in a more complete understanding of local environments and determinants of environmental outcomes, the design of appropriate management strategies for specific agro-ecosystems, and more successful implementation of alternative management strategies. Many development projects have failed because of ignorance of local knowledge systems (Niemeijer, 1995).

In this regard, local soil knowledge is now widely recognized to exist and to be of practical value. Farmers are able to integrate their knowledge of the land and soil properties with the water and nutritional needs of various crops, yield and market prices of crops, and rank the soils into soil suitability classes, which they use to make land use decisions (Shajaat Ali, 2003).

2.5.2 INDIGENOUS KNOWLEDGE AND ETHNOPEDOLOGY

Recently, the importance of local knowledge has become strikingly apparent in the field of soil science (Grossman, 2003). However, it is known that from the very beginning of civilization people have been accumulating knowledge on soil properties, methods of land management, and classifying soil (Krasilnikov and Tabor, 2003). Local soil knowledge is defined by WinklerPrins (1999) as *''the knowledge of soil properties and management possessed by people living in a particular environment for some period of time''*.

Ethnopedology constitutes a complex wisdom system, with some universal principles and categories similar or complementary to those used by modern soil science (Niemeijer, 1995). According to Talawar (1996), the science of ethnopedology encompasses many aspects, including indigenous perceptions and explanations of soil properties and soil processes, soil classifications, soil management, and knowledge of soil–plant interrelationships. In his study in south-western Bangladesh, Shajaat Ali (2003) found that farmers' assessment of soil properties is purely qualitative but yielded mainly identical results offered by the scientific analysis of soil samples collected from the village.

It is increasingly understood that for development purposes, local soil knowledge often forms a much better starting point for communication than Western scientific soil classifications. Tabor (1992) recommended that soil surveyors communicate with farmers and herders to determine the relative productivity of soil types and their value for agriculture, forestry and range. This is not only true for communication with farmers, but also for communication between soil scientists, development workers and extensionists (Niemeijer and Mazzucato, 2003). In addition to this, Tabor, as cited by Gray and Morant (2003), explained that local soil classifications could facilitate communication between farmers, extension workers and researchers

Another important benefit of ethnopedology is its advantage in easily generating important and reliable data. Cools et al. (2003) stated that farmers' knowledge provided a better understanding of the impact of microclimatic variations on crop productivity. This is an important bonus of the participatory approach because detailed climatic data for long periods are rarely available in most rural communities. Shajaat Ali (2003) explained that farmers' knowledge of soils is inherited, acquired through generation-long in situ practical experience and is reflective of their close interaction with the physical environment. Their soil classification method is based upon the qualitative visual and perceptual observation and assessment of the local characteristics of the physical environment and how those characteristics influence the soil–plant relationships and farming practices. Therefore, indigenous soil classification may provide a cheaper method of understanding soils than formal soil surveys (Niemeijer, 1995).

However, the fact that ethnopedological survey is relative and only locally valid is also mentioned as a drawback of the approach for wider application (Krasilnikov and Tabor, 2003). Similarly, Barrera-Bassols and Zinck (2003) explained that one of the main issues mentioned in several ethnopedological reports is the inconsistency of indigenous soil knowledge at the regional scale. Indigenous soil and land classes are often named and characterized differently by members of the same ethnic group but from different villages, while technical soil surveys indicate a regional distribution of the same soil classes.

To overcome these drawbacks, there is currently a pressing need for integrating local knowledge with scientific practices. Ryder (2003) expressed that a two-way dialogue between farmer and soil surveyor in the field would promote timely integration of local soil knowledge and scientific research. Participatory soil surveys, therefore, would facilitate the exchange of empirical farmer knowledge and theoretical surveyor knowledge and enhance rural development projects. The integrated approach identifies and mobilizes the relationship between cultural and scientific information in order to elaborate natural resource management schemes according to local social, cultural, economic and ecological contexts. Together with off community agents (e.g. soil scientists, agronomists, social scientists and planners among others), farmers participate in validating and integrating information into the local decision-making and planning procedures (Barrera-Bassols and Zinck, 2003)

Towards this end, Payton et al. (2003) argued that if the rationale for studying local knowledge about soils is that most progress towards sustainable land management will be derived from the synergy of local and scientific knowledge, then integrating or relating the two knowledge systems is a central issue. Moreover, Niemeijer and Mazzucato (2003) argued that for development planning and interventions to be successful it is necessary to fit external technologies and strategies to the local environmental and cultural context. This requires scientists and development workers to develop a thorough understanding of local soil knowledge and land use practices in relation to the external technologies and development strategies they are promoting. In a similar manner, Barrera-Bassols and Zinck (2003) explained that although an integrated ethnopedological approach still needs to be developed by combining the current trends, a promising bottom-up approach is gaining interest among scientists and farmers.

2.5.3 SUMMARY

Local communities are believed to have vast indigenous knowledge developed from their life long interaction with their environment. It is now generally accepted that this pool of knowledge should be properly tapped in land use planning. Ethnopedology has proven to be of great help in development activities, especially in rural areas where farmers have an in depth knowledge of their land and where scientific investigation of land resources is difficult or impossible. Even in areas where scientific studies are undertaken ethnopedology is becoming an indispensable source of supplementary data and means of communication. Currently the field of ethnopedology is transforming from description of the approach to the possible application in land management issues.

2.6 LAND USE PLANNING IN ERITREA

To assess the possible use of indigenous knowledge and especially ethnopedology in participatory land use planning in Eritrea, it is important to have some background on the state of land use planning in that country. 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. Before independence no effort was made by the colonial powers to undertake land use studies or planning projects. Hence, land use planning is introduced with the promulgation of the Land Reform Proclamation and the establishment of the Department of Land following Eritrean independence.

2.6.1 LEGAL ISSUES

The Land Reform Proclamation established the basis for a new and systematic way of planning. The objectives of Eritrea's new land policy are to establish a revised tenure system that will encourage long-term investment in agriculture and prudent environmental management, assure gender equality, and promote commercial agriculture. The key points in the land policy are that ownership of land is the exclusive right of Government; that every citizen and foreign investor has access to land for farming, pasture, housing and development purposes, and that these would be usufruct rights only (GOE, 1994).

The Proclamation is aimed at reforming the system of land tenure, determining land use, the manner of expropriating land for purpose of development and national reconstruction, and determining the power and responsibility of institutions, which will implement the Proclamation. It declared that, in Eritrea, all land is owned by the State, and that any right over land shall be effective upon government recognition and approval, and that rights are to be recorded in a land register. The Proclamation is expected to change existing tenure systems and to introduce a new and uniform system throughout the country. It 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 is expected to allocate land fairly and equitably without discrimination on the basis of race, religion, gender, or national origin. (See Appendix 3 for further details on land proclamation). Promulgation of the Land Reform Proclamation is considered to be a step forward in the fight against land degradation and towards the introduction of wise land husbandry in Eritrea (GOE, 1995).

However, the Land Reform Proclamation gives only a general framework, and detailed work is needed in drawing up the necessary policies, rules, regulations and guidelines of implementation. Article 46 (Sub-articles 1 & 2) of the Land Proclamation 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 (GOE, 1994).

2.6.2 INSTITUTIONAL ISSUES

The institutions necessary for the implementation of the Land Proclamation are in their infancy. Responsibility lies mainly with the Department of Land of the Ministry of Land, Water and Environment (MLWE). At this time, that Department is focused mainly on building its human and institutional capacities both in quantity and quality. The establishment of functional land-administration bodies at a lower level is another ongoing task.

A land use planning unit has been formed under the MLWE Department of Land in 1996. The focus of the unit is on urban and peri-urban areas owing to the high demand for land for urban expansion and the need to protect agricultural land 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 plans have been approved for 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 the southern zone of Eritrea (Ministry of Agriculture, 2001).

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 densely populated highlands of Eritrea. 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 bio-diversity of Eritrea.

Careful planning can deal with infrastructure expansion with due environmental consideration. Given the existing limited capacity, introduction of land use planning is needed in prioritised areas of environmental and economic significance. The development of a land use policy and associated guidelines and standards for planning are also prerequisites. The Land Use Unit will need to upgrade its human and material resources both in quantity and quality in order to meet this demand. The student, and previous three students trained in land use planning in the University of Pretoria are part of this upgrading programme.

The other land use related units are the Cartographic Unit and the Cadastral Office in the Ministry. Their responsibility is the development of a database as well as the mapping and registration of different land related properties and activities. These units are also at an early stage of development and suffer from human and material shortages.

On the other hand, the Ministry of Agriculture plays an important role in land related activities. Though it has no legal power to undertake land use planning activities, attempts have been made to develop land use land cover maps and partial land use plans at *sub zoba* level. With the limited knowledge and resources it has, good experience has been gained from these exercises. As the Ministry of Agriculture has a larger distribution (it has personnel up to *sub zoba* level) and significant implementation power, closer co-operation and policy integration is needed with the Ministry of Land, Water and Environment for speedy implementation of the land reform.

2.6.3 SUMMARY

Land use planning is a new practice in Eritrea introduced after the promulgation of the Land Proclamation in 1994. The detailed policies, rules, regulations and guidelines for implementation of the Land Proclamation are not yet worked out. Similarly, the institutions responsible for the implementation are not well developed in terms of material and human resources. Currently the main focus is on urban areas, but the need for planning in rural areas is growing due to the scarcity of resources and increasing population pressure.

2.7 CHAPTER SUMMARY

Over the past years, the global trend in land use planning was towards substantial public participation. This is evident from the change in the top-down planning approach to participatory planning, which is a bottom-up approach. There is a general trend towards maximum public participation through power sharing in decision-making.

The use of indigenous knowledge is considered to be the first step in participation in the planning process. There is a general consensus that indigenous knowledge and practices are valuable sources of information and should be tapped properly for any development purposes. Hence, detailed knowledge of the existing social, political and economic conditions of an area as well as the existing local knowledge and practices of a given area should be carefully studied and integrated into the planning system. The indigenous soil knowledge need to be given special attention as it has been shown that farmers have intimate knowledge of their soils due to the life long attachment to their land. They also consider more criteria, not limited to soil physical features that are more relevant in terms of fertility and land use.

As a new country, Eritrea is working towards the implementation of a land reform program. Land use planning is a core issue in this process. However, the institutions responsible for this process are at an early stage of development and are mainly focused on urban areas. There is a growing need for the introduction of land use planning in rural areas where there is high population pressure and scarcity in land resources. For this purpose full participation of farmers should be encouraged and their indigenous knowledge and practices should be properly used in the planning process.

CHAPTER THREE

MATERIALS AND METHODS

3.1 DESCRIPTION OF THE STUDY AREA

3.1.1 COUNTRY INFORMATION

Eritrea was established as an Italian colony on January 1, 1890. Italian rule lasted until World War II when British forces conquered the territory. British military administration lasted from 1941 until 1952 when the United Nations decided to federate Eritrea with Ethiopia. Once in control, Ethiopian Emperor Haile Selassie moved to end Eritrean autonomy and by 1962 Eritrea was transformed into one of the 14 Ethiopian provinces. The creation of an Ethiopian unitary state in 1962, in which Eritrea was incorporated as a province, provoked a long war of liberation that culminated in Eritrean independence in 1991 (Central Intelligence Agency (CIA), 2002).

Eritrea is located in the north east of Africa between 12 and 18-degrees north and between 36 and 44-degrees east. It has a total land area of 125,788 square kilometres. It borders Sudan in the west and northwest, the Red Sea in the north and northeast, Djibouti in the southeast and Ethiopia in the south (Esterhuysen, 1998). It has a coastline of 1 200 km stretching along the Red Sea Coast and more than 350 small and medium sized islands on the Red Sea (refer to Appendix 1a).

Administratively, Eritrea is divided into 6 Zobas (Regions). They are Centre, South, Gash Barka, Anseba, Southern Red Sea and Northern Red Sea. These Zobas are sub-divided into 53 sub-Zobas (refer appendix 1b). It has a diverse population in terms of language, culture and religion. There are nine ethnic groups in the country, namely, Tigrinya, Tigre, Bilen, Afar, Saho, Rashaida, Kunama, Nara and Hidareb. According to the CIA (2002) the total population of the country is estimated at around 4.5 million. The population growth rate is 3.8% and life expectancy is 56.6 years.

Eighty percent of the population lives in rural areas and is highly dependent on subsistence agriculture. Agricultural activities in the rural areas are divided in to three distinct types: Pastoralism, agropastoralism and sedentary agriculture. About five percent of the people are pastoralists and are mainly found in the extreme southeast and around the northern border with Sudan. Twenty five percent of the population in rural areas are agro-pastoralist found both in the eastern and western lowlands, while the remaining 70 % practice sedentary agriculture in the western lowland and highlands (Ministry of Land, Water and Environment (MLWE), 1998).

3.1.1.1 Natural resources

Eritrea is a country with a complex series of landscape and climatic features, which give a wide variety of agro-ecological zones. According to MLWE (1997), Eritrea is divided into six major agro-ecological zones based on broad similarities of moisture and temperature regime, natural vegetation cover, soils, and land use. The major zones are further divided into 56 agro-ecological units based on differences of landform, soil type, land cover or land use. (Refer to Appendix 1c, and for detailed information refer to Appendix 4)

The climate of about 70 % of the country is arid with a mean annual rainfall below 400 mm and a mean annual temperature greater than 26° C (Nastasi, 1993). It ranges from hot arid on the coastal plain areas to temperate sub-humid in isolated micro-catchments in the eastern highland escarpment. Mean temperatures range from 16°C in the highlands to extreme highs of about 30°C along the Red Sea coast in Massawa. The Danakil depression in the southeast, which is more than 130 m below sea level in places, experiences some of the highest temperatures recorded, frequently exceeding 50° C.

Like other Sahelian countries, Eritrea receives its rainfall from the southwest monsoon in the summer months of April to October. "Small rain" falls in April and May and the "main rain" follows in July with the heaviest total precipitation in July and August. Only the coastal plains, and the southern part of the eastern escarpment of the central highlands, have winter rainfall (November to March) that is born by the north and north-east continental air-streams that carry little moisture until affected by the Red Sea where they pick up moisture (FAO, 1994). Appendix 1d shows the rainfall regions of the country.

The main rainy season in the highlands and western lowlands is June to August, but "small rains" normally precede this in April and May. In the eastern lowlands it rains from November to March. Annual precipitation in the highlands varies from 400 to 700 mm, and increases from north to south. In the lowlands, rainfall varies widely with extremely low averages. In the desert climate of the coastal plains, mean annual precipitation is below 200 mm. The Green Belt Zone receives the highest annual rainfall averaging about 900 mm (refer to Appendix 1e).

For a long time the vegetation in Eritrea has been subjected to mismanagement and exploitation. In 1952, Eritrea's forest resources covered 12 525 square kilometres, about 11 % of its land area. This resource has been reduced to less than one percent at present (MLWE, 1998). According to the MLWE (1997) the dominant vegetation types include: acacia bushland and shrubland, savannah woodland, some disturbed forests with *Juniperus procera, Olea africana,* scattered woodland (*Hyphenae palm* along major rivers), sparse scrub, grass and halophytic communities (A*cacia mellifera*). However, the FAO, (1994) classify the natural forests of Eritrea into 6 main categories: highland forests; mixed woodlands; bush or shrub vegetation; grassland to wooded grassland; riverine forests and mangroves. A more detailed classification is given by the FAO (1997) (refer to Appendix 1f).

Water is the lifeblood of Eritrea and yet it is one of the resources in which it is poor. A detailed and comprehensive assessment of the potential of the water resources has not been undertaken. According to the Water Resource Department (WRD), (1997) there are 6 major river basins in the country (refer to Appendix 1g). Preliminary assessments indicate that Eritrea is not endowed with appreciable amounts of water resources, particularly surface water. The *Setit* is the only perennial river, the remaining streams and rivers in the country are seasonal and /or ephemerals and have widely variable flows.

The FAO (1994) has identified twelve major soils in Eritrea. These are: Arenosols, Calsisols, Solonchaks, Leptosols, Luvisols, Lixisols, Gypsisols, Cambisols, Fluvisols, Nitisols, Vertisols and Regosols (refer to Appendix 1h). In the northern and southern sections of the Red Sea coastal plains there are predominantly sandy desert soils. In another part of the plains, ortho-Solonchaks, and Regosols, are found. In the highlands, the predominant soils are chromic, eutric, and calcic Cambisols of strong red colour. Other soils found in the highlands are Lithosols, and Fluvisols. Soils on the western plains include Vertisols and Fluvisols (Land Resource and Crop Production Department, Ministry of Agriculture (LRCPD, MOA), 1999).

3.1.1.2 Land use

As detailed land use studies have not yet been done in Eritrea, there is no standard land use classification system. However, land use categories according to the FAO (2000) indicate that livestock-related activities make use of 56% (6 820 000ha). Cultivated rainfed land accounts for 4.62 % (560 000 ha) and irrigated land amounts to 22 000 ha. Overall forestland represents 0.51 % of the total land (63 000 ha).

There are three categories of land ownership in the country, namely State, *"Diesa"* (village or community) and the family. Of the three land ownership systems, the most common in the highlands is village or communal ownership. In this system the land of the village is communally owned and every household of the community gets an equal share of agricultural land. Land redistribution is done every five to seven years. The main purpose of this redistribution is to give newly married couples access to land and guarantee an equal share of land among members of the community. In this tenure system, the whole community uses the rangeland. Communities develop their own bylaws that govern the use and management of the rangeland.

According to the FAO (1998), the *'Diesa'* tenure system has it own advantages as well as constraints. Some of the advantages include its egalitarian approach. There is an equal share of arable land, in-terms of area and fertility, for all community members. It also gives the security engendered by the guarantee that every family will receive some land. Fragmentation of land due to periodic redistribution and limited incentives for lasting land improvements are mentioned as the main disadvantages. There is also limited property right as land cannot be sold or used as collateral in this tenure system.

3.1.2 THE STUDY AREA

The area selected for this study is in the South zone. It is located in the central highland part of Eritrea. Administratively it is sub-divided in to 12 *Sub Zobas* (Sub Zones) namely, Dekemhare, Segeneyti, Adikeyh, Senafe, Tserona, Mai-Aini, Dubarwa, Mendefera, Emnihaili, Adi-quala, Areza, Maimne. The capital of the region is Mendefera, which is located about 50km south of Asmara. The South zone, with more than 800 villages and a population of about 755 000, is one of the most highly populated regions of the Eritrean highlands.

According to the MLWE (1998), the dominant land use of the area is sparse to intensive cultivation and livestock raising. It is characterized by an irregular and uneven distribution of rainfall. The land tenure system in the areas is "Diesa", where land is owned and managed by the village community. In this region, the population density is high and the pressure on agricultural and rangeland is increasing. The farm units for a given household are very small and are diminishing every year.

The first village, Hadas Agulae, is located in the Sub Zone Mai Aini at about 80 km south east of Asmara, the capital of Eritrea (refer to Figure 3.1). It is situated at an altitude of 1600 meters above sea level, which is the lower boundary of the moist highland agro-ecological zone. The topography is generally rugged. The total population of the village is 1220 in 345 households. The livelihood of the entire community is based mainly on rainfed agriculture. The majority of the cultivated soils of Hadas Agulae village are shallow and infertile. Each household holds around 1.5 to 2 hectares of land, which is normally occurs fragmented in 3 to 4 locations. The main crops grown in the village include maize, sorghum, millet, wheat and barley. There are a few farmers who practice small-scale irrigation, using water from hand-dug wells along the river, growing mainly tomatoes, papaya, and vegetables. The nearest market place is Mai Aini, the capital of the sub zone, situated about 10 km south of the village with which it is connected by an all-weather gravel road.

The second village, Kakebda, is located in Sub Zone Dubarwa at about 50 km south of Asmara (refer to Figure 3.2). The total population of the village is 1143 in 251 households. The livelihood of the community is based mainly on agriculture with a substantial amount of small-scale irrigation. This is due to the abundant availability of

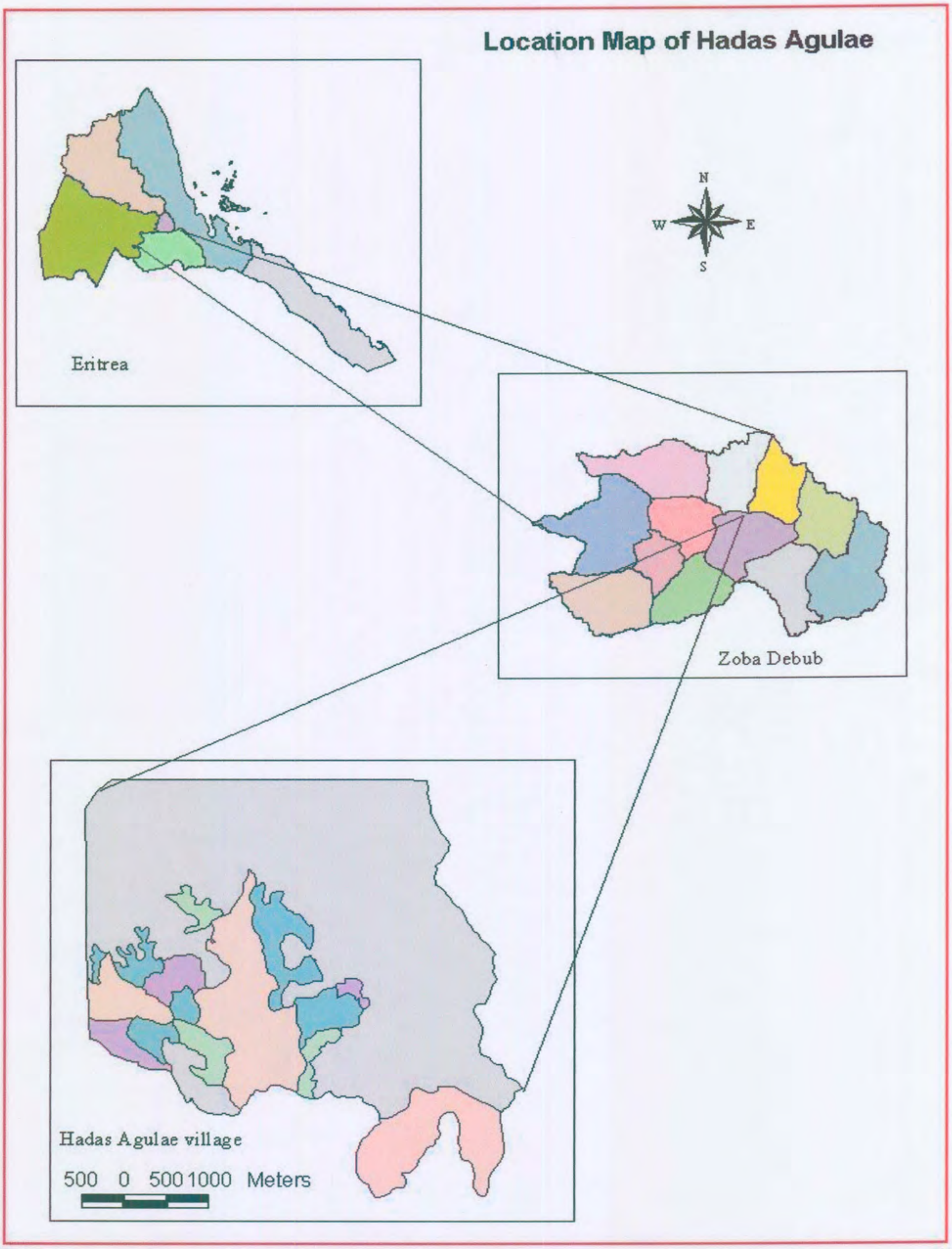

Figure 3.1 Location map of Hadas Agulae village

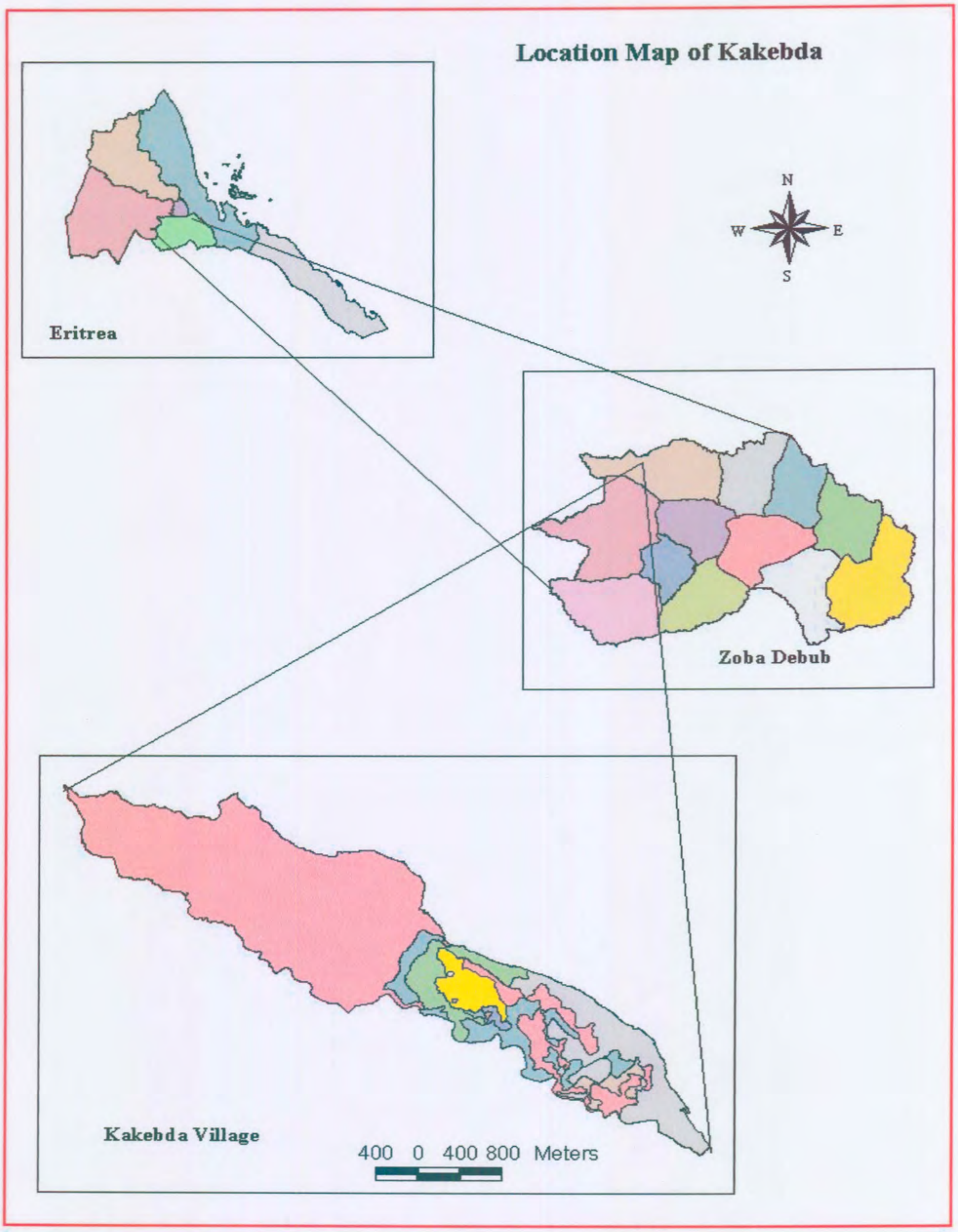

Figure 3.2 Location map of Kakebda village.

ground water in the area and good access to markets. The nearest market place is Dubarwa, which is the capital of the Sub Zone. It is located less than 10 km from the village and is connected by all-weather gravel road. The farmland of the village is relatively fertile (mostly deep alluvial soil) and every household owns 1.5 to 2 hectares of farmland that occurs fragmented in at least four areas.

3.2 METHODOLOGY

The research was done in conjunction with the farmers living in the study area and was participatory in nature. The main stages included the following:

1. Survey of literature relevant to the topic, to explore the existing knowledge.
2. Collection and analysis of data on the present land use planning approaches in Eritrea, in consultation with land related ministries in Eritrea.
3. A survey was conducted in Hadas Agulae and Kakebda villages to examine the traditional land classification, planning, and management systems. The methodology for the exploration of the local knowledge in the two villages included participatory classification and mapping of local land types with farmers on site. In the Hadas Agulae village aerial photographs at a scale of 1:10 000 were used as a base for classification, while in Kakebda village a GPS survey was used, as aerial photos were not available. Village elders who are knowledgeable and responsible for land classification in the village were selected for this purpose. The classification of land was conducted in situ by the village elders by visiting every class of land and was verified after preliminary maps had been produced.

Additional information was gathered from interviews with key informants, which were usually village elders, and by means of field observations. Data related to the land's potential, problems and possible solutions (according to the farmers' perception) was collected. In addition to this, crops, natural vegetation and present land use information for each class were recorded.

Group discussions and field visits were done to explore the logic behind this classification system and to understand the working environment of the traditional institutions responsible for land management. Semi-structured interviews were conducted with each member of the local institutions to further investigate the institutional setup and the criteria and methods of classification.

Conventional soil survey methods were employed and representative soil samples were augured from each land type up to 150 cm where the soil depth permits. With the help of the farmers, soil properties that are important in the local classification method were identified and selected as fertility indicators. For this purpose, soil texture and depth of the different horizons were determined and recorded during the field survey.

For the Hadas Agulae village, the maps produced in the field were digitised, compiled, and different maps were produced using a Geographic Information System (GIS) with ARCVIEW©. Three maps were produced. One shows the classification based on land potential, the second local names (toponymy) and the third is a combined map. Information about the vegetation, land use, problems and possible ameliorations were collected for each class appearing in the combined map.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

Traditional land use and management in the study area has a long history. The land holding system is called *Diesa*, whereby the land is owned communally and redistributed every five to seven years. The fact that land has to be equally redistributed at this interval has prompted farmers to develop different ways of land classification and related local institutions.

In this research two villages in different locations were selected for the study. To get the general overview of the problem, the institutional and technical issues related to land management in general and land classification in particular were investigated. Though the land tenure system and the general institutional set up were found to be the same, striking differences were observed in the farmers' approach to land classification.

4.2 INSTITUTIONAL ISSUES AND MANAGEMENT

Manig (1999) defined institutions as "... *those relatively stable regulating mechanisms and principles governing the interaction between people and their relationship to the environment*". He further explained that institutions are legitimised and sanctioned by a society by common consent. These rules are consciously or unconsciously established by human activities in order to regulate potential conflicts in all social fields, which are considered important.

Farmers in the study area have developed different traditional institutions over generations. This institutional set up could be seen at different planning levels of the community with special focus on agricultural land. The highest planning level being the village or community level, the lowest is the individual farmer level. The local institutions of the two villages were found to be the same.

4.2.1 COMMUNITY / VILLAGE LEVEL

At this level higher decisions, which affect the whole community, are taken. There is a well-organized traditional institution that is responsible for all land related activities in the village. There are village by-laws that govern their activities and the farmers elect the members of this organization democratically. These are different committees responsible for different activities. In the agricultural land they decide the time for land redistribution, classify the land according to its potential, screen persons eligible for land acquisition, and decide on the size of plots for each person. For this purpose, the village residents elect nine farmers in a village general meeting called *Baito Adi.* These farmers form three different committees responsible for different activities. These are, *Aquaro /Metaro, Gelafo /Tserabo and Shimagle tiesa.*

4.2.1.1 *Aquaro* or *Metaro*

This is a group of farmers who are responsible for the classification of land in the village. First they classify the land according to use into different classes, namely agricultural land, rangeland and *tiesa* land. (*Tiesa* land is land that is used for residential purposes). They further classify the agricultural land into different classes according to the land potential. Based on the report they get from *Gelafo* (it is discussed in section 4.2.1.2), they distribute the land to the farmers usually by allocating a given area to a group of farmers called *Janda.* Each group of farmers may differ in its size based on the piece of land to be allocated. Thereafter the group is usually responsible for distributing the land among themselves. After classifying the land into fairly equal parts, the process of distribution is done by drawing lots so as to ensure that there is fair distribution of land.

4.2.1.2 *Gelafo* or *Tserabo*

This is a group of three farmers, which are responsible for identifying who is eligible to get land in the village. They conduct their study and present their findings to the A*quaro.* Based on these findings the *Gelafo* distribute the land. Different by-laws are used to screen farmers for eligibility and to administer the land. These by-laws differ from one area to another. Some of the by-laws from the study area include:

- One should be married to be eligible to get land. However, if one could not get married due to physical or mental problems one has the right to get a full share of the land.

- Married couples get a full share regardless of the number of children they have.
- In case of divorce if the couple do not have children they take half of their share each. But if they have children and the mother has the children during the divorce she gets a full share and the husband gets half. If the husband gets remarried he gets a full share of the land. Usually the village sets aside some land for some unforeseen eventualities, they call this land *Hadega gebar.* Usually this land is the land they get from deceased ones and some land set aside for this purpose during the land redistribution process.
- Land from deceased ones is returned to the village pool. In these villages if the farmer is deceased while the land is planted he gets the harvest and again his relatives get the chance to use the land for another year. But if he is deceased before the land is planted his relatives are allowed to farm the land only for one year.

4.2.1.3 *Shimagle tiesa*

This is a group of farmers that are responsible for distribution of land for residential purposes. However, at present they work under the directions of the government, as there are specific directives, which are used during the distribution of land for residential purposes. Traditionally, any male member of the village community who is married has the right to get a *tiesa* land. Under the new land law, however, even the female members of the community have the right to acquire land for residential purposes in their native village. At this time the *Shimagle tiesa* are usually the same people who represent the *Aquaro/Metaro*. When they are the same they are called *shimagle Meriet* (*Shimagle* = elders; *Meriet* = Land).

4.2.2 FARMERS GROUP

Farmers who are allocated land in one area form a group called *Janda* in the study area. (In other areas of the south zone different names are given to such group and *janda* can have different meanings). At this level, farmers in the group collectively plan and co-ordinate their farm activities. They decide on fallow periods, farming, planting and harvesting time, and the type of crop they plant. They also undertake major soil and water conservation activities if needed. Decisions are taken by consensus among the farmers and this helps the farmers to co-ordinate their limited resources for activities that need collective action.

4.2.3 INDIVIDUAL FARM LEVEL

An individual farmer usually plans for his farm depending on the resources available. The farmer plans for crop rotation, organic fertilizer application, erosion control and moisture conservation measures on his plot of land. The farmer usually works to avoid risk and to optimise production with the limited resources he has.

4.2.4. SUMMARY

The tenure system, which demands equal redistribution of land every five to seven years, has necessitated the formation of local institutions responsible for the classification, distribution and management at village level. At this level farmers are well organized and the local institutions have direct influence on the day-to-day activities of the community. The local organizations at the village level were classifying and allocating land to its best use, which in a way, is planning for the best use of the land. This makes the village level the most appropriate level for participatory land use planning, as there are strong local institutions and good indigenous knowledge for land use planning.

4.3 LAND CLASSIFICATION

Though the local institutions responsible for the land management are similar, the land classification systems in the two villages studied have striking differences. This is due the different factors the farmers consider important for the classification based on the existing situation in their respective villages. Hence, the classification system of each village will be discussed separately.

4.3.1 HADAS AGULAE VILLAGE

In this village, as the area is relatively arid, farmers' criteria for classification include the ability of the soil to receive additional water and in its inherent water holding capacity. Therefore, the location of the area plays an important role. Areas located in the foothills and riverbanks have a high potential of getting additional water from runoff and have a higher potential. In addition to that the soil texture and depth are considered to be very important.

The land of the village has been cultivated for a very long time and the fertility of the soil is very low. For this reason, the farmers use animal manure as fertilizer. Since the animals graze on the hills directly above the farmland, the manure is usually washed down to the farmland during the rain season by runoff. Consequently, areas that get the runoff are benefited not only through the additional water but also through the manure they get at the same time. Based on the above-mentioned criteria, farmers in this village classify their farmland into four general categories, namely *grat efun, grat taff, grat dagusha* and *grat gobo or grat sgem.* Figure 4.1 represents these classes schematically.

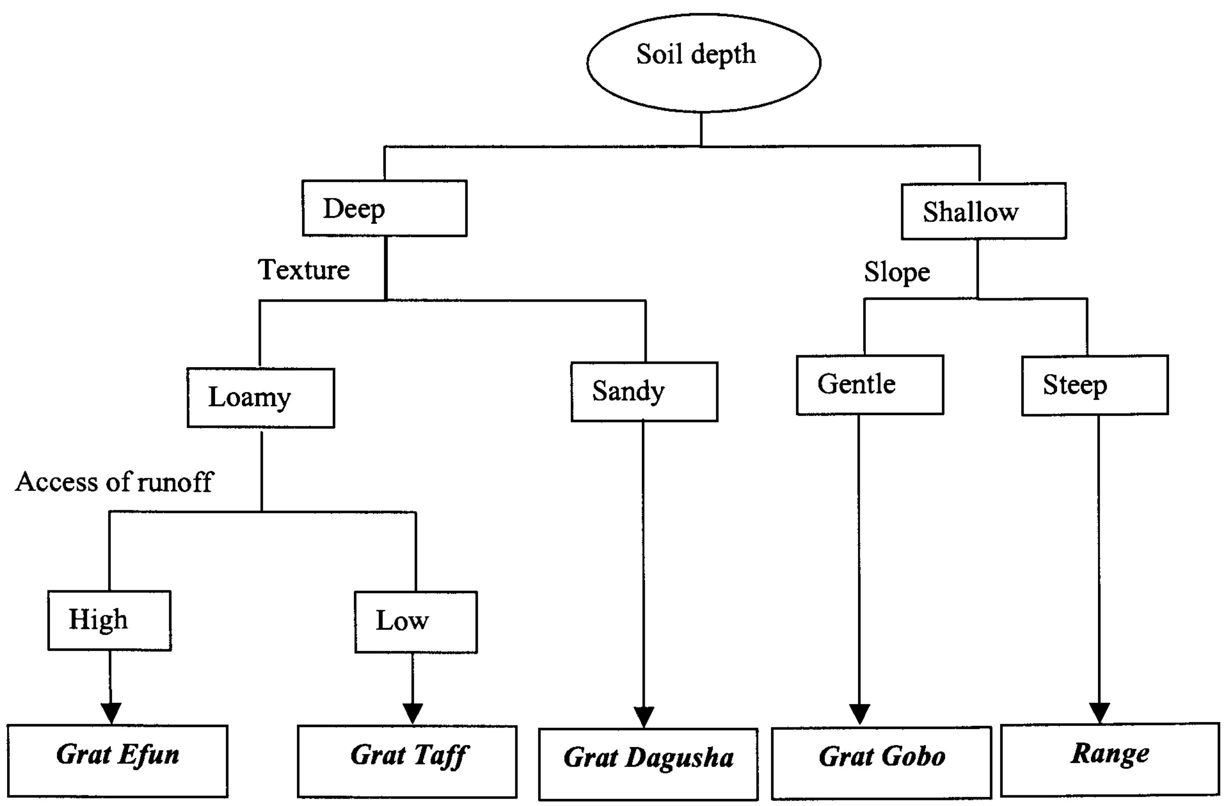

Figure 4.1 Schematic representation of land classification in Hadas Agulae village

4.3.1.1 *Grat Efun (maize field)*

This is the class with the highest potential. It is located in areas where there is a possibility of getting additional water and animal manure. It is located in low-lying areas which get run off from the residential areas where the farmers put their animal manure and, in riverbanks where they can divert water from runoff during the rainy season. Moreover, it also covers areas located at the foot of the hill where there is a high potential of getting additional water and animal manure (which the animals left while grazing in the area) through runoff from the hills during the rainy season.

The soil depth of this class ranges from 100 to 150 cm and the soil texture is sandy loam. This land is relatively fertile and has higher water holding capacity than the other classes. The area is flat with the slope ranging from 0 to 2%. It is mainly used for maize cultivation (hence the name *Efun* = maize). However at this time it is also being used for small scale irrigated agriculture.

4.3.1.2 *Grat Taff (Eragrostis teff field)*

This class is considered the second highest potential area. The soil characteristics are fairly similar to those of *grat efun*. However, it is an area with low probability of getting additional water and animal manure. It is usually located in the low-lying areas and in the centre of the fields where runoff water does not reach. This area is flat with the slope ranging from 0 to 2%. Traditionally the area is used for rainfed *Eragrostis teff* and sorghum farming. Other crops could also grow well in the area except maize, which has a high water demand.

One of the indicators for the farmer to identify this area is also the presence of a weed locally called *Hawi Aina* (*Striga hermonthica).* The farmers consider this weed as an indicator of low fertility. Due to the relatively low slope percentage, some farmers are now using the area for small-scale irrigation with supplementary water from hand-dug wells, when available.

4.3.1.3 *Grat Dagusha (finger millet field)*

This class has a lower potential than the previously mentioned classes mainly due to the soil characteristics. The soil is sandy in texture. It is deep and is mostly found at the foot of the hill where there is considerable deposition. However, its water holding capacity is very low due to the soil texture. Since the area has high temperature regularly, water loss due to evaporation is very high. The slope of the area ranges from 3 to 5%. The farmers consider this area as low potential area and use it mainly for rain-fed finger millet farming.

4.3.1.4 *Grat Gobo* or *Grat Sgem (barley fields)*

This is the class that the farmers consider to be the lowest potential land. It is located in hilly areas where the slope is very steep (>5%) and the soil is very shallow. The area is exposed to a relatively high erosion rate and the water holding capacity of the land is very low. This is because the soil is very shallow and hence cannot retain much water from the rain and what is retained can easily be lost through evaporation. Due to the steepness of the area, the rain water does not get enough time to percolate into the soil and usually drains off to the low lying areas. Therefore, this area is used for rainfed wheat and barley production, which matures in a relatively short time (only three months).

4.3.2 KAKEBDA VILLAGE

The agricultural land in this village is found in a flat area where the soil is alluvial and relatively deep and fertile. The residence area of the community is situated in a hilly area and much of the farmland is located at a distance from the village. The distance of a given land from the village residence area is, therefore, considered as a criterion. Any farmland that is in very close proximity to the village is delineated as one class. Moreover, soil texture and soil depth are also considered during classification as these factors affect productivity. The area is also rich in ground water. Due to this, small-scale irrigation is becoming a common practice in the area. Though previously it was not taken as a criterion, the farmers at this time take ground water availability or proximity of a given land to a ground water source as one of their criteria for classification. Based on these criteria farmers classify their farmland into four general categories, namely, *Ghedena, Member, Gual member* and *Rekik.* Figure 4.2 represents these classes schematically.

4.3.2.1 *Gedena*

In this village the distance of a given area from the village is given a special consideration. All farmland areas that are very close to the village are classified as a special class without any consideration to other criteria. Therefore, the potential of the land may vary accordingly. Due to its shorter distance from the village more animal manure is added to this area by the farmers and from the village premises washed down by run off during the rainfall events. Hence, the productivity of the area is considered to be fairly high.

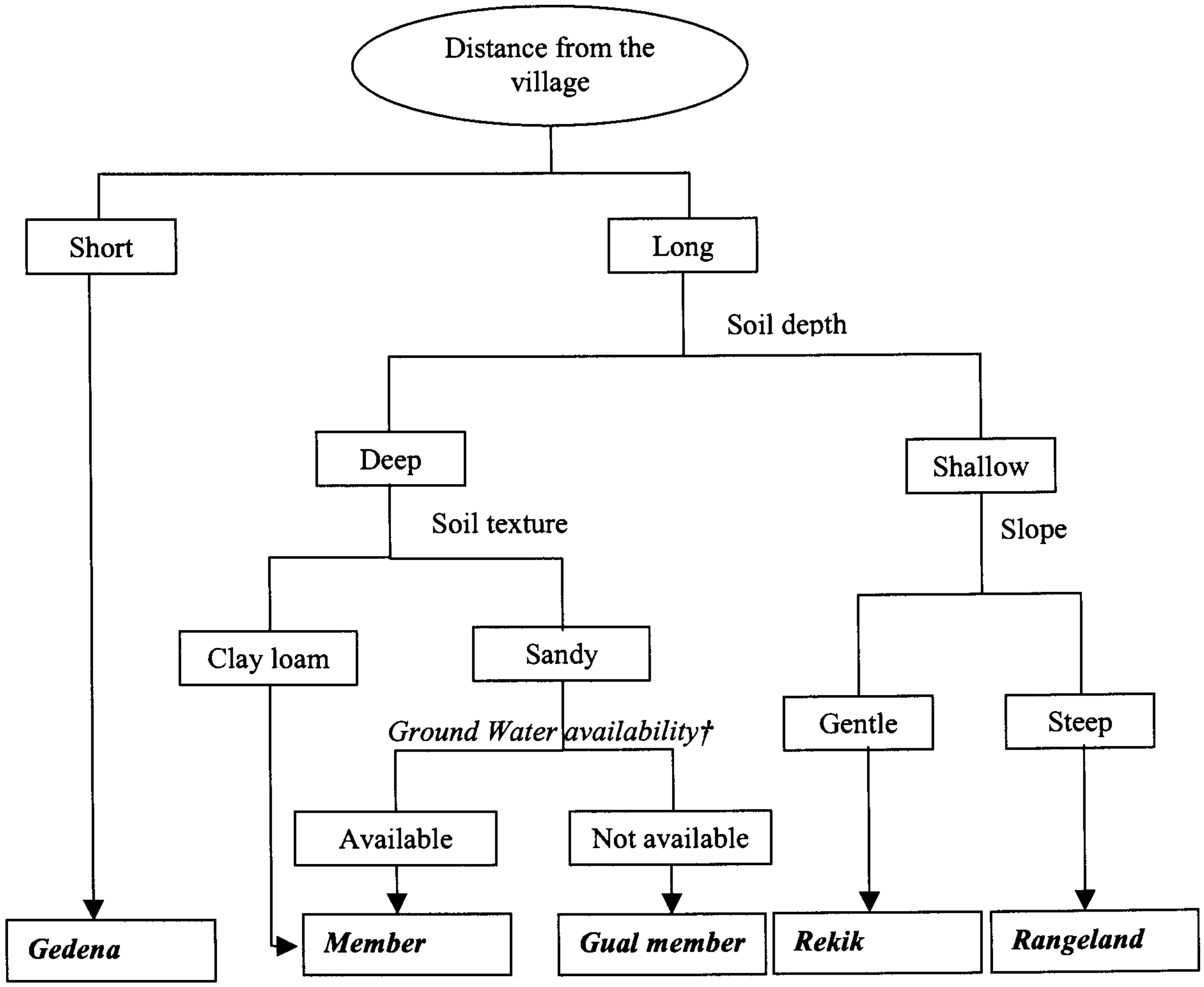

Figure 4.2 Schematic representation of land classification in Kakebda village

† Any land with sandy loam texture was previously taken as **Gual member**. However, if ground water is available, the land is currently considered as **Member**.

4.3.2.2 *Member*

The farmers consider this land as a prime land with high productivity. It is usually land with a soil depth ranging from 100 to 150 cm and with slope percentage of 0 to 2%. The soil texture generally varies from clay loam to loam. Due to the availability of ground water and the village's proximity to the urban areas, small-scale irrigation is introduced in the area and this land is usually used for this purpose. As is noted in Figure 4.2, currently due to the importance of small-scale irrigation in the area, even land with sandy loam soil texture is considered as *Member* land.

4.3.2.3 *Gual Member*

This land is considered to have the second highest potential in the village. The soil is shallower than the *Member* soils and the texture class is sandy loam. The slope is gentle, 2 to 5%. The farmers use this land mainly for rainfed maize and *Eragrostis teff* production. During land redistribution, farmers who get a smaller share from the *Member* are compensated by getting a bigger share of this land. At this time, however, some farmers with access to irrigation water are using this area for vegetable production.

4.3.2.4 *Rekik (shallow soils)*

This land is the lowest potential of all classes. The soil texture is generally sandy and it has soil depth of less than 50 cm. It is also located in areas with a slope greater than 5% and the erosion hazard is higher. This land is used for rainfed sorghum and wheat crops that have a short growth period.

4.3.3 COMPARATIVE ANALYSIS

The results demonstrate that farmers in the study area have not only a systematic and effective way of classifying land but also well-developed local institutions for land classification and management. Though the land tenure system and local institutions of the two villages are the same, farmers in the two villages have different approaches to classifying their land.

In Hadas Agulae village the availability of runoff water is considered a priority, as it is the only means of obtaining supplementary water. On the other hand, in Kakebda village runoff is not given priority, as their main source of supplementary water source is ground water. As farmlands are located in close proximity to the village in Hadda Agulae, there is no any special class based on distance, while in Kakebda distance from the village is used as a criterion for classification. Similarly, farmers in Hadas Agulae use the existence of *Striga hermonthica* as an indicator for low fertility soil. In Kakebda the weed does not occur and is therefore not used as criterion.

With change over time and the increase in the importance of irrigated agriculture, the farmers in Kakebda village have given more consideration to ground water availability. Land that was previously considered as second best, *Gual member,* due to its soil texture and depth is now considered as the best class, *Member*. This clearly demonstrates the adaptability and flexibility in the farmers' classification methods and their response to the changing physical and economic conditions.

4.3.4 SUMMARY

The land classification system in the study area has a dual purpose. The main purpose for the classification is equal distribution of land during land redistribution based on the tenure system of the area. Meanwhile, it also helps the farmers in the allocation of the land and to adapt their management systems based on the potential of the land. For example, the naming of the classes in Hadas Agulae village indicates the use of the land by the farmers. "*Grat efun*" means maize fields, and these fields are mainly used for maize production. Since maize is the major crop in the village, the best land is used for this purpose. Therefore, the farmers' land classification system is one part of land use planning per se.

The farmers' classification methods are best suited for their village as their classification is based entirely on the problems faced by the farmers and the relative potential of the land instead of standards, which may not suit to the given situation. Farmers consider factors that may seem of small significance to the outsider but have high effect on their farming practices. Similar observations have been made by Cools et al, (2003) who demonstrated that farmers have an excellent understanding of their biophysical environment, which is nearly impossible to be captured by land resource professionals owing to the time involved. Therefore, the local classification system helps farmers to develop management systems suitable for each class and it has a direct implication on their farming practices.

It is also important to note that the farmers' classification considers not only the biophysical factors as fertility indicators but also the physical and economic factors. For example they give high consideration to distance from village, access to runoff or ground water and manure. These factors, which are very important to the farmers, may not be easily identified in any scientific classification methods. Such considerations by the farmers draw land classification away from mere soil classification, and this represents the real asset of local knowledge systems.

4.4 TOPONYMY

Local classification nomenclatures, and soil and land taxonomies are considered one of the research fields of ethnopedology (Barrera-Bassols and Zinck, 2003). Local names have been used for centuries in rural areas to name sites or parcels of land. For example, the use of local field and place names to characterize soils in The Netherlands dates back to the middle ages (Siderius and de Bakker, 2003).

A participatory mapping exercise was done in the Hadas Agulae village where the farmers classify their land using the local names they use to name different parts of the village land. It is observed that farmers of this village give different names to different areas of their village, and they could easily draw it on the aerial photo of the village (refer to Figure 4.4). It was observed that these names usually correspond to different land characteristics and in many aspects the farmers name an area based on its peculiar characteristics, which can give valuable information about the land. For example, the name *"Hetsatsat"* means sandy area and the two places called by this name have sandy textured soil.

The other advantage about this exercise is that everyone in the village community knows the names and the exact location of the areas identified on the map. This is a big advantage in smoothing the communication during a participatory land use planning process as is explained in section 4.5.2. In this regard, members of the community could give information about the area easily as the location, boundaries, potentials and problems of the area are well known.

Additional information could also be generated when the traditional land classification map using the land potential is combined with the toponymic map. For this purpose Figure 4.3 and Figure 4.4 are combined and a combined map that shows the potential of the land and its local name is produced (refer to Figure 4.5). The combining of the two maps further enriched the existing information. For example, the area delineated on the toponymic map as *"Hitsatsat"* is classified as *"Grat Dagusha"* on the local land classification map. Therefore, the combined map gives us both sets of information and tells us not only the soil characteristics of the land but also its land potential and use.

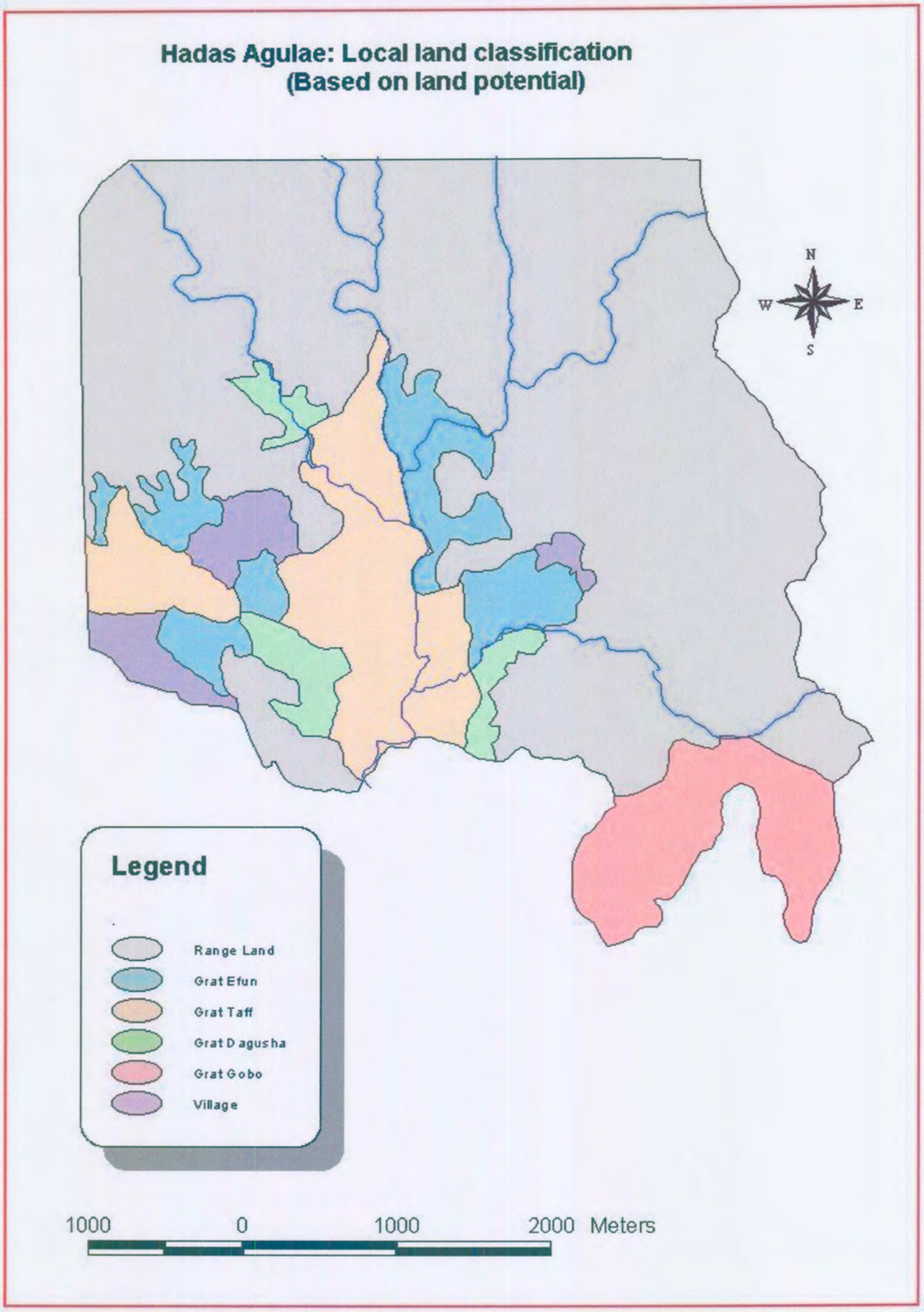

Figure 4.3 Hadas Agulae local land classification based on land potential

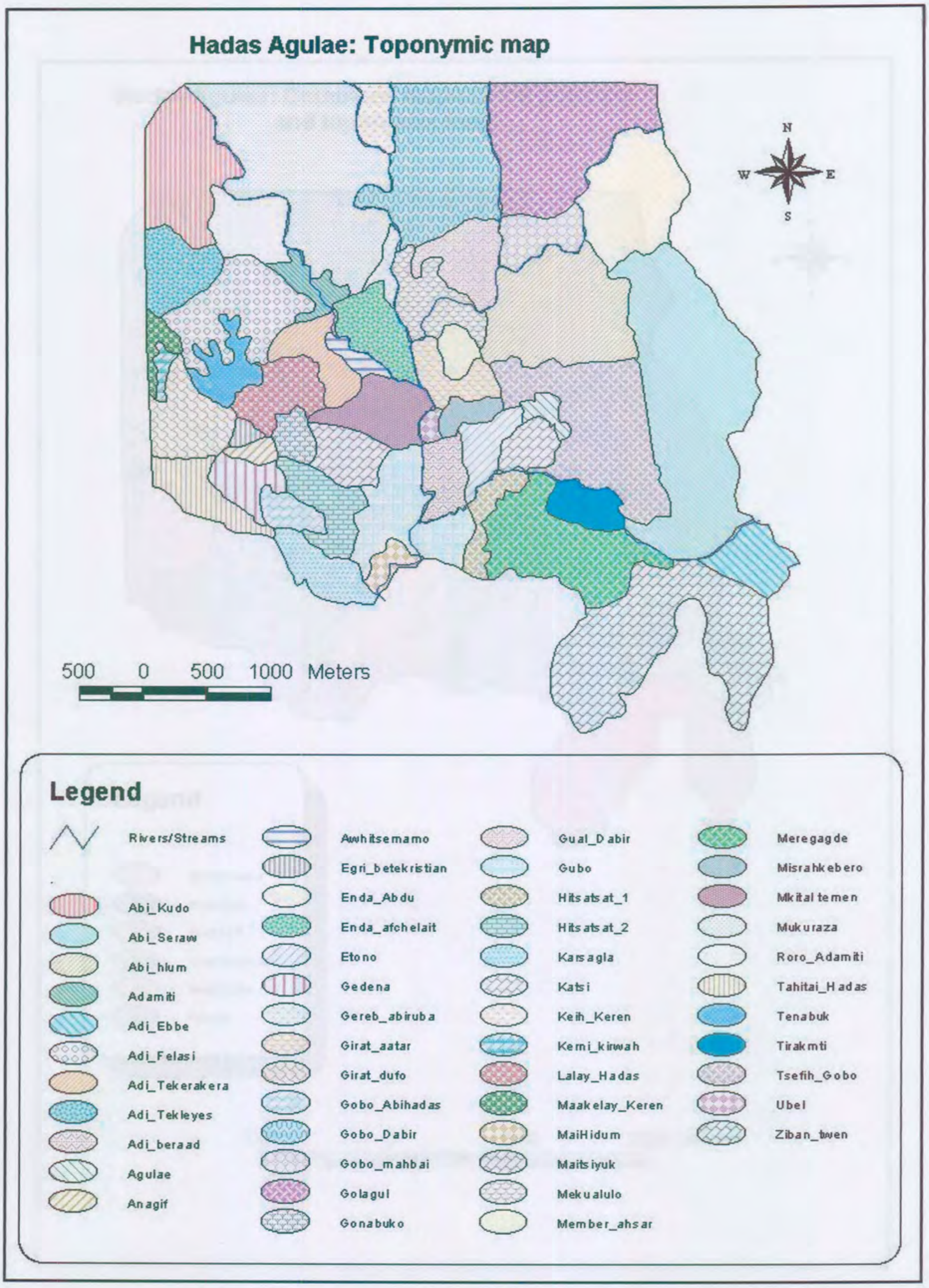

Figure 4.4 Hadas Agulae toponymic map

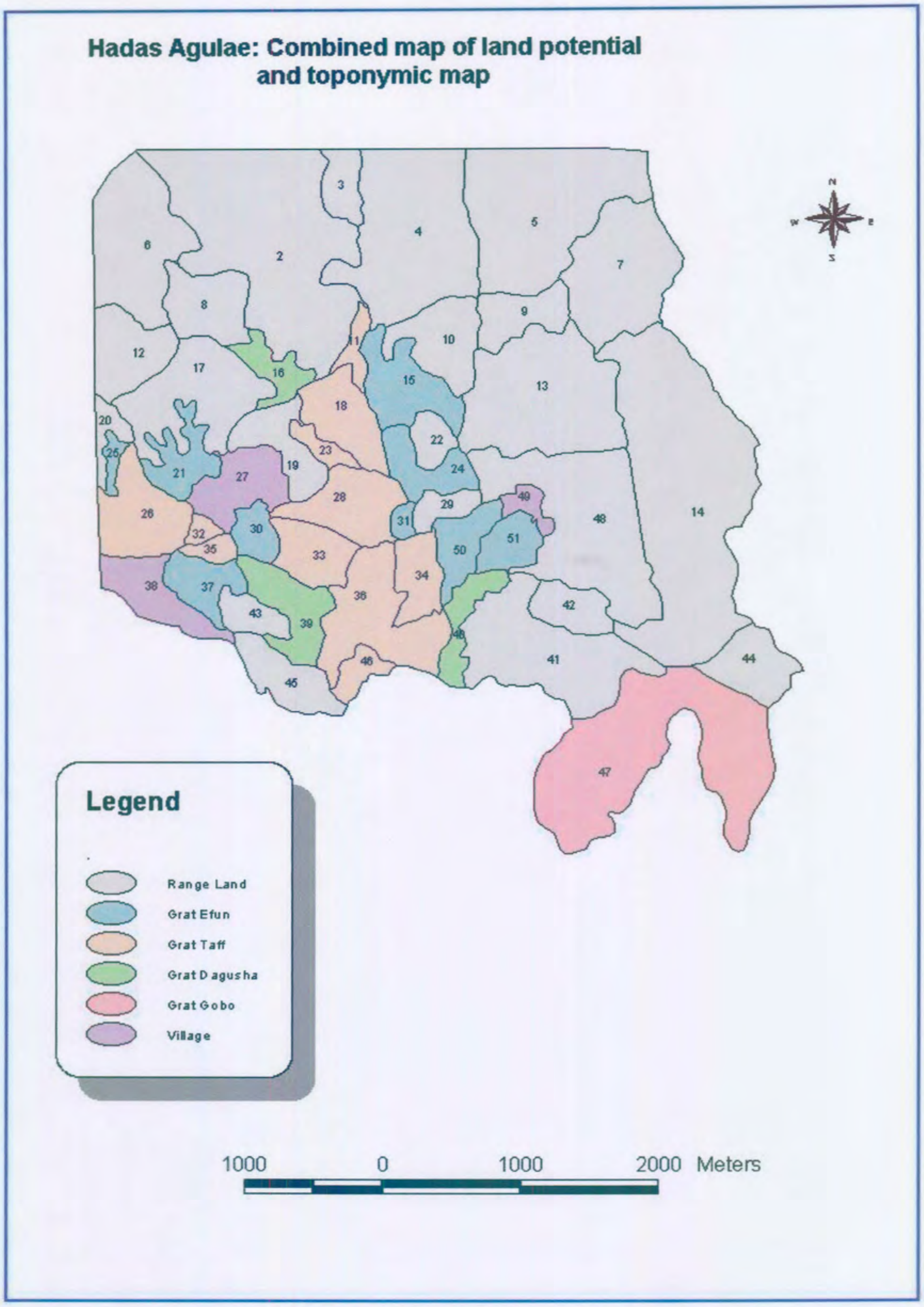

Figure 4.5 Hadas Agulae combined map of land potential map and toponymic map

Note: Refer to appendix 2 for names and additional information of each class.

Substantial information was gathered from the classes identified in this process. Soil, plant and other spatially related data were added using these classes as mapping units. Farmers of the village were able to give additional information on the types of plants growing in each class, potential use of each class, problems related to each class and possible solutions for the problems as recommended by the farmers (refer to Appendix 2)

This information is very valuable in participatory land use planning because it gives the farmers' view on the existing problems and their possible solutions. The maps produced are also helpful visual aids in the whole planning process starting from problem identification to the drawing of the actual plan and its implementation. It can show the spatial relationship of the planning area in an easy and understandable way for the farmers. It also gives a common ground for dialogue between farmers and experts and for communication during the planning process.

4.5 ETHNOPEDOLOGY AND PARTICIPATORY LAND USE PLANNING

The use of local knowledge is the first step in local participation as it opens the way for real involvement of local communities in the planning process. The use of ethnopedology insures that the planning tools are very local and can be mastered by the local population. In addition to this, it shows that there is a willingness and capability of external parties to communicate and interact with local communities and to stimulate autonomy in decision-making. It also allows the local communities to contribute their knowledge, which enhances their self-confidence and sense of belonging.

Currently, the main focus of ethnopedology is shifting from investigating the method of classification towards integrating it into land management issues (Barrera-Bassol and Zinck, 2003, Cools et al., 2003, & Niemeijer and Mazzucato, 2003). One of the relevant issues mentioned by Barrera-Bassols and Zinck (2003) that still hamper reaching methodological integration of ethnopedology with scientific applications is the need to go beyond the classificatory approach as the main ethnopedological research aim and focusing on the management of soil and land resources.

One of the main land management issues is the land use planning. Integration of ethnopedology in land use planning, particularly in participatory land use planning, could be significant. Towards this end, the following discussion will focus on the potential use of ethnopedology in the study area as a stepping-stone in participatory land use planning with special attention to data collection and communication between farmers and planning experts.

4.5.1 ETHNOPEDOLOGY AS A SOURCE OF DATA

Cools et al., (2003) explained that one of the constraints for land use planning at community level is the high cost of conventional soil surveys and land evaluation to assess land quality at the detailed scales required. For this reason, land resource professionals and land use planners usually do not fully understand the micro-scale variations within farmer environments and are, therefore, unable to fine-tune their recommendations to a specific environment.

Ethnopedology could play a role in this regard by using the local land classification as a base for evaluation and as a starting point for scientific inquiries. Krasilnikov and Tabor, (2003) mentioned some benefits of ethnopedological surveys. The first advantage is that it can provide a common language which could help the outsider to quickly gain a better understanding of the local environment, and which is easily understandable by the local communities. Secondly, it can help to identify the relative value of soils and their characteristics. Thirdly, it can assure the quality of the land assessment by a survey team because the team is benefits from the inside knowledge of the local population.

In Eritrea in general, and in the study area in particular, there is lack of necessary data for land use planning. Soil, climatic and socio-economic data are non-existing or not available at a scale necessary for village level planning. For this reason, farmers and their practices could play a great role in generating data that are needed for this purpose. Nordblom, as cited in Cools et al. (2003) stressed that resource professionals use methods for land quality evaluation that often perform poorly when it comes to predicting land productivity at parcel level because their approach is largely deductive. It can be argued that farmers are more knowledgeable because of their close interaction with their land and are the real experts in their environment. Their knowledge could also be used as supplementary information to the data that could be generated by other scientific means.

In this study important data was collected from the farmers, which could be used for the planning purpose. As was discussed in section 4.3, the farmers of the village are able to classify their land in to different suitability classes. From this classification exercise good information was collected about the soil, vegetation, present land use, potential use of the land and problems related to each class (refer to appendix 2). Moreover, the classification system strongly reflects the farmers livelihood systems and farming systems. These and any other spatially related data could easily be collected. The main advantage is also the possibility of generating this data in a short time and with minimum cost. The potential use of the data for planning purposes is significant as it is reliable and is based on a lifetime experience of the local people.

4.5.2 ETHNOPEDOLOGY AS A TOOL FOR COMMUNICATION

For real involvement of the local communities in land use planning, it is not enough to just collect relevant data, but the data, evaluation and recommendations should be accessible both in substance and in a form of presentation in ways that can be understood by all stakeholders. This indicates that smooth communication is a prerequisite for real involvement of the local people in the planning process. In this regard, local names and soil taxonomies have the potential to be used to bridge the gap of communication between farmers and planning professionals. Cools et al. (2003), in his exercise in north-western Syria, observed that the development of the map with the local land units combined with field visits proved to be extremely useful tools for communication on local-level land resources and land suitability between experts and farmers.

In the study area, it is not possible to communicate with farmers using technical jargon, as farmers have very little knowledge of such jargons. This problem could be especially magnified in participatory land use planning where farmers are supposed to participate in all stages of planning from problem identification through data generation to the drawing up of the plan. Therefore, the planning expert should be able to use the language understandable by the local community and ethnopedology could provide the basis for such a language.

Communication starts from the data collection stage and from this exercise it is found that some important tools could be helpful in this context. In the two villages different tools were used for survey. In the Hadas Agulae village aerial photographs at a scale of 1:10 000 were used as a base map and visualization tool for farmers during classification. On the other hand in the Kakebda village mapping is done using topographic maps (at a scale of 1:100 000) and a Geographic Positioning System (GPS) survey. Farmers and the experts had to travel the whole area to map different classes. It was observed that farmers could easily understand aerial photographs, especially at larger scale. This was reflected in the exercise as farmers in Hadas Agulae village could easily recognise their land up to the necessary details. Farmers were able to understand the spatial relationship of their land and mapping of different classes was an easy task. On the other hand, farmers in Kakebda village had difficulties in comprehending the topographic maps. This made it difficult for the farmers to understand the spatial relationship of their land and detailed classifications were therefore difficult and time consuming. Therefore, the availability of aerial photographs at an appropriate scale is very valuable in participatory mapping.

It was also observed that farmers could easily understand the maps produced from the participatory mapping exercise based on their classification methods and toponymy. This is not only because they have been participating in the mapping process but also because the technique and taxonomies used in the mapping exercise are local and easily understandable by the farmers. During 1994 -1997 a German development cooperation (GTZ) project in the study area was mapping the villages using local names and the maps were used as a base for discussions in land use planning. The village communities were able to communicate effectively with the experts and land use plans for different soil and water conservation activities were drawn up fairly easily (personal experience). Similarly, Niemeijer and Mazzucato, (2003) observed that local soil taxonomy can be used for mapping and planning at relatively low cost, at scales relevant for development, and in a language understandable to field staff and farmers.

4.6 CHAPTER SUMMARY

The results of this exercise demonstrate that there are strong local institutions and substantial indigenous knowledge and practice in the study area. The local land classification and the participatory mapping of the villages has also shown that ethnopedology in the area has a potential use in participatory land use planning. It is discussed that its use can be a gateway to participation. It can be used as a means for data collection enabling the capturing of a large pool of land related local knowledge. Moreover, its use as a means of communication between local communities and the planning expert is also reflected. Participatory mapping produced land units, which could easily be used as a base map for land evaluation. Important information that is not easily available in rural areas by scientific means can be generated using this method.

The use of a GIS as a means of data collection, compilation and display is of paramount important. Apart from this, GIS is also used for the processing and production of different maps. Though it is difficult for the farmers to understand GIS applications, it gives the expert a good advantage in the planning process. Furthermore, the expert may also add on layers into the GIS that are out of reach of the farmers, but may prove critical in the planning process. These layers might include climate, hydrology and ground water resources, infrastructure, etc.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Due to the introduction of the new land tenure system, Eritrea is now in transition from different traditional land tenure systems to a new and uniform tenure system. However, the implementation of the new tenure system is likely to be difficult as there is a shortage of necessary human and material resources and technology.

Even though the government is trying hard to develop the necessary institutions, it will take time to reach the stage where it can handle all land-related issues as effectively as is needed. On the other hand, as the traditional tenure systems were in place for generations, there is good indigenous knowledge and traditional institutions of the farmers that can be incorporated into the new system. Therefore, good knowledge of the farmers' practices should be developed so as to identify those that are helpful and easily adaptable to the implementation of the new system. There is hope in this respect as the government is encouraging local participation in all aspects of development. If community participation is secured in the process of implementation of the new land proclamation it will not only facilitate the process it will also guarantee its success and sustainability.

Meanwhile, it is inevitable for the planning process to follow the international trend where participatory land use planning is proving to be appropriate. For this purpose, the farmers' methods and approaches are participatory in nature and transparent. Their local institutions are democratic and hence, are representative of the village community. Therefore, this creates a very conducive environment for village level participatory land use planning.

Moreover, the state of ethnopedology in the study area reflected that farmers have developed good knowledge of their area and they can easily classify the land with minimum cost and in a short time. As the area is mainly used for subsistence agriculture, conventional classification systems, which demand more money, time and experts are not justified. The existence of the necessary traditional institutions, responsible for a wide range of land related issues, is also a bonus. The most knowledgeable people are selected for this purpose and usually they are the village elders who have the advantage of long-term accumulated knowledge of their village. It is thus quite clear that farmers are the best experts in understanding their local environments as they have a comparative advantage to assess land use systems they are familiar with.

To some extent, the farmers' land classification is already a land use plan as they associate land classes with actions and modes of operation. Generally, from the participatory classification and mapping carried out in this exercise it can be concluded that ethnopedologic knowledge in the study area has a practical use as a tool for village level participatory land use planning.

5.2 RECOMMENDATIONS

From the observations made in this exercise, the proposed guiding principles in land use planning in the study area are:

- The most appropriate type of planning for the study area is participatory land use planning. Local communities should have full participation in land use planning activities so that the implementation and sustainability of plans could be guaranteed.
- The most appropriate level for participatory land use planning in the study area is the village level where well-developed local institutions are present and farmers have extensive indigenous knowledge concerning the practices of their land. From this level it is also possible to proceed to the planning of watershed (catchment) areas where the Ministry of Agriculture could implement different land resource development and soil and water conservation activities.
- Participatory land use planning requires a creative mix of traditional and modern knowledge. Since it is not practical at this stage to use scientific soil survey and land evaluation in rural areas, indigenous knowledge in general and ethnopedology in particular should be used in land use planning activities.

- The application of participatory land use planning in this context could be of a wide range but it would mainly be used for natural resource management. This could include planning for soil and water conservation, small-scale irrigation developments and rangeland management.

Any type of planning develops its own procedure as a result of the specific task that it has to perform. Nevertheless, it would seem appropriate to propose a rough structural outline of basic stages in the planning process. Therefore, based on the above-mentioned basic principles the stages identified in the FAO Guidelines for Land use Planning (FAO, 1993) could be adapted into 4 possible general stages. These stages are not meant to be followed in this strict chronological order. They have an iterative nature or could overlap.

Stage 1: Reconnaissance stage. This is the stage where first contact is made with the local population. It includes awareness creation of the village population in preparation of the land use planning exercise.

1.1 *Identification of problems.* The need for land use planning is examined and the land use problems are identified in consultation with the local people.

1.2 *Identification of goals.* The general goals and specific objectives of the plan are set in line with the national and regional priorities.

Stage 2: Pre-planning stage. This is the stage where the biophysical and socio-economic conditions of the planning area are assessed.

2.1 *Training and organization.* Training should be given to local institutions or elected members of the community on how to use aerial photographs, mapping and familiarize themselves with the whole planning process. At this stage the village land use committee, which is responsible for coordinating the planning process, should be established either directly from the existing local institutions or elected village members.

2.2 *Resource assessment and evaluation.* Assessment could be done with the help of the indigenous knowledge of the area. The following steps could be followed.

- Delimit village boundaries with the help of aerial photographs.
- Prepare the local land classification map of the village.

- Prepare the toponymic map of the village.
- Prepare the combined map of local classification and the toponymic map.
- Collect the necessary spatial information based on the land classes identified in the combined map.

Note: The use of GIS at this stage is important to facilitate the process of map production, data collection and presentation.

Stage 3: Planning stage. This is the stage where the maps produced and information gathered in the previous stages would be used in dialogue in the preparation of the land use plan. Different alternative plans could be prepared based on the objectives and goals set, and the best option could be chosen and agreed upon.

Stage 4: Post planning stage. This is the stage where the proposed changes are implemented and the necessary monitoring and evaluation of the implemented changes are done regularly.

5.3 RESEARCH NEEDS

1. Further research is needed to investigate ways of integrating the proposed village level participatory land use planning process in to the regional and national level land use planning.
2. There is a need to investigate the effect of the introduction of the new land tenure system on the existing local institutions and traditional land management.
3. Further investigation is needed on developing appropriate GIS techniques, which could easily be used by the planning experts and farmers in the participatory land use planning process.

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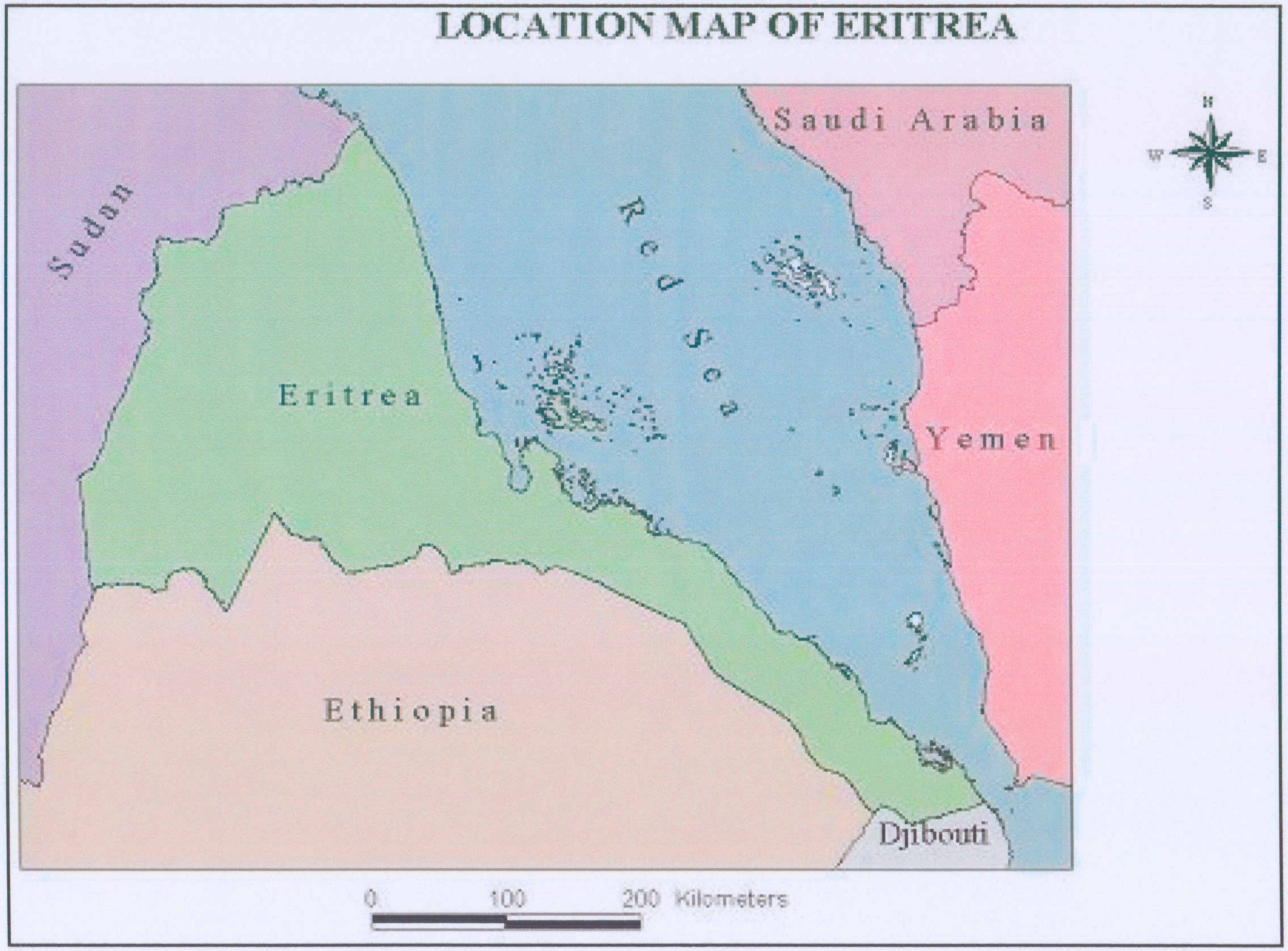
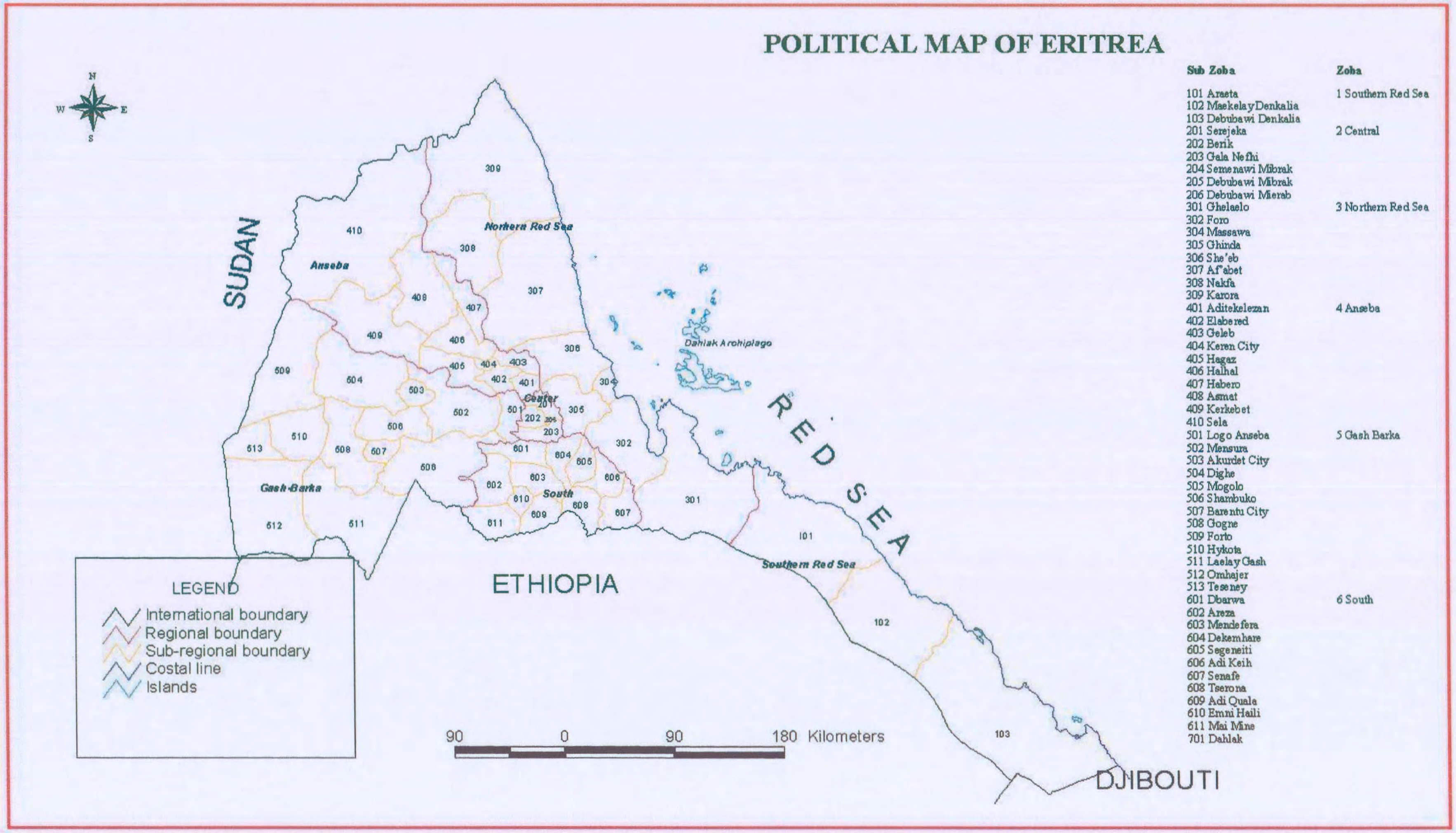
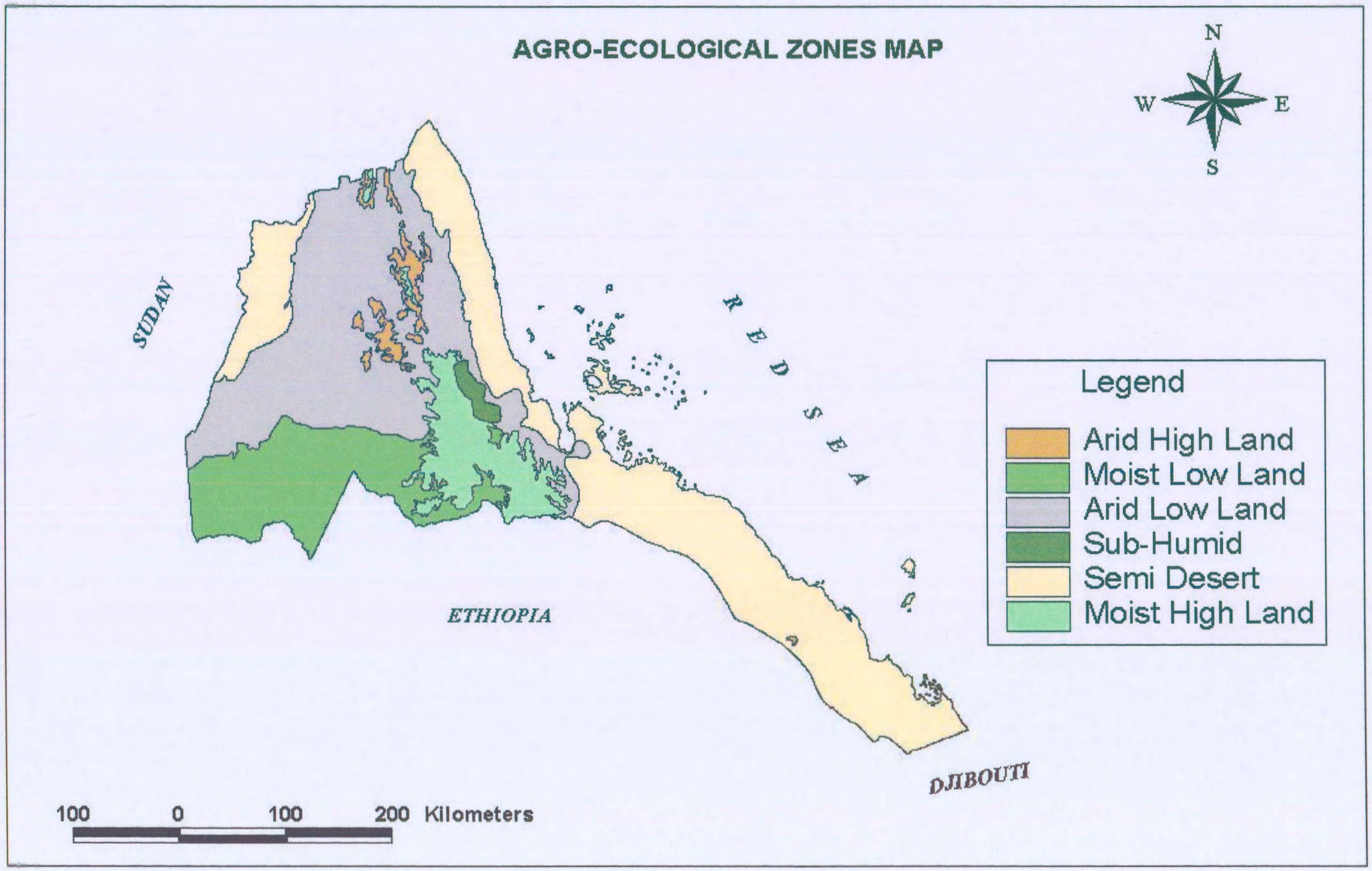
APPENDIX 1a. MAP OF GEOGRAPHICAL LOCATION OF ERITREA (ADAPTED FROM WRD,1997)



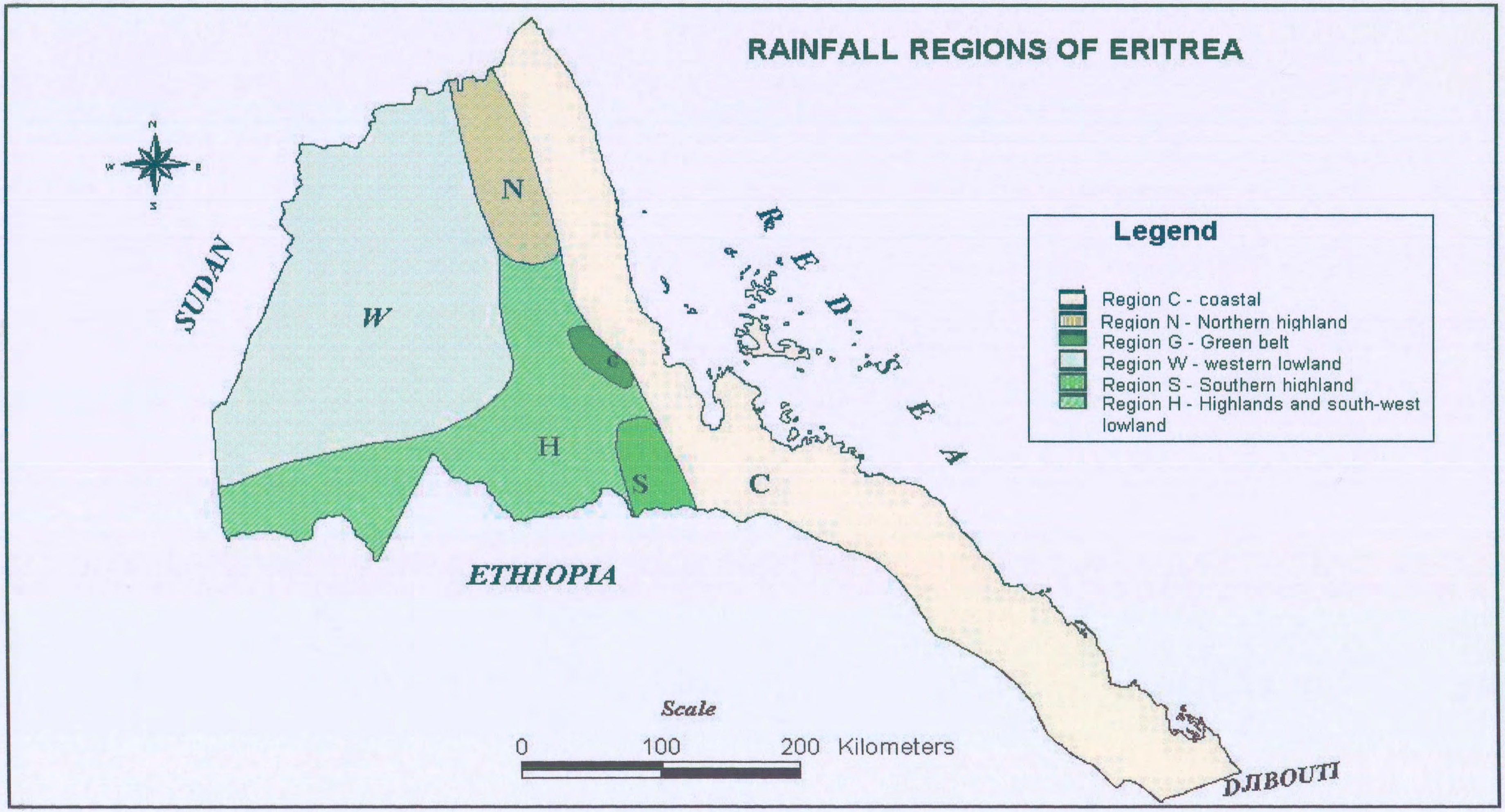
APPENDIX 1b. ADMINISTRATIVE MAP OF ERITREA (SOURCE: ERIWESP, 1996)



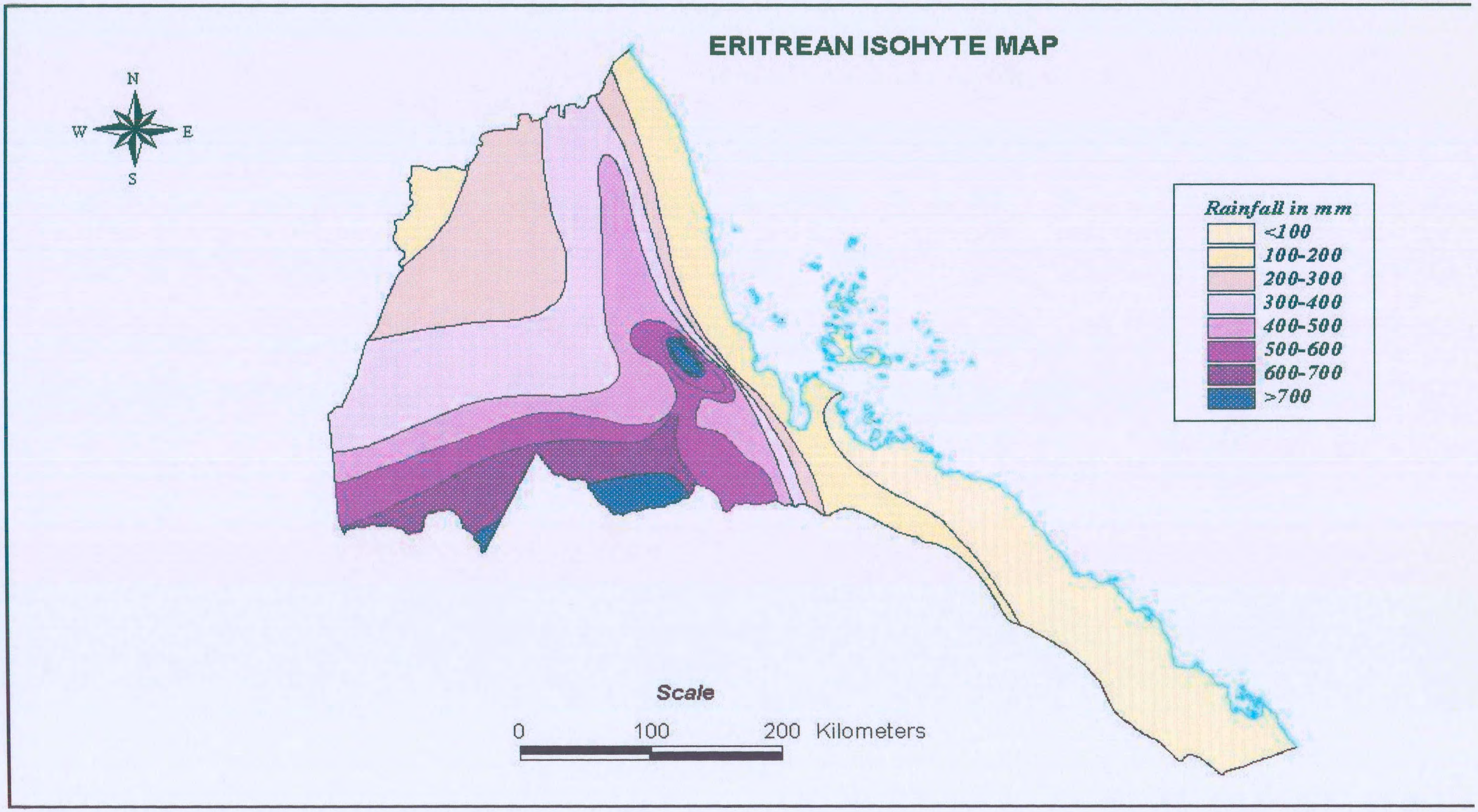
APPENDIX 1c. AGRO-ECOLOGICAL MAP OF ERITREA (SOURCE: DOL, MLWE, 1997)



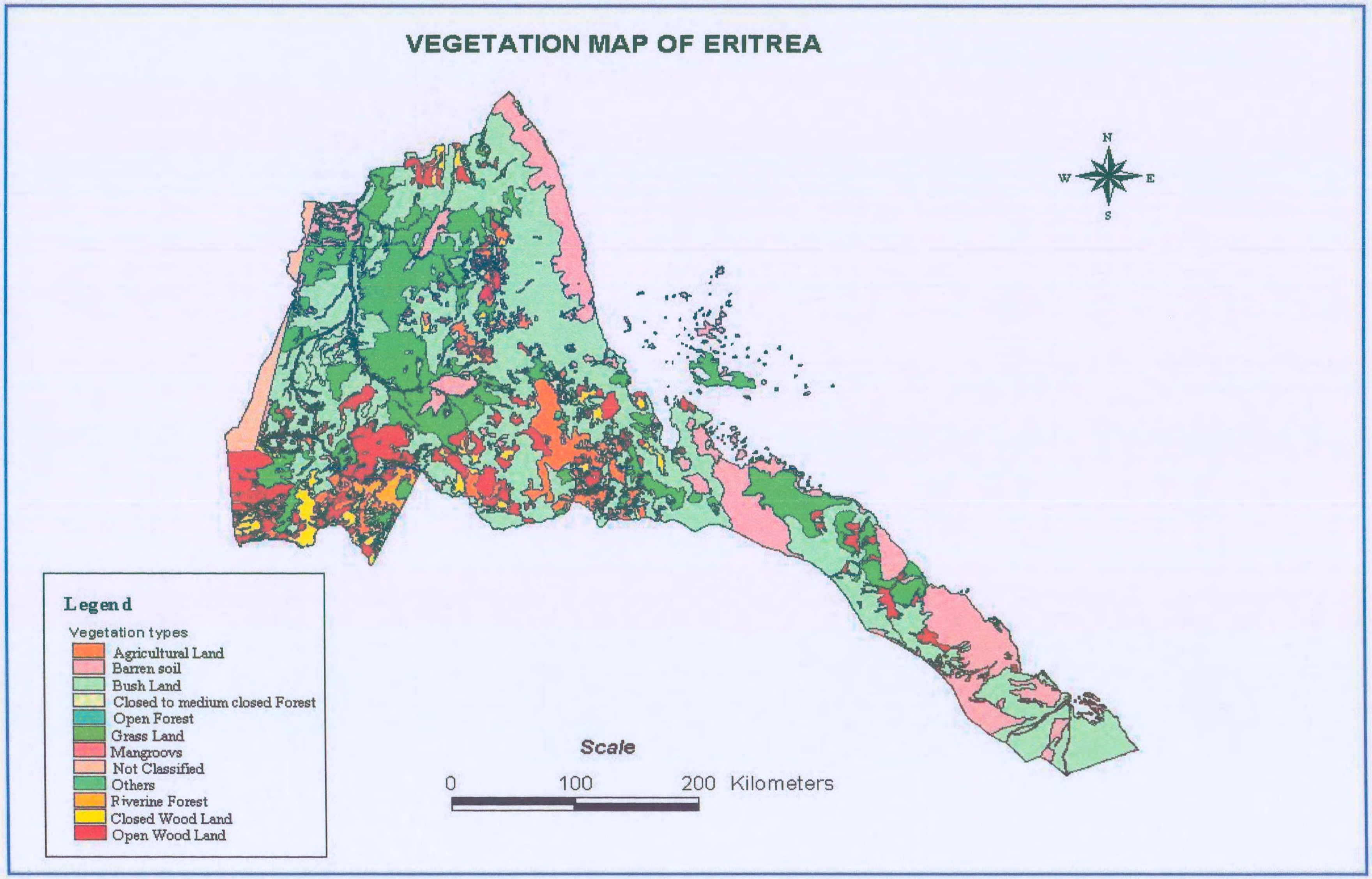
APPENDIX 1d. MAP OF RAINFALL REGIONS OF ERITREA (SOURCE: WRD, 1997)



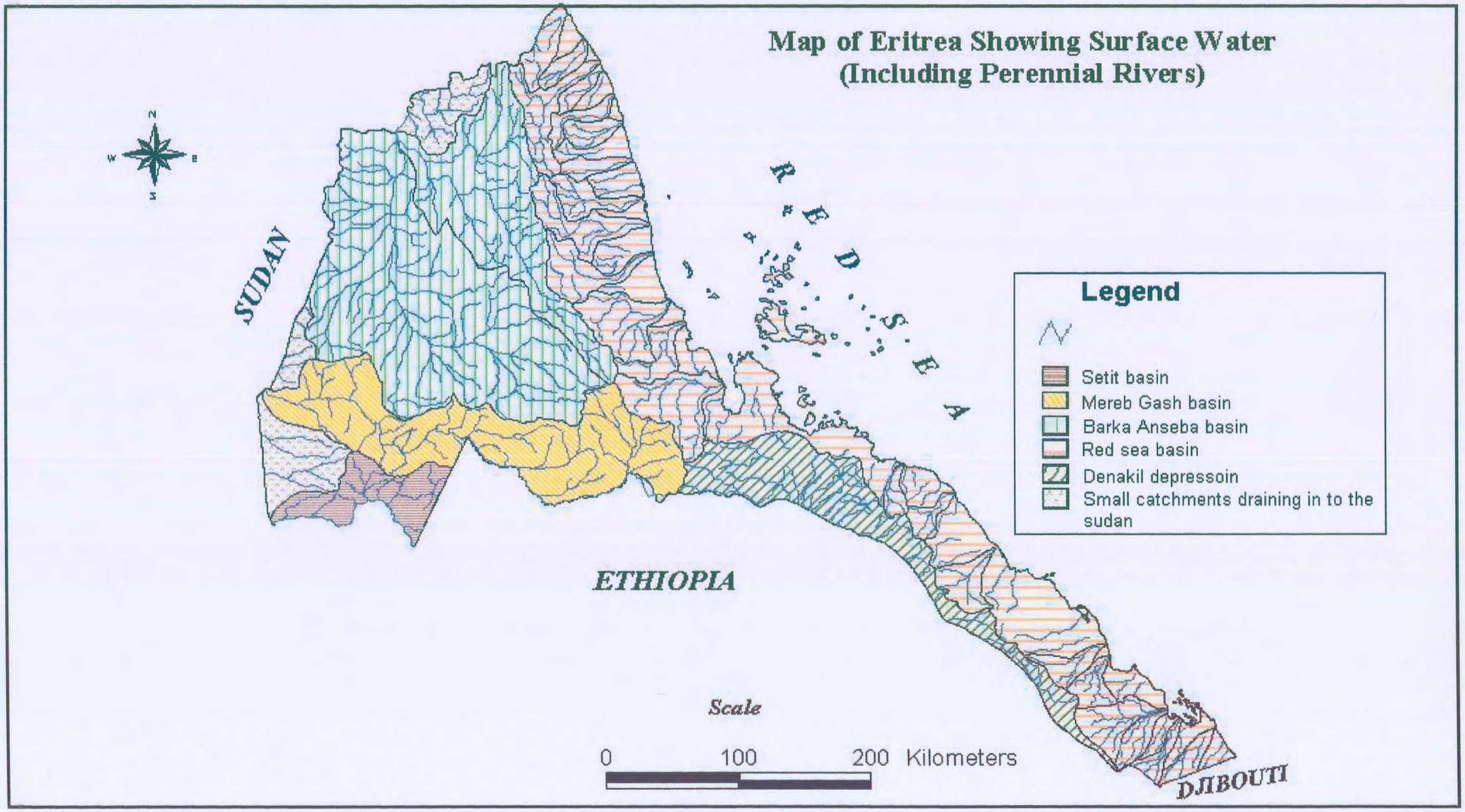
APPENDIX 1e. ISOHYTAL MAP OF ERITREA (SOURCE: WRD, 1997)



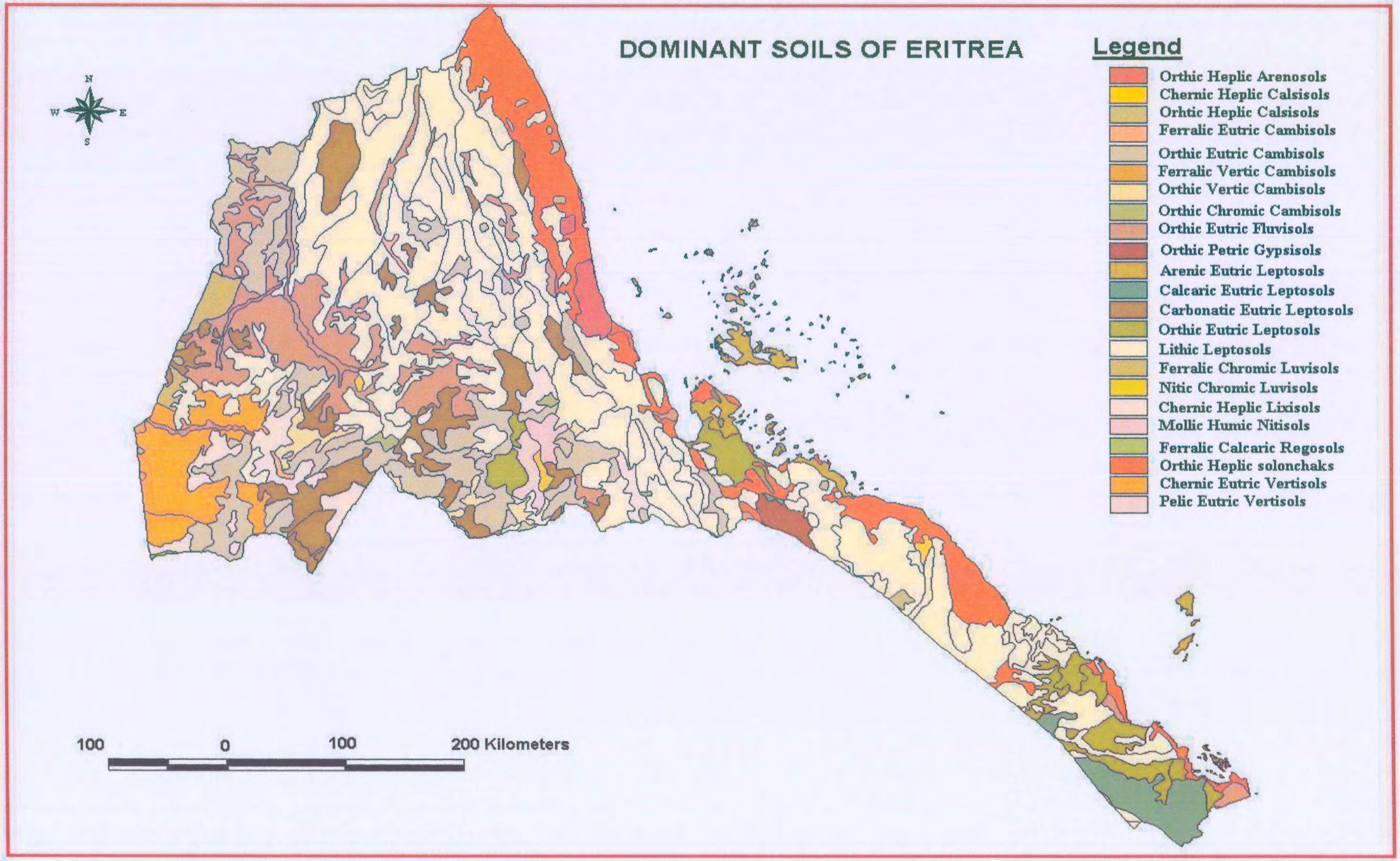
APPENDIX 1f. VEGETATION MAP OF ERITREA (SOURCE: FAO/MOA, 1997)



APPENDIX 1g. MAP OF ERITREAN SURFACE WATER RESOURCES (SOURCE: WRD, 1997)



APPENDIX 1h. MAP OF DOMINANT SOILS OF ERITREA (SOURCE: FAO, 1994)



APPENDIX 2. IMPORTANT DATA OF THE COMBINED MAP

ID IN MAP	NAME	LAND CLASS TYPE	LAND_USE	AREA (ha)	PERIMETER (m)	NATURAL VEGETATION	PROBLEMS	POSSIBLE SOLUTIONS
2	Mukuraza	Range land	Range land	150.9	7077	*Acacia tortilis, Acacia abyssinica, Acacia etbiaca, Cordia monaica, Boscia*	1= Overgrazing. 2= Lack of vegetation cover.	Closure and soil and water conservation.
3	Keih_Keren	Range land	Range land	13.9	1659	*Dodonaea angustifolia, Acacia etbiaca, Albiza amara, Boscia angustifolia*	1= Overgrazing. 2= Lack of vegetation cover.	Closure and soil and water conservation.
4	Gobo_Dabir	Range land	Range land	98.9	4724	Scattered *Dodonaea angustifolia*	1= Overgrazing. 2= Sheet erosion.	Closure and soil and water conservation.
5	Golagul	Range land	Range land	100.0	4534	*Acacia tortilis, Acacia etbiaca,*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Gully treatment. 2= closure for natural regeneration.
6	Abi_Kudo	Range land	Range land	62.6	3688	*Acacia tortilis, Acacia abyssinica, Acacia etbiaca, Cordia monaica, Ficus vesta*	Gully erosion.	Closure and soil and water conservation.
7	Enda_Abdu	Range land	Range land	64.5	3430	*Acacia tortilis, Acacia etbiaca,*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Gully treatment. 2= closure for natural regeneration.
8	Roro_Adamiti	Range land	Range land	29.0	2424	Scattered *Acacia tortilis, Acacia etbiaca*	1= High soil erodibility. 2= Rill erosion.	Closure and soil and water conservation.
9	Gobo_mahbai	Range land	Range land	21.9	2247	*Acacia tortilis, Acacia etbiaca,*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Gully treatment. 2= closure for natural regeneration.
10	Gual_Dabir	Range land	Range land	30.6	2774	*Neem plantation, Acacia tortilis, Acacia etbiaca*	1= Gully erosion. 2= the terracess are in bad condition.	1= Maintenance to the hillside terraces. 2= Replacement plantation.
11	Gereb_abiruba	Grat taff	Agricultural	7.6	1828	*Ficus sycomorus, Cordia africana*	1= Siltation from 'Mukuraza'. 2=The 'Abi ruba' river is eroding the land.	1= Construction of the diversion site. 2= River bank protection. 3= Conservation measures in 'Mukuraza'.
12	Adi_Tekleyes	Range land	Range land	29.2	2259	*Acacia tortilis, Acacia abyssinica, Acacia laeta, Cordia monaica.*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Soil and water conservation. 2= Revegetation.
13	Abi_hlum	Range land	Range land	89.4	4267	*Acacia tortilis, Acacia etbiaca, Albizia amara*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Gully treatment. 2= closure for natural regeneration.
14	Abi_Seraw	Range land	Range land	174.4	7252	*Acacia tortilis, Acacia etbiaca,*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Soil and water conservation. 2= Revegetation.
15	Mekualulo	Grat efun	Agricultural	31.5	3234	*Acacia tortilis, Acacia abysinica, Ficus vesta, Ficus sycomorus*	Gully from River 'Sigma hansa' is cutting the area in to two.	Construction of soil and water conservation measures.
16	Adamiti	Grat dagusha	Agricultural	14.1	2501	*Acacia abyssinica, Acacia etbiaca, Faedherbia albida*	1= River 'Tsaedambura' is cutting the land. 2= Sedimentation.	1= Soil and water conservation. 2= River bank protection.
17	Adi_Felasi	Range land	Range land	56.0	5278	*Acacia tortilis, Acacia abyssinica, Acacia laeta, Cordia monaica.*	Gully Erosion especially from river 'Tsaedambora'.	1= Soil and water conservation. 2= Revegetation.
18	Enda_afchelait	Grat taff	Agricultural	28.6	2489	*Acacia tortilis, Acacia etbiaca, Cordia africana, Faedherbia albida*	1= Rockiness 2= low soil fertility.	Soil and water conservation to increase moisture and fertility.

. . . continue

19	Adi Tekerakera	Range land	Range land	23.8	2842	*Acacia etbiaca*	1= Overgrazing. 2= Gully erosion.	Soil and water conservation.
20	Maakelay Keren	Range land	Range land	82.2	1950	*Acacia tortilis, Acacia abyssinica, Acacia laeta, Cordia monaica.*	1= Sheet erosion. 2= Gully is cutting down the slope.	1= Soil and water conservation. 2= Revegetation.
21	Tenabuk	Grat efun	Agricultural	19.5	3432	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Some gullies are starting to cut down the field from 'Gubo'.	Maintenance and stabilize the present soil bunds.
22	Member_ahsar	Range land	Range land	10.2	1260	*Acacia tortilis, Acacia etbiaca, Balanites aegyptica*	1= Sheet erosion. 2= Low vegetation cover.	Afforestation.
23	Awhitsemamo	Grat taff	Agricultural	7.1	1471	*Acacia tortilis, Acacia etbiaca, Faedherbia albida*	1= River 'Mai mirakat' is eroding its side to the farm.	1= Check dam construction and terracing. 2= Riverbank protection.
24	Girat_aatar	Grat efun	Agricultural	19.8	2454	*Acacia tortilis, Acacia abysinica, Cordia africana, Balanites aegyptica, Fae*	Sedimentation from ' Abi hlum' and 'Minbar yehsar'.	1= 75% of the area can be irrigated if water is diverted from 'Abiruba', which has base flow from July to December. 2= River bank protection.
25	Kerni_kirwah	Grat efun	Agricultural	4.2	1248	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Some gullies are starting to cut down the field from 'Gubo'.	Maintenance and stabilize the present soil bunds.
26	Girat_dufo	Grat taff	Agricultural	35.3	2786	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Rill and gully erosion.	Soil and water conservation measures.
27	Lalay_Hadas	Village	Residential	27.8	2688	-	-	-
28	Mkital temen	Grat taff	Agricultural	32.4	2750	*Acacia tortilis, Acacia etbiaca, Faedherbia albida*	1= River Mai 'mirakat' is eroding its side to the farm.	1= Check dam construction and terracing. 2= Riverbank protection.
29	Misra hkebero	Range land	Range land	10.0	1476	*Acacia tortilis, Acacia etbiaca, Boscia angustifolia*	Overgrazing and sheet erosion	1= Closure. 1= Soil and water conservation.
30	Gonabuko	Grat efun	Agricultural	11.3	1377	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Rill and gully erosion.	Soil and water conservation measures.
31	Ubel	Grat efun	Agricultural	3.9	817	*Ficus sycomorus, Cordia africana*	1=Sedimentation from ' Misrah kebero'. 2= The 'Abi ruba' river is cutting the fields.	1= River bank protection. 2= Ground water exploitation. 3= Conservation measures in 'Misrah kebero' to protect sedimentation.
32	Egri_betekristian	Grat taff	Agricultural	3.9	838	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Rill and gully erosion.	Soil and water conservation measures.
33	Maitsiyuk	Grat taff	Agricultural	22.5	2040	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Some gullies are starting to cut down the field from 'Gubo'.	1= Maintenance and stabilize the present soil bunds 2= Gully control.
34	Adi_beraad	Grat taff	Agricultural	19.2	2157	*Acacia albida, Cordia africana, Balanites aegyptica.*	The soil bunds constructed in 1995 are in bad shape.	The soil bund need some maintenance and realignment according to the diversion canal constructed.
35	Anagif	Grat taff	Agricultural	5.8	1075	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Some gullies are starting to cut down the field from 'Gobo'.	1= Maintenance and stabilize the present soil bunds 2= Gully control.
36	Gubo	Grat taff	Agricultural	52.2	4469	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	'Abi ruba' is eroding to the side of the farm.	1= River bank protection. 2= Ground water exploitation.

. . . continue

37	Gedena	Grat efun	Agricultural	18.3	2193	*Acacia tortilis, Acacia albida, Ficus vesta, Cordia africana*	Some gullies are starting to cut down the field from 'Gubo'	1= Maintenance and stabilize the present soil bunds 2= Gully control.
38	Tahitai_Hadas	Village	Residential	25.8	2842	-	-	-
39	Hitsatsat_2	Grat dagusha	Agricultural	27.3	2946	*Acacia tortilis, Acacia albida, Acacia etbiaca, Balanites eagyptica Cordia*	Siltation problem.	Soil and water conservation to increase moisture availability and protect siltation.
40	Hitsatsat_1	Grat dagusha	Agricultural	15.8	2651	*Acacia tortilis, Acacia albida, Acacia etbiaca, Balanites eagyptica Cordia*	Siltation from 'Meregagde'.	Soil and water conservation to increase moisture availability and protect siltation.
41	Meregagde	Range land	Range land	73.9	4812	*Acacia etbiaca*	Rocky area and very steepy, high soil erosion (sheet and rill).	1= Closure. 2= Soil and water conservation.
42	Tirakmti	Range land	Range land	17.6	1752	*Acacia tortilis, Acacia etbiaca, Calotropis Procera*	1= River ' Terakimti' is eroding the side of the area. 2= Siltation	1= Check dam construction and terracing. 2= Riverbank protection.
43	Gobo_Abihadas	Range land	Range land	12.2	1577	*Acacia etbiaca*	Rocky area and very steepy, high soil erosion (sheet and rill)	Closure for natural regeneration.
44	Adi_Ebbe	Range land	Range land	24.9	2162	*Acacia etbiaca*	1= Overgrazing. 2= lack of vegetation cover.	1= Closure. 2= Soil and water conservation.
45	Karsagla	Range land	Range land	24.1	2391	*Balanites aegyptica, Acacia tortilis*	Gully from river 'Emba abur' (from neighboring village).	1= Closure. 2= Soil and water conservation.
46	MaiHidum	Grat taff	Agricultural	9.3	1491	*Acacia tortilis, Acacia etbiaca*	Rivers 'Abiruba' and 'Kar sagla' are eroding from two sides.	River bank protection and terracing.
47	Ziban_twen	Grat gobo	Agricultural	130.1	7002			
48	Tsefih_Gobo	Range land	Range land	95.3	5821	*Acacia etbiaca, Eucalyptus spp, Nim trees, Acacia saligna, schinus mole*	Some terraces are in bad shape	1= Maintenance of the hillside terraces. 2= Replacement plantation.
49	Agulae	Village	Residential	7.0	1483	-	-	-
50	Etono	Grat efun	Agricultural	18.5	2237	*Acacia albida, Cordia africana, Balanites aegyptica.*	The soil bunds constructed in 1995 are in bad shape	The soil bund need some maintenance and realignment according to the diversion canal constructed.
51	Katsi	Grat efun	Agricultural	15.3	1672	*Acacia albida, Cordia africana, Balanites aegyptica.*	The soil bunds constructed in 1995 are in bad shape.	The soil bund need some maintenance and realignment according to the diversion canal constructed.

APPENDIX 3. FACT SHEET: 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.

APPENDIX 4. SUMMARY OF THE 1998 AGRO-ECOLOGICAL ZONES CLASSIFICATION

	Sub-Humid Escarp.	Moist Highland	Moist Lowland	Arid Highland	Arid Lowland	Semi-Desert
Area (ha)	103,000 (0.8%)	up to 897,920 (7.4%)	1,970,000 (16.2%)	up to 310,100 (2.5%)	4,179,550 (34.3%)	4,700,100 (38.8%)
Topography	Slopes, mountains and hills	Highland mountains and escarpment	Plains, small hills and plateaux	Mountain plateau	Undulating plains and small hills	Plains with small hills
Dominant Slope	8-100%	mostly 3 - 30% but (range 0 -100%)	2 - 30% (range 0-50%)	2 - 100%	0 - 30% (range 0 -50%)	0 - 50%
Altitude (m.)	600-2600	1600-2600	500-1600	1600-2600	400-1600	100-1350
Rainfall (mm.)	700-1100	500-700	500-800	200-500	200-500	200
Average tempe-rature (° c)	16-27	15-21	21-28	15-21	21.29	24-32
PET (mm.)	1600-2000	1600-1800	1800-2000	1600-1900	1800-2000	1900-2100
Vegetation	Extensively influenced byhuman activity, Juniperus/ Olea forest and bushes	Trees and shrubs (Juniperus; Olea; Cordia; Acacia senegal)	Bushland and Grassland with Acacia tortilis and Acacia senegal trees	Bushland with scattered trees	Bushes with scattered trees and Hyphaene palms along rivers	Bushes and grass with trees in wadis
Soils	Lithosols; Cambisols; Fluvisols	Cambisols; Luvisols; Lithosols; Regosols; Vertisols	Cambisols; Vertisols; Fluvisols; Luvisols; Lithosols; Regosols	Lithosols; Cambisols, Xerosols; Regosols; Bare rock	Xerosols; Cambisols; Fluvisols; Lithosols	Solonchalks; Xerosols; Fluvisols; Lithosols; Cambisols; Regosols; Andisols
Crops	Maize, sorghum, coffee, barley	Barley, wheat, taff, sorghum, maize, finger millet, pulses	Sorghum, barley, cotton, fingermillet, pearlmillet, maize	Sorghum, pearlmillet, barley	Sorghum, pearlmillet	Localised sorghum, maize under spate irrigation
Livestock	Cattle, goats, sheep	Sheep, cattle goats	Cattle, goats, sheep, camels	Cattle, goats, sheep, camels	Goats, cattle, camels, sheep	Goats, camels, cattle, sheep
Productivity	Moderate to high depending on slope and soil depth	Moderate - potential yields for barely 5-20 Q/ha dependable and 10-20 Q/ha median	Moderate to high for sorghum (25-30 Q/ha. dependable; 35 -40 Q/ha median); potential for irrigated crops; good for grazing and wildlife	Low: potential yield for barley 0-5 Q/ha.(dependable); 5 -10 Q/ha. (median)	Low: potential (5-15 Q/ha for sorghum (dependable); 10 - 25 Q/ha. (median) on good soil; local irrigation potential; good for browsing livestock and irrigated crops	Very low for crops except under irrigation; low potential for livestock browse
Sub-Zones	3	10	8	3	12	19

Source: Ministry of Land, Water and Environment, Eritrean Biodiversity stock taking assessment. 1998.