THE REPUBLIC OF
NAMIBIA

Ministry of Agriculture
Water and Rural
Development

Department of Water
Affairs (DWA)
Directorate of
Rural Water Supply (DRWS)

THE REPUBLIC OF
FINLAND

Ministry for Foreign
Affairs

Finnish International
Development Agency
FINNIDA

WATER SUPPLY AND SANITATION PROJECT IN OHANGWENA REGION, NAMIBIA

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

OCTOBER 1994

DRAFT REPORT NO. 1

FINNCONSULT OY

Project No. 28103701-8

WATER SUPPLY AND SANITATION PROJECT IN OHANGWENA REGION, NAMIBIA

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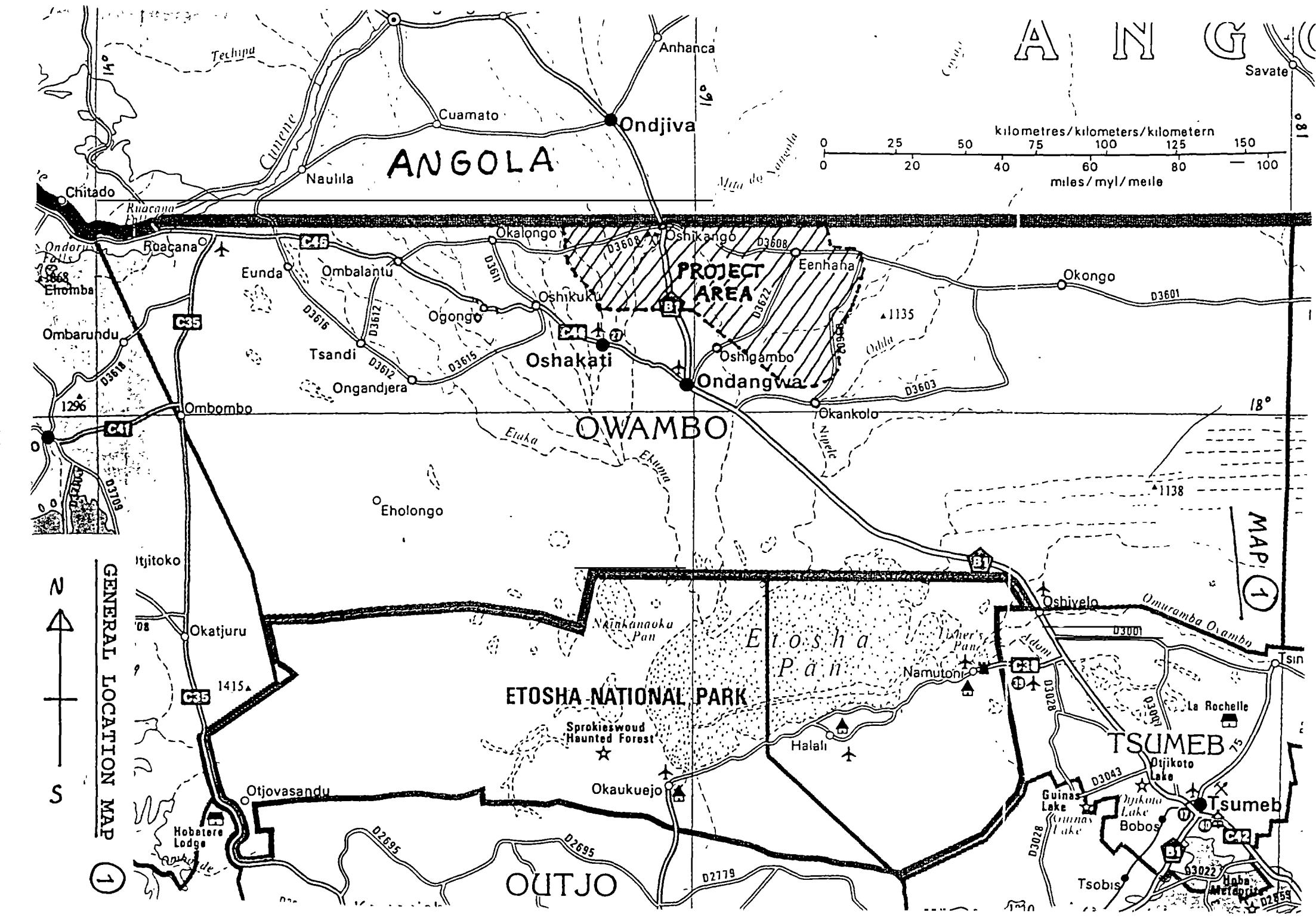
ANGOLA
Anhanca
Savate
Techipa
Cuamato
Ondjiva
Cunene
Naulila
Chitado
Ruacana
Ruacana Falls
Ondorusu Falls
Eholmba
1868
Okalongo
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D3608
D3608
Eenhana
PROJECT AREA
Okongo
D3601
Eunda
Ombalantu
C46
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D3622
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C35
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D3618
D3616
D3612
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Ombombo
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18°
C41
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1138
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Okatjuru
1415
C35
Nainkanaoka Pan
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Fisher's Pan
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C41
B1
D3028
D3028
La Rochelle
TSUMEB
Tsin
ETOSHA NATIONAL PARK
Sprokieswoud Haunted Forest
Halali
Otjikoto Lake
D3043
Guinas Lake
Otjikoto Lake
Bobos
Tsumeb
C42
Otjovasandu
Okaukuejo
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D2695
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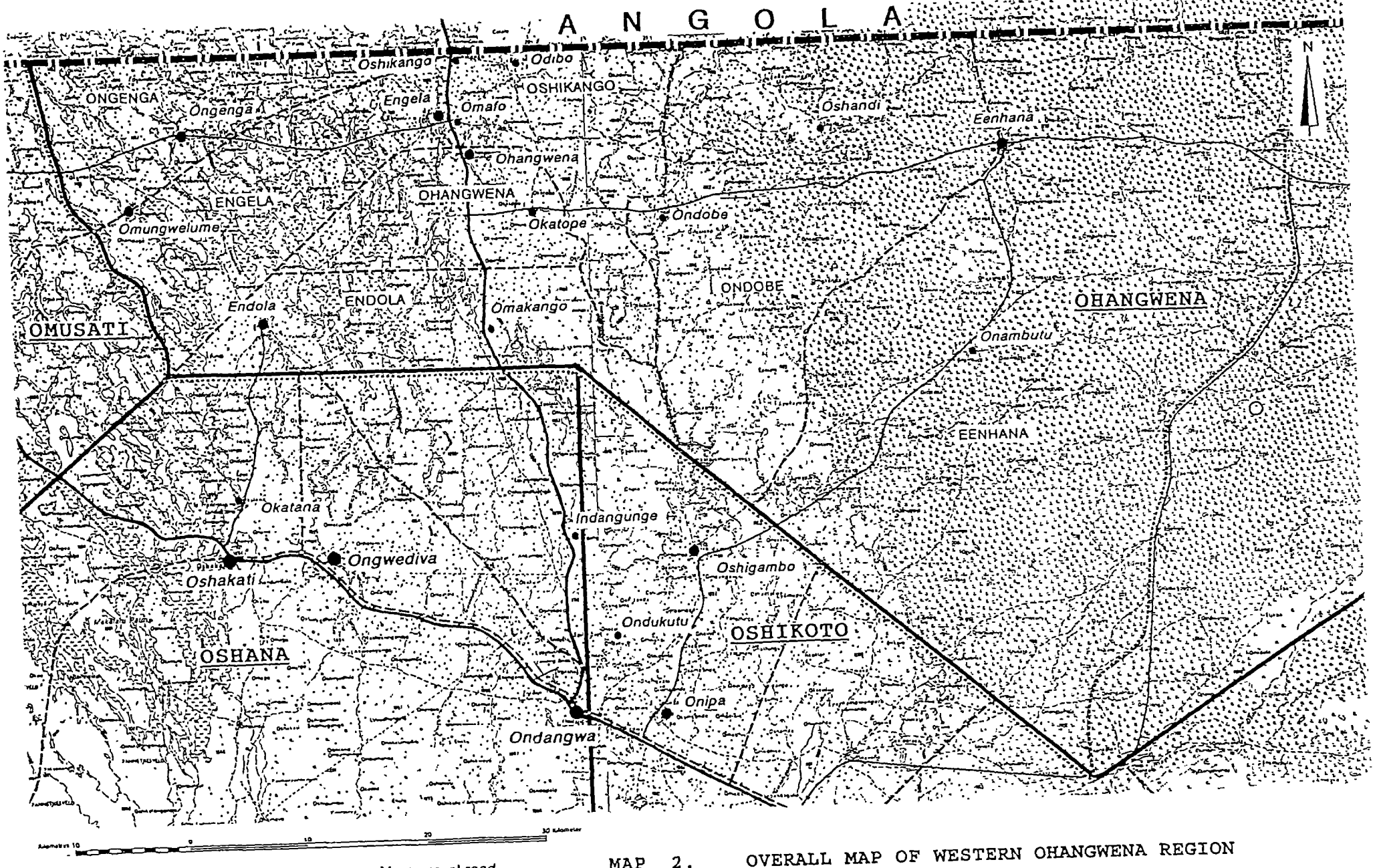
GENERAL LOCATION MAP 1



MAP 2. OVERALL MAP OF WESTERN OHANGWENA REGION AND WSSPOR PROJECT AREA

EXECUTIVE SUMMARY

This Environmental Impact Assessment Study (EIA Study) has been prepared by Mr Kari Silfverberg, Environmental Planner, as a component of the ongoing Water Supply and Sanitation Project in Ohangwena Region (WSSPOR). The project is a part of the bilateral development cooperation programme between Finland and Namibia, implemented by the Department of Water Affairs (DWA) of the Ministry of Agriculture, Water and Rural Development (MAWRD), with development assistance services provided by Finnconsult Oy. Scheduled project duration is from March 1992 until the end of 1996.

The main purpose for the study has been to investigate environmental conditions in Ohangwena Region and north-central Owambo, particularly issues related to water supply and sanitation development and the activities of the project, and on the basis of these investigations prepare recommendations concerning prevention and mitigation of adverse environmental impacts as well as possibilities of environmental enhancement through project activities. The findings and recommendations of the EIA Study will be taken into consideration during preparation of a Water Supply Development Plan for Ohangwena Region, scheduled to be finalized during 1995.

Since the project is mainly concentrating on institutional development, training and community mobilization, there are very limited adverse impacts on the biophysical environment in the project area, arising from physical upgrading and construction activities undertaken by the project. The most important environmental consequences of the WSSPOR project are related to the Water Supply Development Plan, which is being prepared by DWA with assistance from the project.

A summary of recommendations, altogether 12 main recommendations, is presented in Chapter 11. The most important finding of the study is that water supply development is a major factor determining settlement patterns and densities of human and livestock populations within the region. Due to semi-arid climate and rather poor sandy soils, the region is vulnerable to environmental degradation caused by overutilization of natural resources by people and livestock. The process of land degradation and deforestation

have already reached alarming dimensions in Ohangwena Region and many other densely populated parts of Owambo.

Therefore it is of utmost importance that the numerous sectoral development activities being implemented within the region, particularly improvements of water supply, should be sufficiently coordinated with a strong emphasis on the carrying capacity of land, natural vegetation and water resources. This need for coordination and consideration of environmental sustainability calls for the preparation of an overall regional land-use plan to guide future developments of water supply infrastructure as well as other development efforts within the region. Although legal and institutional frameworks for land-use planning and control are not yet sufficiently established at the central government level, there are no major institutional constraints for the starting of the process to prepare an interim overall land-use plan for Ohangwena region. The sooner this process can be started the better.

1 INTRODUCTION

The Water Supply and Sanitation Project in Ohangwena Region (WSSPOR) is a part of the bilateral development cooperation programme between Finland and Namibia. The project is implemented by the Department of Water Affairs (DWA) within the Ministry of Agriculture, Water and Rural Development (MAWRD), and scheduled duration is from March 1992 until the end of 1996. Consultancy services for project implementation are provided by Finnconsult Oy

The project area, comprising totally about 3 880 km2 with a population of about 125 000, consists of the western and central parts of Ohangwena administrative region in the densely populated northern parts of the country (former Owambo Region). The project area extends in the north to the border between Namibia and Angola, and it is transected by the main northern trunk road from Ondangwa to Oshikango and Angola.

Climatically Ohangwena region is semi-arid, and its natural environment has generally a rather low population carrying capacity. The majority of the rural population is practicing traditional subsistenace agriculture with livestoock husbandry as an important component. A major constraint to human life in the region is lack of perennal surface water resources and high salinity of many groundwater aquifers. Environmental degradation caused by unsustainable use of natural resources, mainly arable land, grazing land and natural vegetation, has continued already for some decades, and it has reached alarming proportions in the densely populated western and central parts of the region. Unless this process of land degradation can be reserved in the near future, there is a danger that the natural resource base of the rural population will be badly depleted already within 20 years time. The role of water supply development in influensing the pattern and density of human settlement as well as size and distribution of livestock herds is very important. Thus the preparation of a regional water supply development plan, which is an important component of WSSPOR project activities in 1994-95, will have a significant effect on future environmental and socio-economic conditions in the region.

This EIA Study is a component of the preparation of the water supply development plan. The study provides environmental base data to be used in plan formulation as well as recommendations for environmental enhancement and prevention/mitigation of adverse environmental impacts. The study has been carried out in 3 periods during April-October 1994 by Mr Kari Silfverberg, Environmental Planner, with the assistance of WSSPOR staff. Since this EIA Study has been carried out as a project component during project implementation, it does not fulfil the requirements of a standard EIA study and process, which normally is an integral part of project planning and preparation. This study has mainly a role as a component of the preparation of the Water Supply and Sanitation Plan for Ohangwena Region

This study report (Draft 1) will be distributied for comments to FINNIDA, pertinent Namibian institutions and concerned professionals dealing with issues discussed in the report. A final EIA Study Report will be compiled in November 1994 when comments have been received.

2 OBJECTIVES OF THE STUDY

According to the Terms of Reference the main objective of the study is to make it possible to incorporate environmental issues into the Water Supply and Sanitation Development Plan and Annual Work Plans of the project. Thus the study has concentrated mainly on the following issues:

* Investigation of existing environmental and socio-economic conditions in Ohangwena Region with main emphasis on environmental issues related to water supply

* Comparison of environmental consequences and opportunities of alternative water supply options

* The need for land-use planning to guide the development of water supply infrastructure

These issues have been studied in depth, and on the basis of the findings 12 main recommendations have been formulated concerning incorporation of environmental issues into the WS development plan and operational plans of the project. These recommendations are presented in Chapter 11.

3 MATERIALS AND METHODOLOGY

The Study has been carried out on the basis of previously collected baseline data, which has been complemented with field observations and discussions with representatives of relevant institutions and projects both in Windhoek and Ohangwena region.

Field observations and discussions were carried out during 4-5 weeks time in 3 periods in April-May and October 1994. Altogether 3 workshops (2 in Ongwediva and one in Windhoek) were arranged during the study period in order to receive a wide range of views and opinions concerning important issues and findings of the sutyd. A final workshop was arranged in October in Windhoek to discuss findings and recommendations with high-level decision-makers of relevant government institutions.

Collected data and findings have also been compared with data about related issues and conditions in other African countries, e.g. Botswana, Zimbabwe, Tanzania, Kenya and Sudan. A considerable part of collected data has been obtained from baseline studies and reports prepared by the WSSPOR project during its preparation and implementation stage since early 1992, as well as from studies carried out by other projects and institutions in Ohangwena and neighbouring regions.

These institutions and projects include the following:

- DWA and other departments of the Ministry of Agriculture, Water and Rural Development
- Ministry of Environment and Tourism, including the Directorate of Forestry
- Ministry of Lands, Resettlement and Rehabilitation
- Ministry of Local Government and Housing
- Ministry of Health and Social Services and the Health Care Development Project in Engela Area
- Diocesan Water Project
- The Rural Development Centre in Ongwediva (RDC)
- The UNICEF-funded water supply and sanitation project in Owambo
- The SARDEP project for sustainable agriculture and rangeland management funded by GTZ
- The Franco-Namibian Rural Development Project in Owambo
- The Integrated Area Based Programme (IABP) in Ukwalundhi
- Ogongo Agricultural College
- Oshakati Human Settlement Improvement Project (OHSIP)

4 DESCRIPTION OF ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

This section gives a summarized description of present conditions in Ohangwena region. Further details can be found in specific technical and survey reports listed in Annex 5.

4.1 Location and General Area Description

Ohangwena region is located in northern Namibia, stretching along the Angolan border for about 220 km in a 25-60 km wide strip in west-east direction, lying approximately between 15° 30' and 18° east and 17° 20' and 17° 50' south. It forms the north-central part of the former Owambo Region. Bordering regions are Omusati and Oshana in the west, Oshikoto in the south and Okavango in the east. (See maps 1,2 and 3).

The total area of the region is 10 582 km2 and regional population about 180 000. Thus the average population density is about 17 people/km2.

The WSSPOR project area, totally about 3 880 km2, comprises the western part of Ohangwena region, covering following constituencies: Ongenga, Endola, Ohangwena, Engela, Oshikango, Ondobe and Eenhana. Total population in the project area is about 125 000. Population densities are highest in the western parts, ranging from about 25 to 100 people/km2, and lowest in the eastern parts, on average less than 5 people/km2. (See maps 4 and 5).

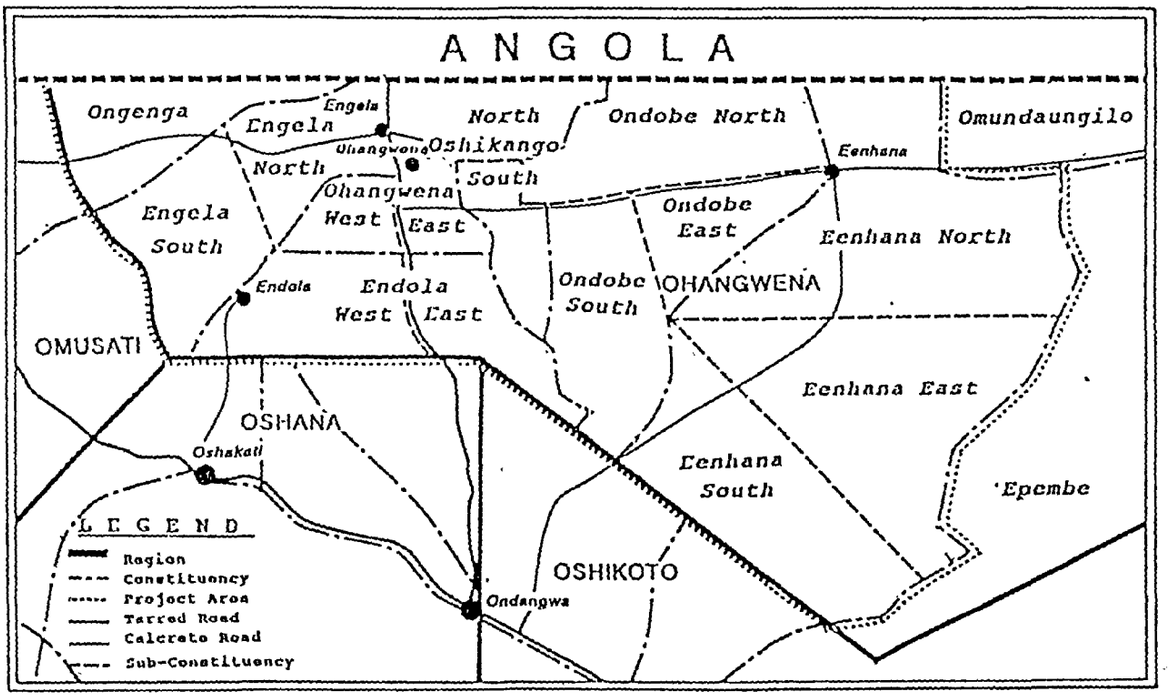
Main towns and growth points in the project area are Ongha, Engela, Ohangwena, Oshikango, Omungwelume and Eenhana. These population centers are located along the two main roads in the area: the connection from Ondangwa to Oshikango and Angola in the north and the connection from Ondangwa via Oshigambo to Eenhana in the northeast.

The main northern trunk road from Tsumeb to Ruacana on the Angolan border passes south of Ohangwena Region, and the road from Ondangwa to Oshikango and Angola transsects the western part of the region. The most important growth area in the north, the Oshakati-Ongwediva-Ondangwa axis lies close to the region on its southwestern side.

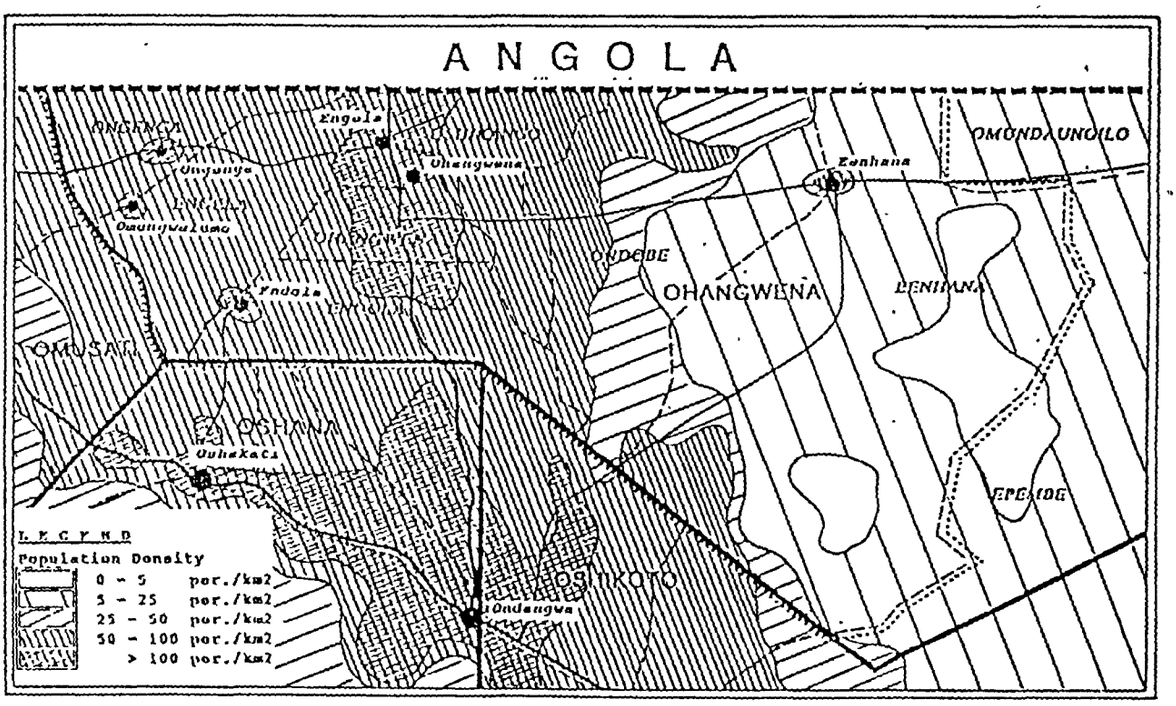
The topography of Ohangwena Region is characterized by an extremely flat plain between 1090 and 1150 m above mean sea level. The gradient of the plain is approx. 1:2500 decreasing from north to south.

There are no perennial natural surface water resources in Ohangwena, but the western parts of the region belong to the drainage system of the Cuvelai delta, consisting of shallow ephemeral drainage basins called oshanas. These oshanas cover about 35 % of the region. Significant water flow occurs only during years of high rainfall i northern Namibia and southern Angola.

MAP 3. Administrative boundaries



MAP 4. Simplified population density



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The nearest perennial rivers are Kunene river in the northwest, flowing from Angola along the border to the Atlantic ocean, and Okavango river in the northeast, flowing from Angola through Caprivi to Botswana. These two rivers are important sources of water for the whole of northern and central Namibia.

Vegetation cover in the region corresponds with population densities. Sparsely populated areas in the east have still some dense forests and woodlands, while the densely populated western parts are largely devoid of natural vegetation cover.

4.2 Climatic Conditions

Meteorological information gathered at the third order meteorological station at Ondangwa is considered representative for most of Ohangwena Region. The climate of the region is classified as tropical semi-arid with a dry season of 5-6 months. According to the modified Köppen system Ohangwena can be classified as a warm steppe region. Similarities between climatic conditions in northern Namibia and the Sahel region in northern Africa are obvious.

Climate = B S h g w

where B = Dry region with rainfall deficiency
S = Tropical semi-arid
h = Annual mean temperature above 18°
g = Month with maximum temperature in early summer
w = Rainfall during summer

Mean annual rainfall in the region varies between 450 and 550 mm, increasing from west to east. The rains occur usually between October and May, concentrating mainly on the period January-March. Rainfall is highly variable from year to year and place to place. Recorded variations during the 50-year period 1940-1990 in central Owambo range from less than 200 mm to about 980 mm during a calendar year. A general trend of decreasing rainfall has been observed since early 1980s.

Most of the rain falling in the region has its origin from moisture transported by trade winds from the Indian Ocean. During their movement across southern Africa these winds lose much of their humidity. Rainfall occurs often during convective thunderstorms and can be very heavy during short periods.

Mean monthly temperatures at Ondangwa range from 17,5° C in July to 26° C in December. Average daily maximum temperatures during the hottest period in October-December can reach 35° C. Average daily minimum temperatures in the winter months of June and July can reach down to 6° C. Frost has very seldom been experienced. Absolute maximum and minimum temperatures recorded at Ondangwa are 40,2 C (November 1972) and -3 C (June 1964).

Wind conditions in Ohangwena region are rather calm for most of the year. Strong winds occur usually only before and during thunderstroms in the rainy season. Easterly and northeasterly winds are common during most of the year.

TABLE 1 Longterm Monthly Mean Values Of Temperature, Relative Humidity And Rainfall At Ondangwa

MONTH	MEAN MONTHLY TEMPERATURES C			RELATIVE HUMIDITY	MEAN MONTHLY RAINFALL
	MAX.	MIN.	MEAN	AT 14 H	MM
July	26 4	8.3	17.5	23 %	0
August	27 7	10.3	20.0	19 %	1
September	33 3	13.8	23.5	17 %	3
October	34 4	17.4	25.9	21 %	12
November	33 1	18.7	25 9	32 %	43
December	33.1	19.0	26 1	34 %	76
January	31.5	19.3	25.4	44 %	105
February	30.6	19.1	24.8	48 %	112
March	30.1	18.8	24.5	50 %	91
April	30.2	16.3	23.3	39 %	36
May	28 9	12 0	20.4	26 %	7
June	26 6	8 9	17.7	24 %	1

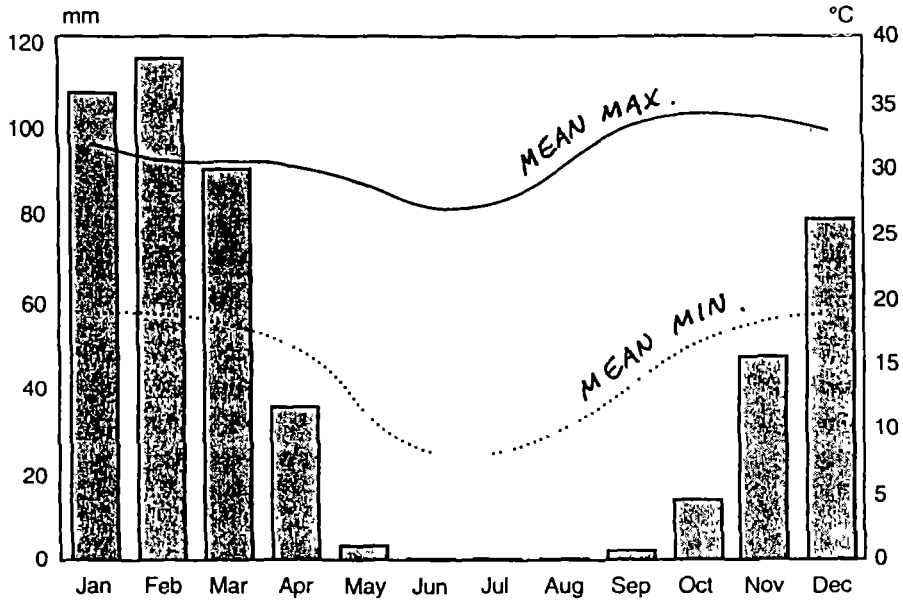
Mean annual rainfall is 487 mm.

Evaporation is very high due to strong solar radiation, low humidity and rather high temperatures. Mean annual evaporation measured from an open water surface at Ondangwa is as much as 2 485 mm, about 5 times as much as mean annual rainfall. Some recent studies indicate that up to 83 % of all precipitation evaporates soon after it has fallen. Since about 14 % of total precipitation is returned to the athmosphere by plants through evapotranspiration and some water moves to ponds, pans and oshanas, only about 1-2 % of rainfall recharges groundwater resources (Figure 2). Local variations may however be significant, depending on topography, vegetation and soil sonditions.

Athmospheric humidity in Ohangwena is low most of the year. Mean monthly values of relative humidity range from about 17 % in September to about 50 % in March.

Fig. 1.
Average monthly rainfall, and maximum and minimum temperatures in Ondangwa

Rainfall 1902–1975, temperatures 1944–1975



FROM: ERKKILÄ & SIISKONEN, 1992

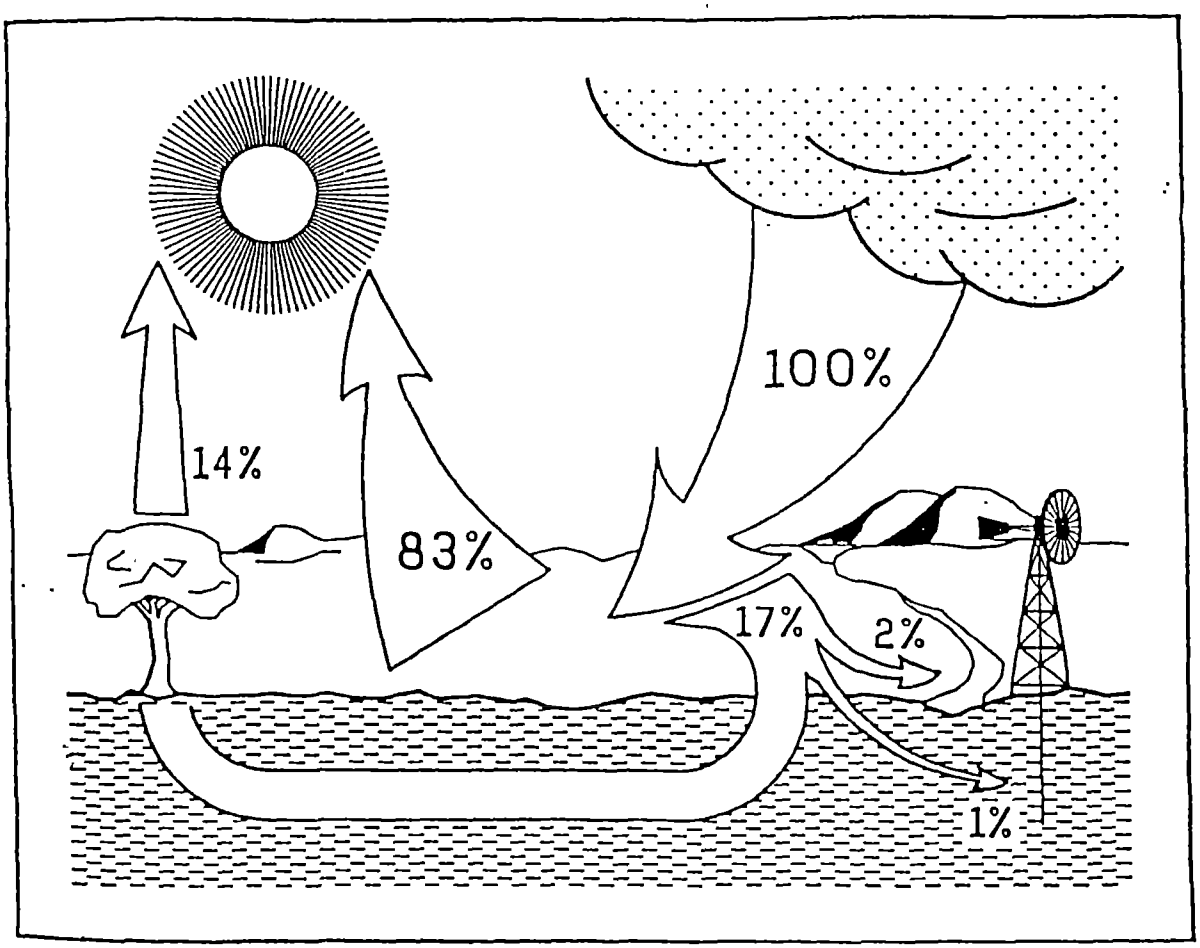


FIGURE 2. DIAGRAM OF WATER BALANCE (DWA)

TABLE 3. OWAMBO - GENERAL GEOLOGY AND STRATIGRAPHY (AFTER MILLER AND SCHALK, 1980; MILLER, 1990)

AGE	GROUP/SEQUENCE	FORMATION	DESCRIPTION	SURFACE DISTRIBUTION	COMMENTS
Recent	KALAHARI	Andoni	Ochre sand silt. May contain pyrites	Seen occasionally in road borrow pits and river banks	Present throughout area at shallow depth
		Olukonda	Medium grained sand, red clay gravel bands	Borehole intersection only	Seen in several boreholes
Cretaceous late 64 Ma		Beiseb	Upper sand grading into limestone. Basal sandstone conglomerate	Borehole intersection only	Seen in several boreholes
Cretaceous 110 Ma	KAROO	Etendeka	Basalts, minor sand-stone	Borehole intersection only	Identified in several drilling programmes
		Etjo	Aeolian sandstones	Borehole intersection only	Identified in Coal Commission borehole
Carboniferous 500 Ma		Dwyka	Tillite, boulder shale, limestone, etc.	Borehole intersection only	Identified in Coal Commission borehole
500 Ma	DAMARA	Mulden	Phyllite, quartzite, conglomerate	Borehole intersection only	Identified in Coal Commission borehole
		Otavi	Dolomite, conglomerate, shale,limestone	Not observed in project area	Present on basin W and S margin
900 Ma		Nosib	Quartzite, conglomerate, schist,marbles	Not observed in project area	Present on basin W and S margin
>2000 Ma	PRE-DAMARA	Epupa Complex	Paragneisses, orthogneisses	Not observed in project area	Only found in Kaokoland

The Non-solonetz Soils occur in the western area bordering the Kunene Region and are associated with calcrete. The soil is typically a brown sandy loam, non-saline, non-sodic and inherently fertile.

Black Clays occur in scattered locations all over Owambo and are associated with the floors of oshanas and pans. The clays are highly expansive and usually non-saline and non-sodic, but salinity may increase with depth.

Two-thirds of the Project Area is covered with aeolian sands. Solonetz soils occur in the remaining third as broad north-south striking strip in the central part of the area. Distribution of soil groups is shown on Map 6.

Agriculturally the soils in Ohangwena region are generally rather poor. The high sand content of the soils result in a low water retaining capacity and a low organic matter content. Other deficiencies include a low content of nitrogen, calcium, potassium and phosphorus. Micro-nutrients such as manganese, iron, and zinc are also in inadequate supply, and it has been suggested that the lack of molybdenum in the region's soils could result in a soil toxicity situation with excessive use of nitrate fertilizers

Low-lying ground in oshanas is generally too saline for crop production. The low relief of the region, coupled with a clay content in the oshanas, tends to slow down water movement and increase its residence time. When the drainage of arid region soils is impeded and the surface evaporation excessive, soluble salts accumulate on the surface horizon. These soluble salts, if in a high enough concentration, interfere with the growth of most plants by encouraging the plant to give off water from its own structure to the soil.

4.4 Surface Water Resources and Drainage System

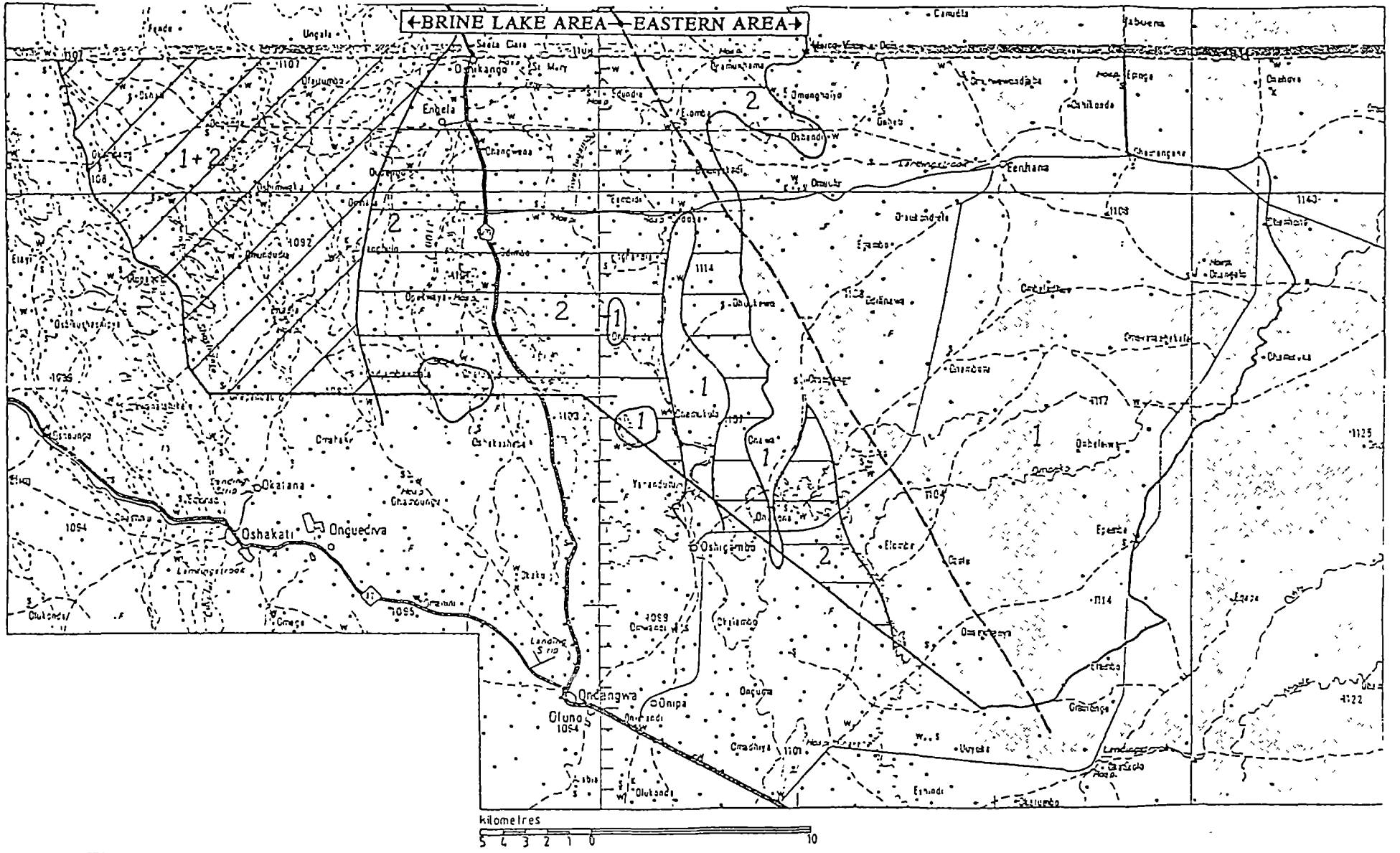
Within Ohangwena Region there are no permanent rivers or lakes. The water resources available for the inhabitants and their livestock are the following:

a) **Rainfall** during the rainy season. Rainwater can be collected from roofs and surface catchment areas into reservoirs and ponds.

b) **Surface water** which flows during the rainy season in ephemeral rivers and oshanas and collects in natural pans. This water can be channelled and stored in ponds and reservoirs.

c) **Groundwater** in different types of aquifers. Many of the aquifers in Ohangwena region contain however saline water, which is unsuitable for human consumption without removal of salts.

d) **River water** transported from Kunene river in Angola by means of canals and pipelines to major settlements in Omusati, Ohangwena, Oshana and Oshikoto regions.



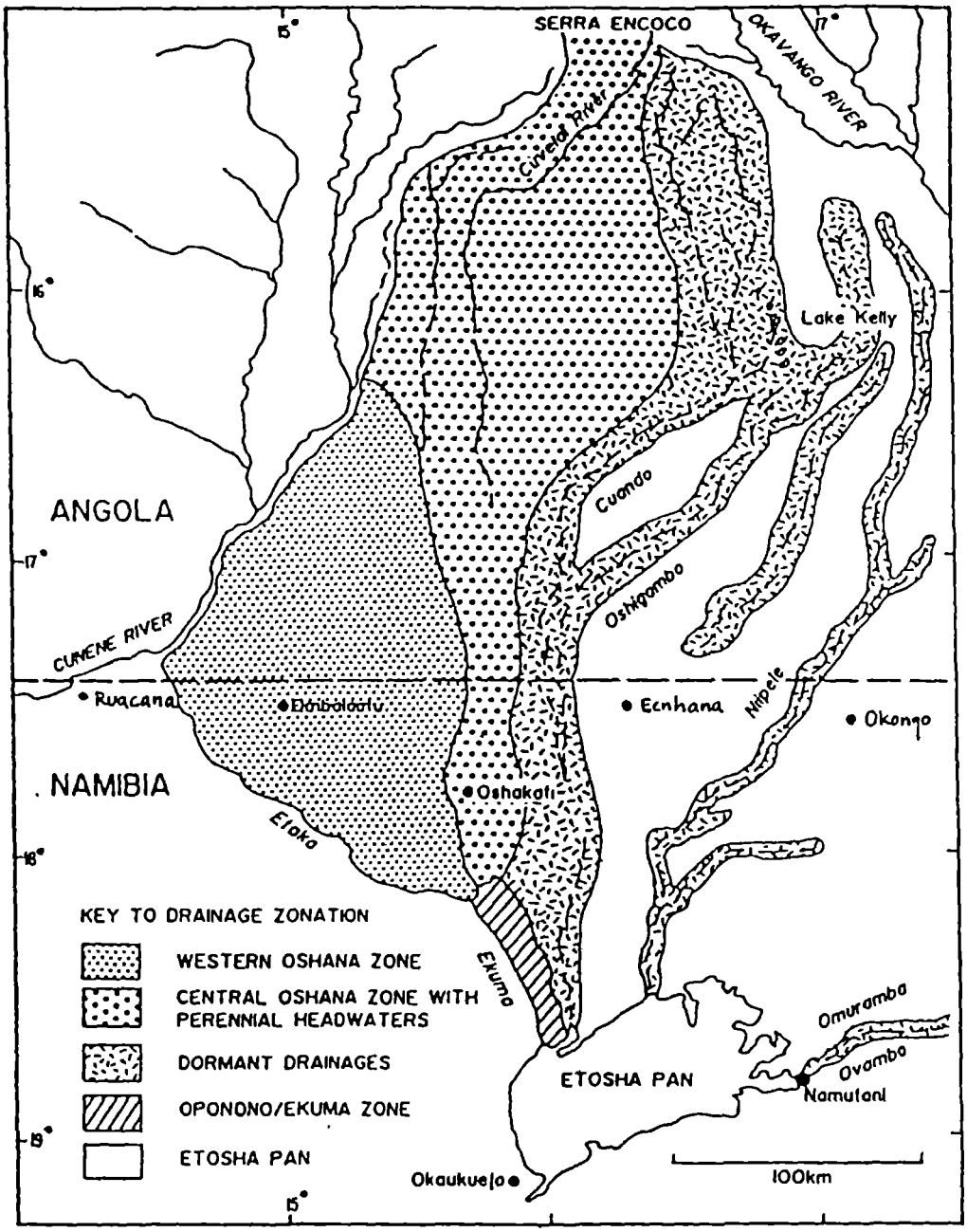
Legend:

- 1 Aeolian sands
- 2 Solonetz soils
- 1+2 Mixed aeolian sands and solonetz soils

Major groundwater areas in Damara Sequence

Kalahari Sequence Aquifers not plotted

MAP 6. MAJOR GROUNDWATER AREAS AND SIMPLIFIED SOIL DISTRIBUTION



Division of the major drainage systems in Owambo into different zones. Eastern dormant drainages flow infrequently and only under exceptional circumstances. The western and central oshanas flow more frequently, but only the central oshanas have perennial headwaters in Angola. With sufficient rain, which falls only occasionally, water flows into the Etosha Pan from the entire system.

MAP 7. THE CUVELAI DRAINAGE SYSTEM IN SOUTHERN ANGOLA AND OWAMBO

From: Marsh & Seely (editors), 1992.

The western part of Ohangwena region belongs to the **Cuvelai floodplain** or inland delta, a drainage system of seasonal rivers and oshanas, which originates from the Sierra Encoco highlands in Southern Angola, where mean annual rainfall exceeds 1 000 mm. The Cuvelai drainage system is a part of Etosha basin and it ends up in the huge Etosha saltpan some 80 km south of Ondangwa. At Etosha mean annual rainfall is about 430 mm.

The Cuvelai delta is about 70 km wide at the Angolan border, and then gradually converges towards the Etosha pan. The total catchment of the Cuvelai system covers approximately 40 000 km2. (See map 7).

Oshanas are shallow, vegetated, interconnected channels and pans, lying in a valley of very low gradient, in which water accumulates, moves and/or stands depending on the amount of water present in any one season. There is no well-defined flood channel and the velocity of water rarely exceed 0.5 m/s. The banks of oshanas are lined with trees and bushes.

The term **efundja** refers to floods in the oshana system that occur when good rains have fallen over the whole catchment area of the Cuvelai. From usage among the local population it appears to refer only to large floods originating in Angola, and not to localised rains and small-scale floods.

Water flow in the oshanas and seasonal rivers differs from year to year and place to place. When southern Angola receives abundant rainfall the central oshanas may flow strongly for several months, possible even as far as **Etosha pan**. It has been estimated that a once-in-fifty-years flood in the central oshana zone with perennial headwaters would have a magnitude of up to 1 490 m3 per second. The seasonal flood (efundja) does however not every year spill over from Angola to Namibia.

Strong local rainfall over the western or central oshanas may also cause water flow within the oshana system, sometimes even moving in a northerly direction. Local rainfall appears to be responsible for any water flow and ponding in the dormant eastern drainages. These old channels are now filled with sand, are vegetated and have only occasionally flowed this century. It is expected that under present climatic conditions they would probably only flow during an exceptionally high rainfall event Oshana water flow and direct rainfall both contribute to shallow groundwater recharge.

During 38 years of monitoring there have been 4 years with large floods, 20 years with variable floods and 14 years with no flood at all. During March-April 1994 the flood in the central oshana system was rather strong.

4.3 Geology and Soils

The whole project area is situated in **the Kalahari group geological formation**, which is floored by mid-Proterozoic crustal rocks of the Congo craton. The formation contains possibly as much as 8 600 m of sedimentary rocks of the Proterozoic Damara sequence, some 360 m of Karoo rocks and about 130 m of cretaceous rocks overlain by a blanket of unconsolidated Kalahari sequence sediments up to 600 m thick. The successive layers of sands, sandy clay, sandstones and conglomerates of the Kalahari group are up to 500 thick and of Tertiary to Quaternary age (30-40 million years). Kalahari sandstones can be seen everywhere in the bottoms of wells, borrow pits and water reservoirs.

The Andoni formation in the upper portion of the Kalahari sequence is the most widespread Kalahari formation comprising of interbedded white medium-grained semi-consolidated sand, light green clayey sand and green clay. The sand occurs in bands 10-200 m thick, and can be slightly pyritic or haematitic. Calcrete and dolcrete occur in nodular form, locally as mature consolidated sheets. The entire sequence is discontinuously covered in upper Kalahari windblown sand and alluviums, forming dunes to the east and pans and interfluves to the west. General geology and stratigraphy is presented in table 3.

The common parent material of the alluvial plain in the region is a remarkably uniform, relatively unweathered, medium-textured sand. The soils of Ohangwena region can broadly be classified into four groups:

1 Aeolian sands (arenosols)
2 Solonetz soil
3 Non-solonetz soils
4 Black clays

The aeolian sands or arenosols are present on the fringe of the central alluvial depression. The clay contents is relatively low, varying between 2 % and 8 %. These soils are also generally non-saline. Although much more complex in distribution and classification, it can generally be stated that grey sands cover the whole of the eastern area, while red and brown sands are characteristic in the gentle relief of the western area of Owambo. There are also sands, enriched with locally derived material, in narrow lenses in the higher lying areas between the oshanas.

The solonetz soils are medium textured alcaline soils with an essentially sandy structure. They cover virtually the whole central alluvial plain and are characterized by a bleached (white) surface. There is also a definite transition between an upper and a lower, more compacted, solonetz horizon having lower permeability and high sodium activity. This profile is typical of soils in flat areas with saline parent material and poor drainage. The upper layers of these soils are shallow, but cultivation is practiced on higher lying areas between the oshanas.

The most prominent oshanas of the Cuvelai are the **Oshana Gwashuui** which pases Ogongo, the **Oshana Shalupumbu** which runs past Okalongo, the **Oshana Cuvelai** passing Oshakati and the **Oshana Oshigambe** at Oshigambo. Run-off in the **Oshana Etaka** mainly originates from local rainfall and its watershed lies just to the east of Eunda. The northerly course, known as the **Oshana Olushandja**, drains towards the Kunene River and the southeasterly course runs into **Lake Oponono**. From Lake Oponono the water of the Cuvelai and the Etaka is carried by the **Oshana Ekuma** into the **Etosha Pan**. The most significant oshana in the northeast is the **Oshana Odila**. An extensive zone of permanent sand dunes is found in the southeastern area and dry water courses occur in the roughs between the dunes. The raemaining part of this area is dotted with numerous small pans and little run off occurs, even after heavy rainfall.

The oshana system covers the western two thirds of the project area. The eastern portion contains only one large oshana, the Oshigambe.

The seasonal flood in the Cuvelai system is very important for the rural economy in Ohangwena region. Fresh surface water, naturally or artificially collected in pans and oshanas, provides high quality water for rural households until it evaporates. The floodwaters also recharge groundwater, bring in fish, which is an important source of protein for the inhabitants, and regenerate grazing for livestock.

Disturbances to the flow of water in the oshana system have since the 1970's been created by infrastructure developments both in southern Angola and northern Namibia. Especially construction of roads and canals with raised embankments across the oshana system has to some extent changed and prevented the free flow of water in the oshanas.

Utilization of the run-off in the oshanas is done by constructing dams, ponds and pumped storage reservoirs. The depth of excavation dams is limited by local saline water tables, which in some areas may be as shallow as 3 m below ground. Excessive evaporation from large shallow reservoirs is a significant problem, which has in some cases been tackled by introducing pumped storage dams with high embankments which increases water depth in the reservoir. Most of these earlier structures have unfortunately become unoperational due to siltation and lack of maintenance.

Many ponds and surface-water reservoirs have later been created from borrow-pits excavated during construction of roads in the 1970's and 1980's. These ponds are much used for livestock watering, but for human consumption well water or piped water is preferred.

The natural condition of surface waters in the oshanas is usually rather good and does not pose either biological or bacteriological problems. However, contamination of standing water occurs due to inadequate human sanitation and by contamination from livestock.

Bulk water supply from Kunene river

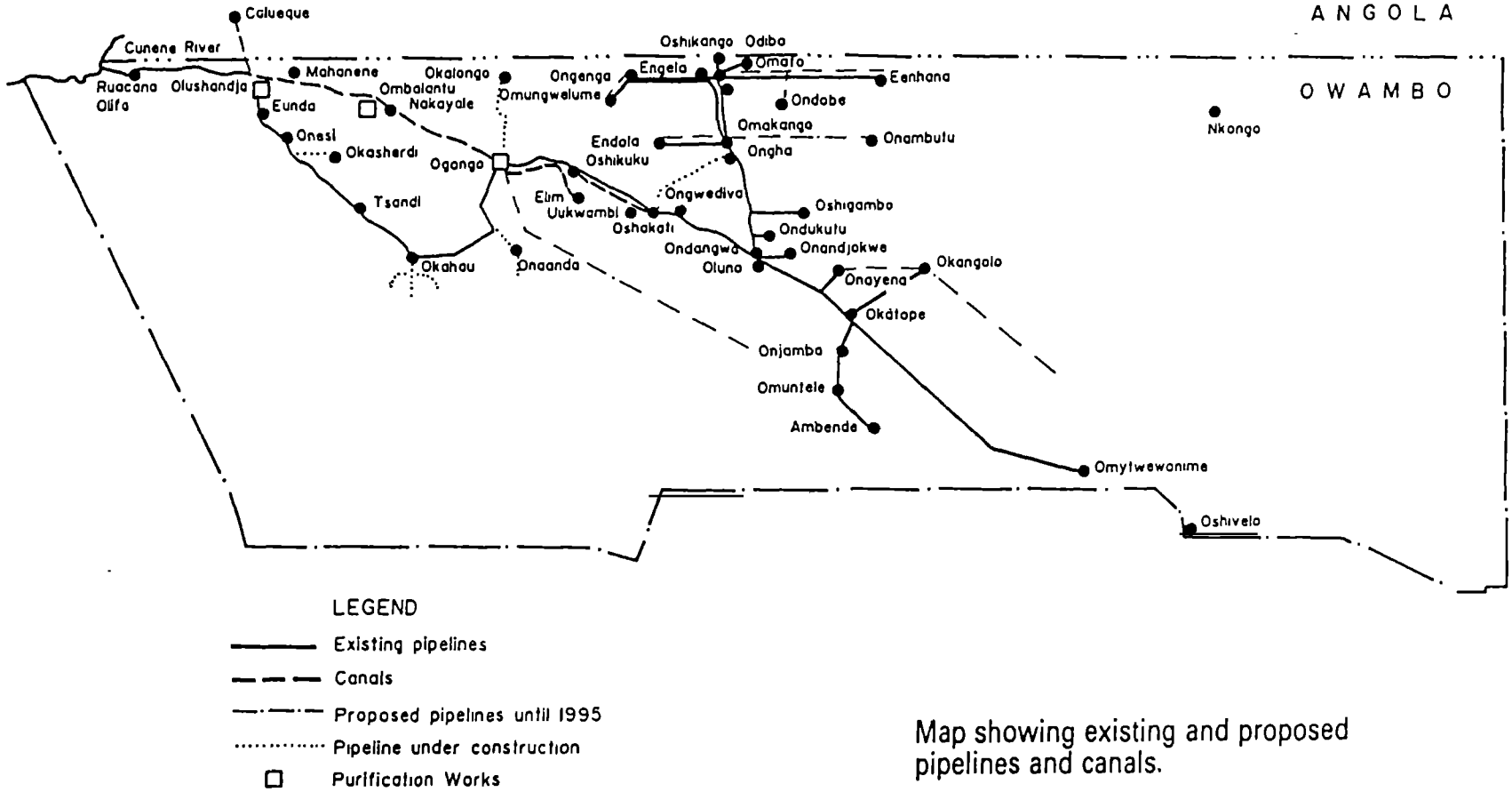
The only perennial surface water source available for inhabitants in Ovambo is **the Kunene river**, which flows from southern Angola to the Namibian border at **Ruacana falls** and then along the border to the Atlantic Ocean. An agreement signed in 1926 between the governments of Portugal and South Africa allows the Namibian government to abstract from Kunene river a maximum of 6 m3 per second. Present pumping capability at Kunene river is far less than the agreed upper limit.

An extensive scheme of canals, pipelines, storage dams, pumping stations, water purification plants and reservoirs has been established since the 1960's to supply major settlements in Owambo with perennial water from Kunene river. This bulk water supply network is the largest water supply system in the country. At present it consists of 29 pumpstations, 92 km of canals, 950 km of pipelines and 9 purification plants.

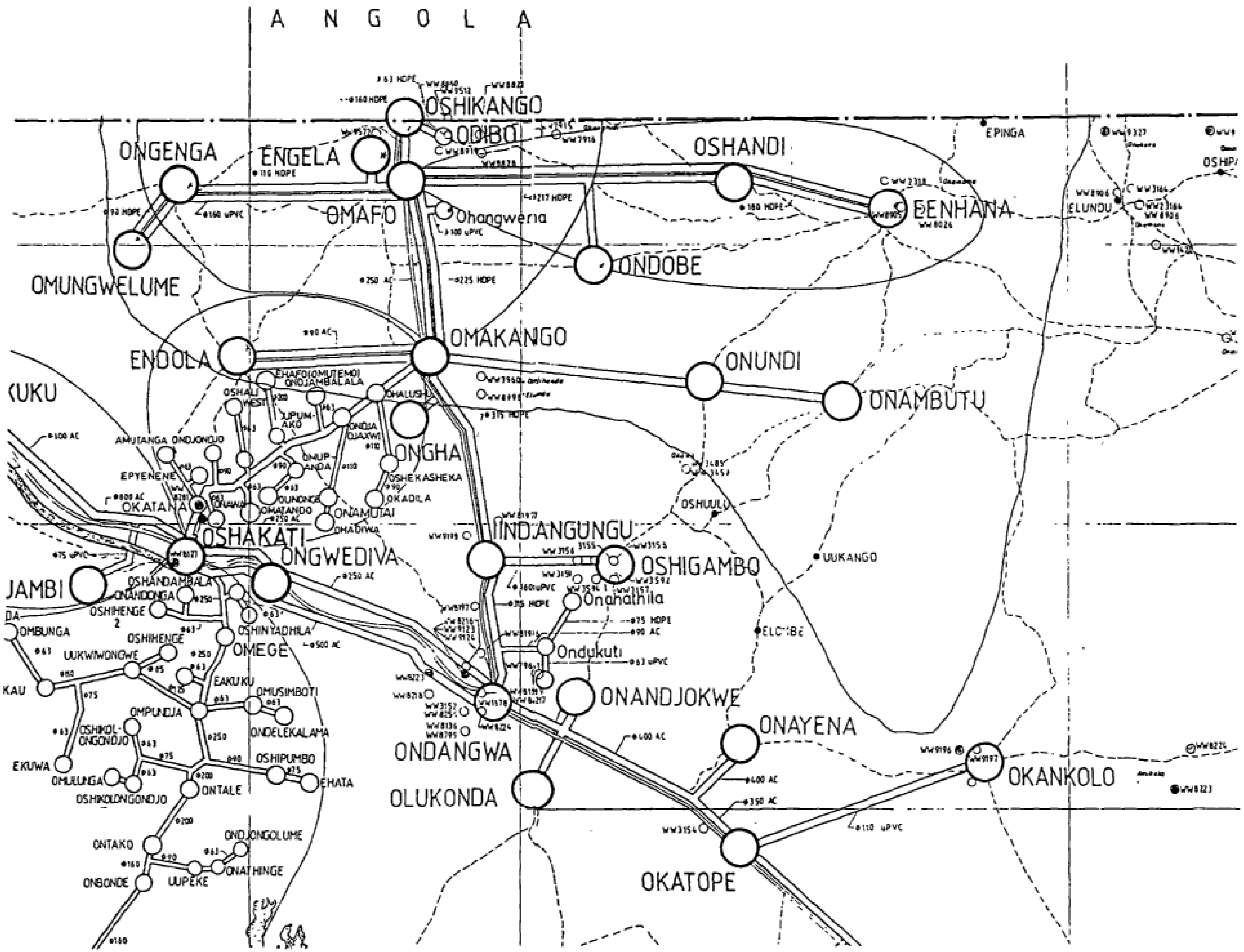
A part of this scheme is the **Ondangwa-Oshikango State Water Scheme**, also known as the **Herringbone Scheme**, which is located within the WSSPOR project area. The length of the Herringbone Scheme is at present about 230 km, and it supplies about 43 000 inhabitants (12 000 at growth points and 31 000 in rural areas) Its main bulk water supply artery runs from Ondangwa in the south to Oshikango at the Angolan border. Branch lines reach to the western and eastern sides of this main artery. At present a new pipeline from Omafo to Eenhana (48 km) is under construction with financial assistance from France, and the Omakango-Onambutu pipeline is under upgrading.

The availability of permanent water provided by the state water scheme has strongly influenced the settlement and land-use patterns of the area. Concentration of people and livestock to levels that exceed the carrying capacity of the land has taken place in many areas along the scheme. Further land degradation can be prevented only if effective land-use planning and control as well as improved livestock management and control of stocking rates is introduced A comprehensive overall land-use plan should form the basis for future planning of extensions to the bulk water supply scheme.

MAP 8. EXISTING AND PROPOSED CANALS AND PIPELINES IN OWAMBO

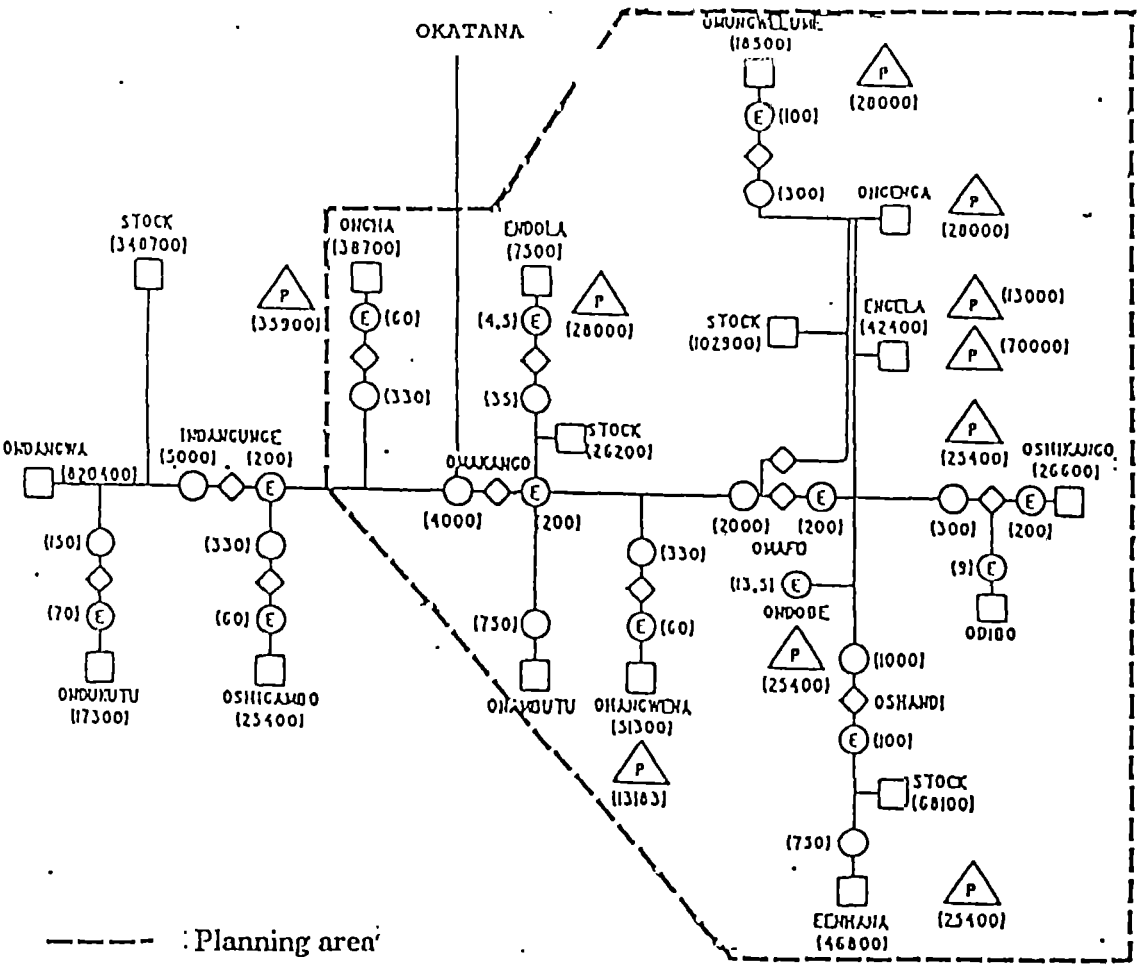


Map showing existing and proposed pipelines and canals.



MAP 9. EXISTING AND PROPOSED PIPELINES OF THE HERRINGBONE SYSTEM IN WESTERN OHANGWENA REGION AND OSHAKATI - ONDANGWA AREA

schematic lay-out of the Herringbone system



Symbol	Capacity of Component and Units	Description
	( ) m3/a	Consumer
	( ) m3	Pumped storage dam
	( ) m3/a	Pipeline
	( ) m3/h	Pumping station
	( ) m3	Clear water reservoir

FIGURE 3. SCHEMATIC LAYOUT OF THE HERRINGBONE WATER SUPPLY SYSTEM

4.5 Groundwater Resources

The Cuvelai basin drainage system is underlain by **a large deep aquifer (DA) with saline water**, the underground "Brine lake", which has its origin in Lake Etosha, a large saline lake which existed still some 35 000 years ago. During its largest extent about 3 million years ago, lake Etosha covered an area of about 70 000 km2 (about the size of present-day Lake Victoria in east Africa), and reached up to the present 1 120 m countour line. Maximum depth of the lake was about 40 m. Since the lake did not have an outlet to the sea, evaporation caused gradually salinity to rise. Progressively also the sediments under the lake floor became salinized.

The saline brine lake area is more or less confined to the Etosha depression, which covers the western part of the project area. The deep saline aquifer occurs below a depth of 50 m, and generally salinity increases with depth. Salinity levels in excess of 10 000 mg TDS/l have been measured from numerous boreholes. Such water cannot be used for human and livestock consumption without desalination.

The borderline of the eastern area where fresh deep groundwater can be found runs approximately from a point about 20 km east of Oshikango at the Angolan border in southeasterly direction passing east of Ondobe and Okankolo. The majority of the inhabitants within the project area live within the brine lake area with saline deep groundwater.

Two types of shallow aquifers lying above the saline brine lake aquifer have been identified in the western part of the project area:

a) Main shallow aquifer (MSA), and

b) Discontinuous perched aquifer (DPA).

These aquifers are the main sources of potable gorundwater in central Owambo. Both depend exclusively on annual recharge from rainfall and rainwater collecting in oshanas and pans. Figure 4 illustrates the location of different aquifers.

FROM: MARSH & SEELY (ed.), 1992

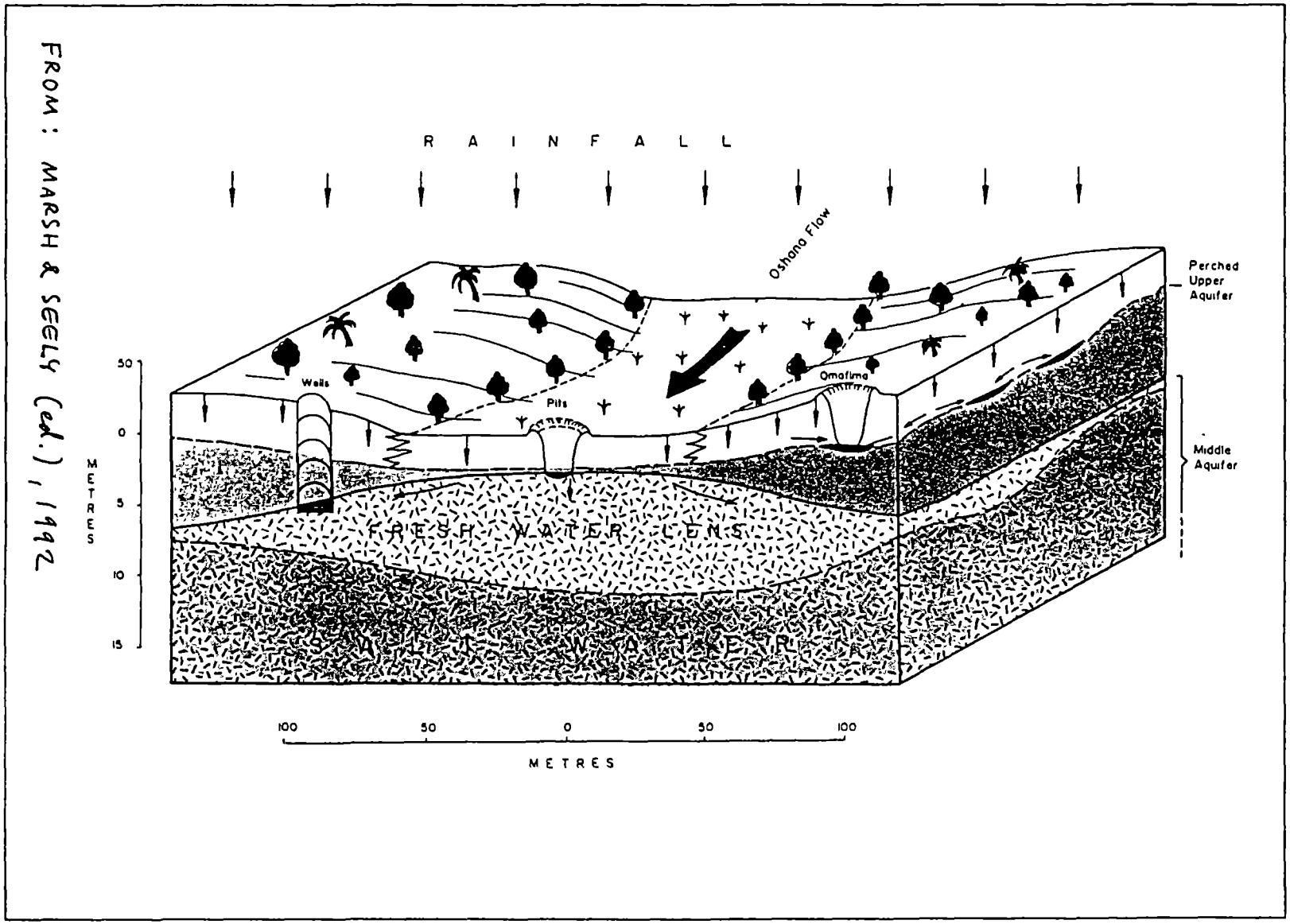


FIGURE 4. DIAGRAM SHOWING GROUNDWATER AQUIFERS AND RECHARGE SYSTEMS AND LOCATION OF WELLS AND OMAFIMA

The MSA is located within the Kalahari sandstones at depths of 10-30 m. Water is traditionally tapped by hand-dug wells (ndungus) equipped with handpumps or windlasses. MSA water quality varies from drinkable to highly saline.

The DPA is an ephemeral or seasonal water source, located mainly in association with calcrete layers in or close to oshanas and pans, at depths of less than 15 m. The depth of the potable water body seldom exceeds 40 cm. During the dry season water levels drop considerably, and many of the wells and waterholes tapping the DPA source dry up. The traditional waterholes are shallow hand-dug conical pits known as omafima, which commonly serve only one or a few families. New omafima are usually dug every year in oshana beds and pans during the dry season. Fig trees are often indicators of the presence of a shallow perched aquifer.

The Eastern area

In the sparsely populated eastern part of the project area, east of the brine lake area, fresh groundwater can be found at depths of 70 to 100 m. About 85 % of the boreholes that have been drilled in the area, have been successful. Due to the depth of the water table wells and boreholes have to be equipped with windmills, diesel driven pumps or solar power pumps, which increases the cost of water significantly. Extensive geohydrological investigations and drilling tests are required before any conclusions can be made on the availability of fresh groundwater to sustain large scale urban and/or rural development.

4.6 Vegetation and Wildlife

The types of natural vegetation found in Ohangwena region are associated with small changes in topography, rainfall, drainage pattern and soils. Common vegetation types can be broadly classified into following 5 assemblages:

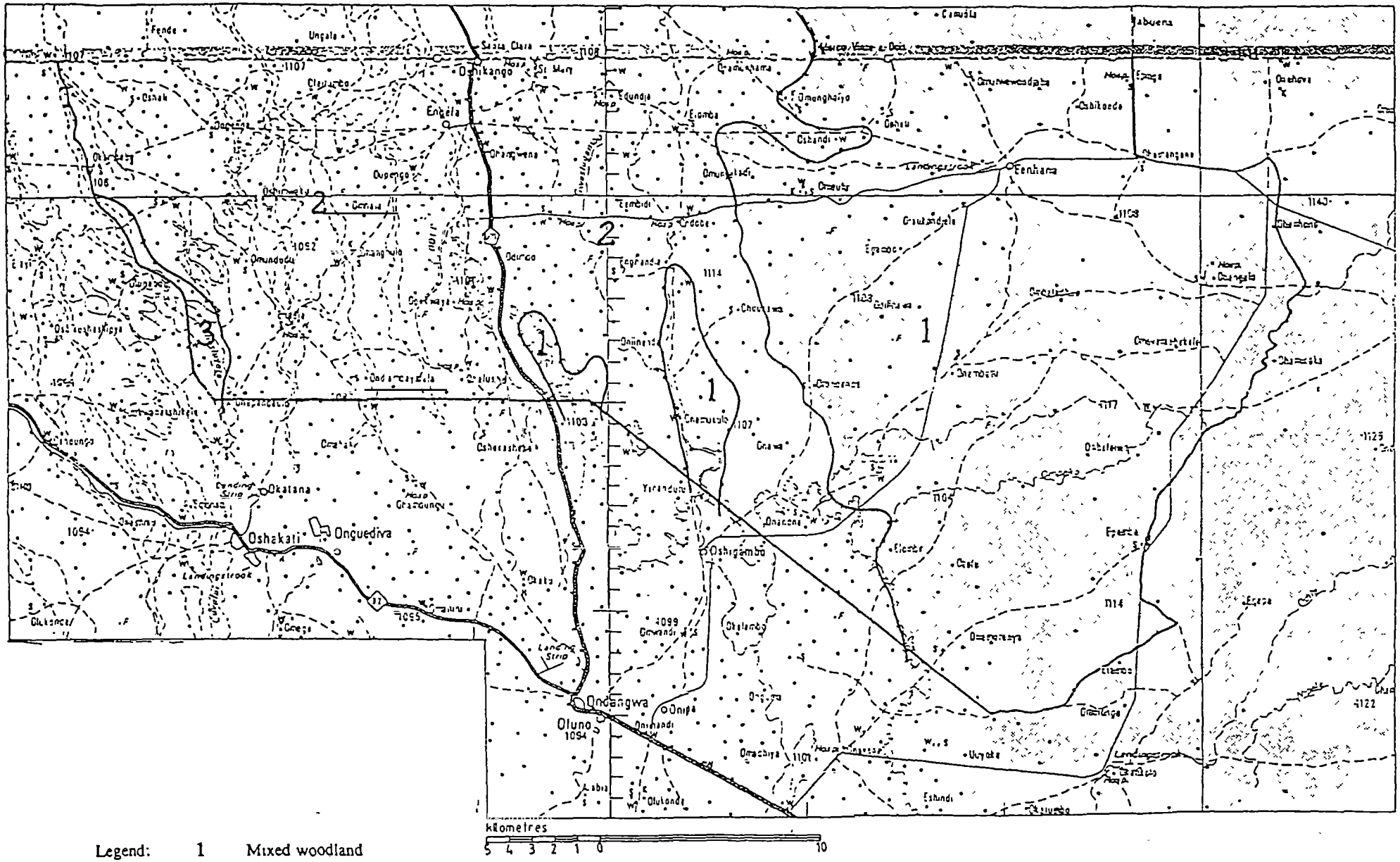
a) Mixed dry woodland and forest

b) Palm and marula savanna

c) Mopane woodland and savanna

d) Mopane-acacia shrub savanna

e) Open grassland



Legend:

1 Mixed woodland

2 Palm savanna

3 Mopane woodland and savanna

MAP 10. VEGETATION TYPES

Mixed dry woodland and forest, associated with deep aeolian sands occupy the eastern area east of the Cuvelai drainage basin and extends into Okavango region. The trees grow higher and denser eastwards where rainfall slightly increases. The woodlands contain a large variety of deciduous trees, with vaalboom, camelthorn (Acacia erioloba) and wild seringa as the main species.

Also rather common species are kiaat or wild teak (Pterocarpus angolensis), manketti tree (Ricinodendron rautanenii), Combretum species and Terminalia sericea. Other important species include Zambezi teak (Baikea plurijuga), copalwood (Guibourtia coleosperma) and tamboti (Spirostachus africana). Grass cover is moderate, but in the eastern area grasses tend to be less palatable than elsewhere.

The eastern dry woodland and forest areas are still sparsely populated due to water supply difficulties, and also because of insecurity and military activity in the area during the liberation war in the 1970's and 1980's. Increasing population pressure in the densely populated western areas has however recently created a migration into the eastern parts of Ohangwena, and the remaining woodlands are becoming seriously threatened. Also increasing demand for fuelwood and poles for fencing and house construction has become a threat to the woodlands. Especially endangered by increasing logging and woodcutting are valuable construction and pole woods, such as Zambezi teak and kiaat. Much of the present logging activities are illegal. As long as effective control systems do not exist, illegal cutting will continue and increase.

The western parts of Ohangwena region, which belong to the Cuvelai drainage basin, are densely populated, and natural vegetation has been much altered by human activity and livestock. Some 30-40 years ago there were still many intact woodlands between the settlements, but now almost the whole area has become a modified agricultural landscape with clear signs of increasing environmental degradation. The topography is a mosaic of large flat grass-covered depressions (oshanas and pans) and slightly raised sandy ground with farmland, farm compounds, grazing land and scattered trees.

The dominant type of natural vegetation in the western area is **palm and marula savanna**. Scattered fan palm trees (Hyphaene petersiana), which surround depressions and drainage lines dominate the landscape visually. Large fruit trees, mainly marula (Sclerocerya birrea), sycamore fig (Ficus sycamorus) and baobab (Adansonia digitata), can be seen scattered troughout the landscape. Big termite mounds (Macrotermes michaelseni and M. natalensis) are often associated with fig and marula trees.

Secondary growth of mopane shrub (Colophospermum mopane) and camelthorn (Acacia erioloba) may also be associated with palm and marula savanna. Grasses are important components of the sandy more elevated areas. When such land is left ungrazed it may grow dense stands of tall grasses.

The **mopane woodland and savanna** vegetation group is associated with solonetz soils and is characteristic of the central and northwestern parts of the Cuvelai drainage basin extending across the Etaka. Marula, palms, baobab, and manketti trees commonly grow in isolated communities within mopane woodland. Sometimes also Acacia species, African ebony (Diospyros mespiliformis), and Terminalia sericea may be found in mopane savanna and woodland.

These areas have to a large extent been denuded of natural vegetation, except important fruit trees, due to extensive use of mopane timber and branches for palisades, fencing, house construction and firewood, and due to clearing of the land for cultivation and grazing land. Grass cover is moderate, consisting of various perennial and annual grasses. In well-developed mopane stands grass is usually scarce, which may be due to the very dense and shallow root system of mopane trees.

Mopane-acacia shrub savanna occurs in the south-central parts of Owambo on saline ground close to the Etosha pan, but can also be found elsewhere on the fringes of oshanas and pans. Halophytic vegetation dominates and Acacia newbrownii sometimes forms thick stands.

Open grassland is abundant in the western parts of Ohangwena region, especially on seasonally flooded land on the edges of oshanas and pans. Flooding of these areas, from local rainfall or more distant sources, contributes nutrients and water and thus stimulates grass growth. These areas are widely used as communal grazing lands and represent an important element of the farming system. Towards the end of the dry season most of the grass has been grazed and trampled down to very short stubble.

Most of the trees that grow scattered on farmland and grazing land are preserved due to certain valuable products (fruits, pods, leaves, branches etc.) that are continuously harvested. This system is a kind of traditional agroforestry practice, although trees are not actively planted and regenerated. These trees and products include the following:

Baobab	Fruit and leaves used as livestock fodder. Fruit and bark has also medicinal use. Fibers used for rope and matting etc.
Bird plum or brown ivory (Omuye)	Fruits are edible and much valued.
Camelthorn	Pods are valuable livestock fodder. Branches used as firewood and implements. Bark has medicinal use.
Fan palm (Makalani)	Sap has been used for palm wine, but since sapping easily kills the tree, the practice has been forbidden. Fronds used as fencing material, for basketry and as firewood. Natural regeneration of palms is rather strong.
Manketti	Fruits and kernels are edible. Kernels are rich in protein and give high quality food oil. Leaves have medicinal use.

Marula	Fruits are highly valued. Used for food and brewery, kernels for food oil. One mature tree can yield 0,4-1,6 tons of fruits annually.
Mopane	Branches are used as fencing and house construction poles and firewood. Leaves can be used as livestock fodder. Mopane has good coppicing vigour.
Sycamore fig (Omukwiyu)	Fruits are edible and good livestock fodder. Leaves, bark and roots have medicinal uses.

Some characteristics of most common trees in Ohangwena region are presented in table 4.

Wildlife

The eastern forests and woodlands are the main habitats for wildlife in Ohangwena region. Large wild mammals have become almost extinct during the last 40-50 years. This is due both to increased hunting as well as disturbances in the area during the liberation war in the 1970's and 1980's. Small numbers of antelopes (e.g. bushbuck, eland, gemsbok, greater kudu and wildebeest), springbok, baboons, hyenas, jackals, leopards and warthogs can occasionaly be seen in remote locations in the woodlands, and sometimes also occasional wide-ranging elephants visiting from the woodlands of southern Angola, which are more endowed with wildlife.

Many species of large mammals, which were common in Owambo still in the 1950s, can now be found only in the **Etosha National Park**, which is located some 80 km south of Ondangwa. Etosha is considered to be one of the most important game parks in Southern Africa. It covers about 22 270 km2, stretching about 280 km in a 60-100 km wide belt from Otjovasandu in the west to Oshivelo in the east.

As much as 98 species of reptiles have been identified in Owambo as well as 16 species of amphibians and 94 species of small mammals, including hares, honey badgers, mongoose, porcupines, hedgehogs, tree squirrels and ground squirrels, rats, mice, shrews, pangolins etc. Hares and squirrels are commonly hunted, and frogs are an important component of people's diet during the wet season. Rodents and other vermin associated with human habitation are very common.

Totally as much as 411 species of birds have been recorded in Owambo. The Cuvelai basin drainage system supports a rich diversity of birdlife, particularly wetland species. These include also rare or endangered species, e.g. Wattled crane. Some of the bird species are hunted by shepherd boys with slungs and arrows for food

TABLE 4. PRINCIPAL CHARACTERISTICS OF MOST COMMON TREES IN THE STUDY AREA

Scientific name*****	Local name****	Family**	Protected*	Growth***	Drought***	Potential utilizations***and******					Comments*** and **
						Firewood	Fodder	Food	Medical**	Wood	
Acacia erioloba	-	Mimosoideae	Y	S	XXX	XXX	X	XXX	X	X	Tolerates saline soils
Baphia massalensis	Ofufe	Papillonoideae	N	-	-	-	-	-		-	On Kalahari sands
Baikiaea plurijuga	Omupapa	Caesalpinioideae	Y	-	-	-	-	-		XXX	Withstands abrasion
Bauhinia macrantha	Omutwanghutu	Caesalpinioideae	N	-	-	-	-	-	X	-	
Berchemia discolor	Omuve	Rhamnacae	Y	S	XX	X	X	X		XX	Resists termites
Boscia albitrunca	Omunghudi	Capparaceae	Y	S	XXX	X	XXX	X	X	X	Tolerates saline soils
Burkea africana	Omutundungu	Caesalpinioideae	Y	S	XX	XX			X	X	Host for eadable worms
Colophospermum mopane	Omufyati	Caesalpinioideae	Y	S	XXX	XXX	XXX	X		X	Host for eadable worms
Combretum imberbe	Omukuku	Combretaceae	Y	S	XX	XXX			X	X	Resists termits
Combretum mechowianum	Omupupwaheke	Combretaceae	N	-	-	-	-	-		-	
Commiphora africana	-	Burseraceae	N	-	-	X	XXX	X	X	X	Good insectcide
Dichrostachys cinerea	Ongete	Mimosoideae	N	S	XX	XXX	XXX	XXX	X	X	Resists termites
Diospyros lycioides	Oshimumu	Ebenaceae	N	S	XXX		X				Tolerates saline soils
Diospyros mespiliformis	Omwandi	Ebenaceae	N	S	X	X		X	X	X	Resists termites
Ficus sycomorus L.	Omukuyu	Moraceae	Y	S	X	X	X	X	X		Resists termites
Hyphaene ventricosa	Omulunga	Arecaceae	N	-	-	-	-	XX		-	
Lonchocarpus nelsii	Omupanda	Papilionoideae	Y	-	-	-	XXX	-	-		
Peltophorum africanum	Omupalala	Caesalpinioideae	Y	I	XX	XX		X	X	XX	
Pterocarpus angolensis	Omuuva	Papilionoideae	Y	S	XX	XX			X	XX	Resists termites
Ricinodendron rautanenii	Omunghete	Euphorbiaceae	Y	-	-	X		X		X	On Kalahari sands
Sclerocarya birrea	-	Anacardiaceae	Y	I	XX	XX	XXX	XXX	X	XX	Highly nutritius fruits
Terminalia sericea	Omwoolo	Combretaceae	N	S	XX	XXX	X		X	XX	Resists termites

Y= Yes
N= No
S= Slow
I = Intermediate

Draught :
X Somewhat susceptible
XX Moderatly resistant
XXX Very resistant
Blanc: Susceptible

Utilizations (except medical):
X ——▶ XXX
Increasing importance
Blanc: no utilization

Medical:
Blanc: no utilization
X: used

When there is a "-" it means that no data were available

* A. ERKKILA and H SIISKONEN (1992)
** K.C PALGRAVE (1983)
*** R J. POYNTON (1973)
**** P.J. LE ROUX (1971)
***** B.H.C.TURVEY et al (1977)
****** D. ROCHELEAU et al. (1988)

The fish life in seasonal oshanas and pans is similar to sump lakes in other parts of southern Africa. It is dominated by 3 genera: Barbus, Clarias and Oreochromis. 17 fish species have been recorded in the permanent headwaters of Cuvelai river in Angola. Large amounts of fish enter the oshanas in those periods when strong efundjas spill over from Angola to Owambo. Fishing is an important activity during flood periods. Fish are caught with nets and baskets arranged in openings of small earth and brushwood dams built across flooding oshanas.

Development of small-scale fish farming in dams and ponds has much potential and should be encouraged.

4.7 Population, Human Settlements and Infrastructure

Total population in Ohangwena region is at present about 180 000, and average population in the project area is about 125 000. The western part, to the west of the Ondobe-Oshigambo line is densely populated, with population densities between 25 and 100 persons/km2. The highest density, around 100 persons/km2, is found along the Ondangwa-Oshikango-Angola trunk road in a strip extending some 5 km on both sides of the road. This area includes the following growth centers: Omakango, Okatope, Ohangwena, Omafo, Engela and Oshikango Other growth centers in the western area are Endola, Omungwelume, Onganga and Ondobe. The eastern part of the project area is much more sparsely populated, with densities mainly below 10 persons/km2. Main growth centers are Oshandi, Eenhana and Onambutu

(Density figures different in Prodoc and Draft Water Supply Development Plan.)

Most of the inhabitants in the project area live in rural areas (113 000), and only about 11 % (11 700) in semi-urban centres. Population growth is at present fairly high, more than 3 % annually. Estimated total population in year 2005 is between 164 300 and 184 500. The majority of the inhabitants of the project area belong to the **Kwanyama language group** of Owambo people. Minority groups are Mbalantu, Kwambi, Ndonga and Kwaluudhi.

About 57 % of the population in Ohangwena are less than 19 years of age. Only about 34 % are in the working age group from 20 to 59 years and about 9 % are above 60 years. Women are in the majority in all age groups (53 % of total population), but in the age-group 20-59 they constitute as much as 64 %. This is explained by labour migration to other parts of Namibia. A considerable part of the male population in Ohangwena region travels to mining areas, commercial farming areas and industrial centres in order to look for cash income.

Infrastructure developments in Owambo during the 1970's and 1980's created an internal migration towards those areas provided with roads, water supply, electricity and community facilities. A rapid population growth started along the main development axis Oshakati-Ongwediva-Ondangwa to the south of the project area and in the area of Omakango-Ohengwena-Engela-Oshikango along the Ondangwa-Oshikango main road. The growth of these urban and semi-urban centres continues still. A further growth factor was the repatriation of Namibians from abroad after independence in 1990. Although some amount of employment opportunities exist within government services as well as trade, small industries and workshops within the growth centres, the majority of inhabitants in the urban and semi-urban areas are also engaged in farming and livestock economy.

Major centres are listed below.

TABLE 5 Major Centres In And Around Ohangwena Region

Place or area	Estimated population in 1990	Status
Oshakati-Ongwediva	65 000	Town
Ondangwa-Oluna	15 000	Town
Oniipa	7 000	Town
Omafo-Engela *	4 000	Growth point
Ohangwena *	3 500	Growth point
Nkongo (Okongo)	3 000	Growth point
Oshigambo	3 000	Growth point
Eenhana *	3 000	Town
Oshikuku	2 000	Growth point
Okalongo	1 500	Village
Omungwelume *	1 500	Village
Okankolo	1 500	Growth point
Total	109 500	

* Centres within the project area

Modern infrastructure in Ohangwena region and its surroundings is concentrated along the 2 main roads: Ondangwa-Oshakati-Ogongo-Ombalantu-Ruacana (Route C 46) and Ondangwa-Ohangwena-Oshikango (Route B 1). These roads, which were originally built for military purposes in the 1970's and 1980's are asphalted and in good condition. Good quality gravel roads within the project area are the following:

- A connection from Ombalantu in the west via Okalongo and Ongenga to Engela and the Ondangwa-oshikango main road. This road has also a connection via Endola to Oshakati.

- A connection from Omafo eastwards via Oshandi to Eenhana and further to Okongo and Okavango region.

- Another connection from Ondangwa-Oshikango main road via Okatope and Ondobe to Eenhana.

- A southwestern connection from Eenhana to Oniipa and Ondangwa via Onambutu and Oshigambo.

Further transport facilities are provided by airports in Ondangwa and Oshakati, with regular flights to Windhoek. Telephone services are within the project area provided in Oshikango, Engela, Eenhana and Ohangwena.

A main 330 Kv powerline runs from Ruacana Falls Hydropower Plant via Oshakati, Ondangwa and Oshivelo to the rest of the country. Plans exist to extend the network from Ondangwa to Omafo, Engela and Eenhana. At present the main centers within the project area have to rely on diesel generators for electricity supply.

Water infrastructure is briefly described in sections 4.4. and 4.5. More data can be obtained from the Regional Water Master Plan for Owambo Region (DWA 1990) and specific reports listed in Annex 5. Plans and possibilities for future WS development are discussed in chapters 5 and 6.

4.8 Land-use Patterns and Farming Systems

The agro-pastoralist people of Owambo lived in pre-colonial times on small farms in dispersed settlements that formed local "kingdoms", which were separated from each other by vast woodlands. During the colonial period settlement patterns were divided by the political border between Angola and Namibia. This border cut straight across the cultural, economical and physiographic units of the region. In recent times the settlement pattern has been rapidly changing due to population growth, rapid urbanization and warfare in the 1970's and 1980's. The former vast woodlands extending between the different kingdoms and communities have now disappeared from almost the whole of the Cuvelai basin region.

Availability of potable water from ephemeral surface water sources (seasonal rivers, oshanas and pans) and underground aquifers has been the most important environmental factor determining settlement patterns and population densities in Owambo. Thus the majority of the people have settled in the Cuvelai basin area, and only few people in the eastern woodlands with deep Kalahari sands.

The farms in the Cuvelai area are usually 2-5 hectares in size, situated on higher ground surrounded by grazing land, and often separated by oshanas and pans. Important fruit trees, such as marula, fan palm, manketti, baobab, sycamore fig etc. are scattered over the landscape, growing on farmland and on the edges of oshanas and pans. Cultivated lands are usually surrounded by fences made from poles, branches, brushwood and sometimes fencing wire.

The fenced farmland is called **the epya** and the surrounding communal grazing land **the eputa**. Fencing of the whole farmland, not only the homestead, became common during the wartime, when South African military vehicles used to drive on cultivated fields. Owambo farmers tried to protect their fields by fencing, and this habit seems to continue even after the re-establishment of peace.

Within the fenced epya farmland lies the family homestead, **the egumbo**. Traditionally the egumbo is surrounded by a high palisade of closely standing poles of mopane, terminalia or kiaat. Internally the egumbo may be further divided by smaller palisades forming closed courtyards around small round houses with thatched conical roofs and walls made of poles and branches plastered with clay. The traditional way of building fences and homesteads consumes enormous amounts of pole wood. A medium-size farm may consume more than 7 000 poles of different sizes. The lifetime of good quality termite resistant poles (mainly mopane and terminalia) is usually 6-8 years. A typical layout of a farm in Owambo is presented in Figure 5.

Introduction of wood-saving methods of fencing and viable substitutes to traditional fencing and construction materials is an urgent task if remaining forests and woodlands are to be saved from total destruction.

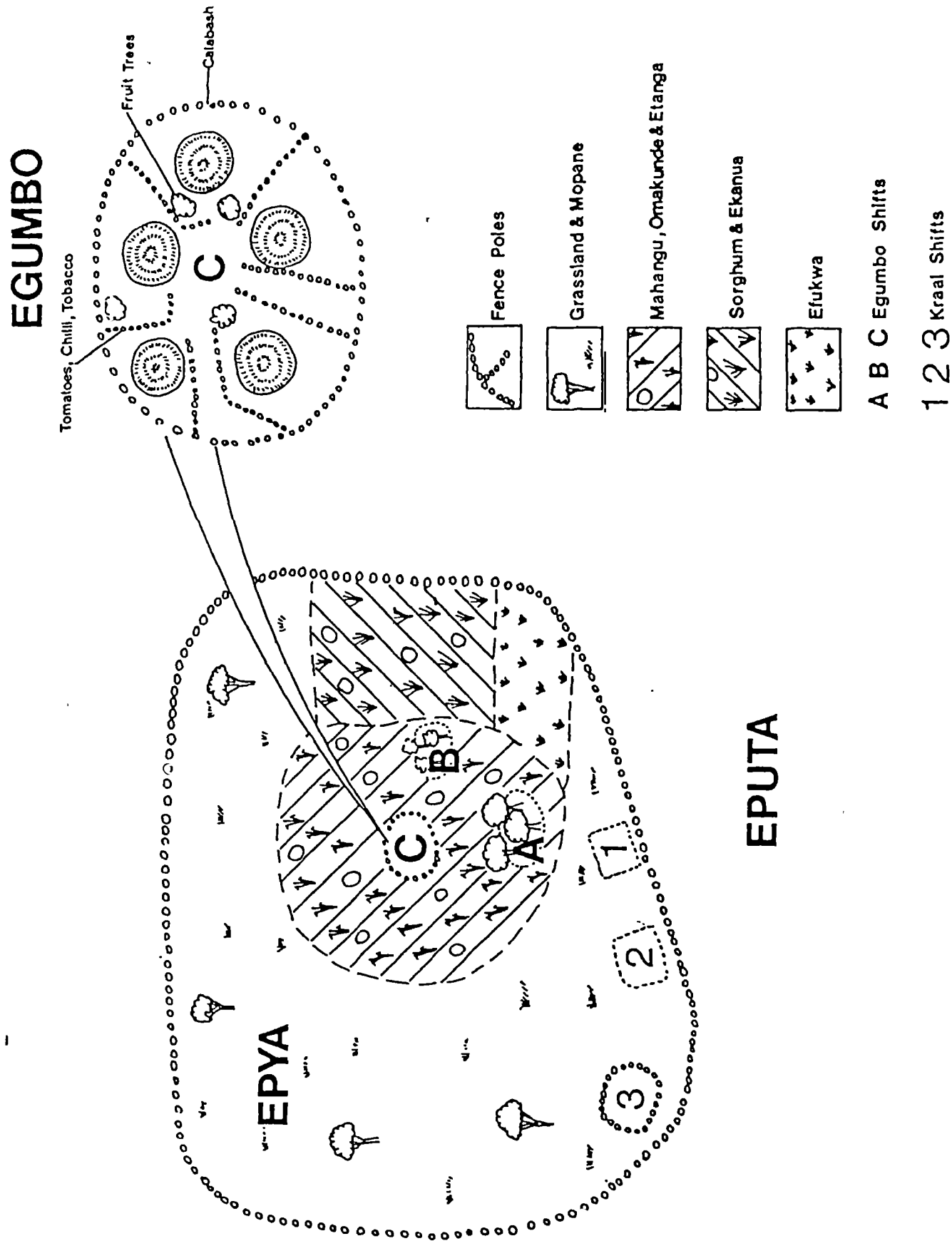


FIGURE 5. LAYOUT OF A TYPICAL OWAMBO FARM

FROM: ENVIRONMENTAL ASSESSMENT OF OKWALUUDHI, UNAM, 1993

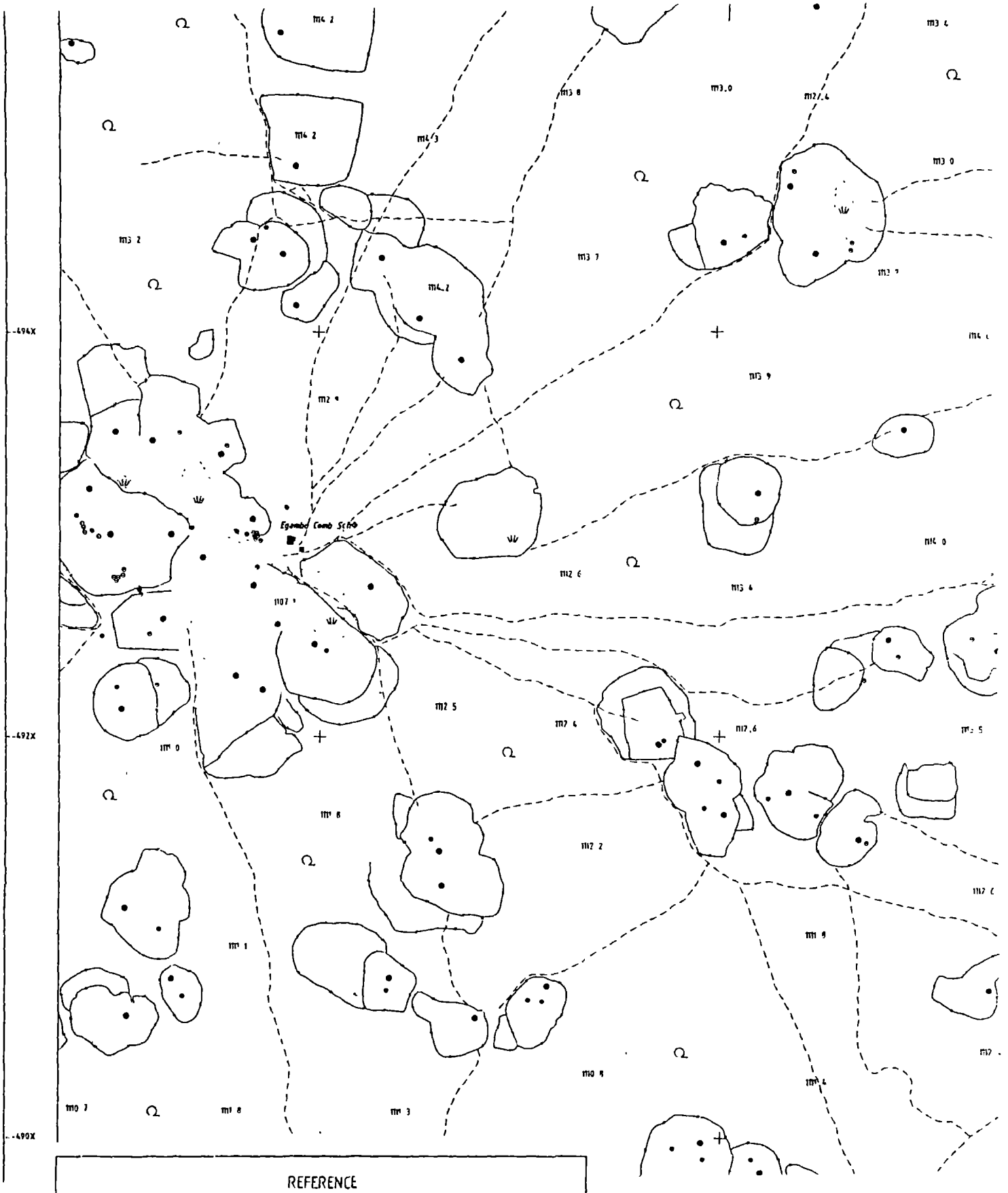
REFERENCE

- Huts
- Buildings
- Wells
- Trees and Bush
- Pipeline
- Fence
- Fence
- Non-perennial Water
- Waterhole
- Index Contour (5/10 metres)
- 1113.9 Spot elevation
- Footpaths
- Secondary Roads
- Main Roads
- Ground Control Point

MAP II.

SETTLEMENT PATTERN AROUND ONDOBE

SCALE:
APPROX. 1/30 000



MAP 12.

SETTLEMENT PATTERN AROUND EGAMBO SOUTHWEST OF EENHANA

SCALE:
APPROX. 1/30 000

Land and Resource Tenure

The land tenure system in Ohangwena region and northern Owambo in general is based on a traditional communal system of land distribution and management. Modern private landownership and land markets exist only to a small extent in urban areas. However, a gradual process of land privatization has already started in densely inhabited areas. Rural land in Ohangwena region can generally be divided into following 3 categories:

1) Semi-private farmland (epya land), which is allocated to a farmer and his family for his lifetime by the local chief or headman.

2) Communal land within the settled zone (eputa land). This land is mainly open grazing land and seasonally flooded oshana land between the individual farms.

3) Communal land outside the settled zone. This land includes distant grazing lands (land around cattle posts) as well as woodlands in eastern Ohangwena.

Land distribution and land-use control has traditionally been the responsibility of traditional chiefs and headmen. The farmers have received land allocations for their lifetime by paying a land fee in cash or kind to the headman, who is supposed to administer the funds for the benefit of the community. In some areas the land fee has however become private property of the headman

When the farmer dies, the land has to be reallocated to his widow or son, and a new fee has to be paid. A common land fee is nowadays 400-600 Namibian dollars, depending on the size of the land. With increasing population pressure and demand for farmland, the land payments tend to increase rapidly.

Communal lands within the settled zone are unfenced and used on a free-access basis by community members for grazing and collection of fuelwood, building and fencing poles and wild fruits etc. Wells and waterholes within communal lands may be communal or private. Fishing in the oshanas during floods is free for all community members.

With growing population density the amount of communal land compared to semiprivate farmland is rapidly decreasing, and in some areas the eputa is reduced to a series of access corridors between epya farmlands. In such cases the value of the eputa as place for free-access resources is negligible. The decrease of the amount of communal grazing land results in increasing pressure on limited grass resources unless cattle herds are reduced or livestock management practices adapted to growing scarcity of grazing land.

Communal lands outside the settled zone include forests and woodlands in the east as well as distant grazing lands that are used as cattle posts, where cattle are moved when grass resources in the farmlands and surrounding communal lands have been depleted. A tendency towards sedentarization of these grazing lands has been observed in many places in Owambo. This means, that cattle and other livestock are maintained permanently at the cattle posts by employed herders while the owners live elsewhere.

Another recent phenomenon is the fencing and privatization of communal grazing lands by wealthy cattle owners both within and outside the settled zone. Private access to these lands is usually acquired by paying rental fees to the local headmen. This practice is clearly in contradiction both with traditional laws and with the land tenure policy of the government. Some of these illegally fenced grazing lands have subsequently been provided with wells and/or boreholes for livestock watering.

The legal and administrative aspects of land use and tenure are presently rather unclear in Owambo, since the powers and responsibilities of traditional leaders versus government institutions have not yet been clearly defined. New legislation and policies regarding local government, land-use control and land tenure is urgently needed to rectify the present confusing and unclear conditions. The ongoing legislative process concerning land tenure is at present dealing only with commercial farming areas to the south of Owambo. No new Land Bill for communal farming areas can be expected to be tabled in the near future

Farming Systems

The traditional farming and land-use system in Ohangwena region can be classified as an agro-silvo-pastoral system which combines crop cultivation, management of trees providing edible fruits, fodder etc. and livestock rearing. All three components of the system are essential to maintain the productivity of the system

Climatical and soil conditions in northern Owambo can be considered to be rather marginal for dryland crop cultivation. Small changes in the amount and timing of rainfall may easily result in crop failures over large areas. In these cases livestock products and fruits, nuts etc can to some degree compensate for the losses in crop production.

The crop cultivation component of the system consists primarily of omahangu (pearl millet), which is the traditional staple food crop in Owambo. It is more drought tolerant than sorghum and maize and thus better suited for the semi-arid conditions of Owambo. The common cropping pattern is mixed cropping with different crops growing on the same field. Additional crops besides omahangu can be sorghum, maize, watermelon, pumpkin, groundnuts, beans and cowpea. Maize and sorghum are usually grown only close to oshanas where soil moisture is higher. Due to rather low rainfall the yields of omahangu are fairly meager, on average only 400-500 kg per hectare annually. During dry years yields may drop down to less than 200 kg/ha.

In addition to field crops farmers also keep small vegetable gardens within the homestead (egumbo). These gardens usually include some fruit trees and provide tomatoes, calabash, cassava, sweet potatoes, spinach, chilli, tobacco etc. Handwatering of vegetable gardens in the dry season is common when water supply is sufficient, but large-scale irrigation is very rare in Ohangwena region.

Women are responsible for most of the crop cultivation activities. They do most of the planting, weeding, harvesting and processing of field crops. Men are mainly responsible for the ploughing of fields, management of livestock and construction of fences, buildings and grain storage. Many farms are completely run by women when the husbands are staying outside Owambo looking for cash income.

Artificial fertilizer is very little used in Ohangwena region. The traditional method to maintain soil fertility is the use of livestock manure, which is collected from the cattle-pens within the egumbo and epya. Livestock is also allowed to graze on omahangu stalks on the farmland after the harvest. The importance of livestock as a producer of organic fertilizer is widely racognized.

Another method to maintain soil fertility is to shift the location of the egumbo within the epya with regular intervals of 4-8 years. Since organic material, such as crop residues and manure from poultry and small livestock is accumulating within the egumbo, this material will become part of the farmland when the egumbo is shifted. This system will not work anymore if construction of houses from permanent materials such as cement blocks and burnt bricks becomes more common.

The tree component of the system is important for maintaining some vegetation cover during the long dry season and for the reduction of soil erosion and improvement of rainwater infiltration into the soil. There is however and obvious need to diversify and improve the practices of tree growing and management of trees on the farmlands and grazing areas. Important trees are usually preserved on the farmland and harvested, but active planting and propagation of trees is less common. Traditionally important tree species are marula, makalani (fan palm), manketti, fig, baobab, birdplum and mopane (see section 4.6).

The livestock component of the farming system provides many important products and services, such as:

- meat, milk, hides and eggs
- a means of wealth accumulation (investment fund)
- insurance in case of crop failure
- draught power and means of transport
- manure for maintenance of soil fertility

Most of the cattle is of local sanga breed, which is well adapted to the semi-arid and harsh conditions of Owambo. Goats and sheep are kept for meat and hides, and mules, donkeys and horses for animal traction and transport. Poultry is commonly kept within the egumbo, and sometimes also pigs.

Cattle rearing in Owambo is usually not based on commercial rationales, it can better be considered as a traditional way of life. Cattle ownership has a high social status, and a large herd gives its owner economic security during difficult times. A sustainable take-off rate would be around 10 % annually, but in most years the actual take-off is much less. A significant constraint for commercial livestock production is lack of marketing outlets and facilities.

Small livestock, calves and milking cows are usually kept continuously on and nearby the farm, and sheltered in cattle pens or kraals within the epya during nights. Cattle are usually herded by young boys, but goats and donkeys are allowed to roam freely around.

Traditionally cattle movements and management follows seasonal changes in rainfall and vegetation. With the onset of main rains in January and February large and small stock is grazed on new grass near the homestead. As grass becomes finished within the eputa, stock are moved into the epya where they feed on omahangu stalks and crop residues after the harvest, and fertilize the fields with manure. When fodder and grass is becoming even scarcer during the dry season, part of the herd is taken to distant cattle posts in western and southwestern grasslands or eastern woodlands. Cattle herds are to some extent taken to the eastern woodlands also in the rainy season, when water is available in the pans. This seasonal migration of livestock (transhumance), called ohambo, becomes more and more important when competition for limited grazing land and fodder resources in the densely settled areas increases with growing livestock numbers

The pattern of transhumance in Owambo has undergone considerable changes since the 1970's due to following reasons:

1) Fences erected along the Angolan border and around Etosha National Park have reduced availability of distant grazing areas.

2) Installation of boreholes and piped water supply in grazing areas has reduced cattle movements during the dry season.

3) Availability of young boys for cattle herding has decreased with growing interest in education. The boys who attend school, can not spend long periods herding cattle.

Exact numbers of livestock are difficult to obtain due to the transhumance system, and since people are reluctant to tell the size of their herds. Livestock numbers also fluctuate with changing climatical conditions. Herds are decimated during droughts, and start to grow again during rainy years. A strong trend of increasing livestock numbers in Owambo can however be seen from livestock censuses and herd estimations during 40-50 years time.

TABLE 6 Comparison of Livestock Numbers in Owambo in 1945, 1973 and 1992

Livestock	1945	1973	1992
Cattle	250 000	450 000	485 000
Goats	120 000	325 000	500 000
Donkeys	6 000	40 000	120 000
Pigs	..	20 000	30 000
Sheep	..	6 500	8 000

Sources: Analysis of Farming Systems, 1993 (Franco-Namibian Rural Development Project), Marsh & Seely, 1992
Owambo Region Water Master Plan, 1990

Even though cattle herds have increased about 50 % over the 47-year period, the number of cattle per family has decreased, since human population has increased almost fourfold during the same period.

Important to note is the tremendous increase of the number of donkeys, from 6 000 to 120 000. It has been estimated, that only about one third of all donkeys are economically utilized. The rest are roaming freely around and exerting a heavy pressure on limited grass resources.

Average herd size per family in Ohangwena region is nowadays estimated to be about 12-15 heads of cattle and about the same amount of goats. Many families, however, own only a few heads of cattle, while wealthier families may own several hundred heads, located in different cattle posts.

The main limiting factors for herd sizes are availability of water supply during the dry season and availability of grazing land, palatable grass and other fodder resources, e.g. crop residues and mopane leaves etc. Improvements of water supply has in many areas resulted in increase of livestock numbers well above the long-term carrying capacity of the land, which in different parts of Ohangwena region has been estimated to be between 10 and 15 hectares/livestock unit (LSU). One LSU represents one head of cattle or 4 heads of small stock.

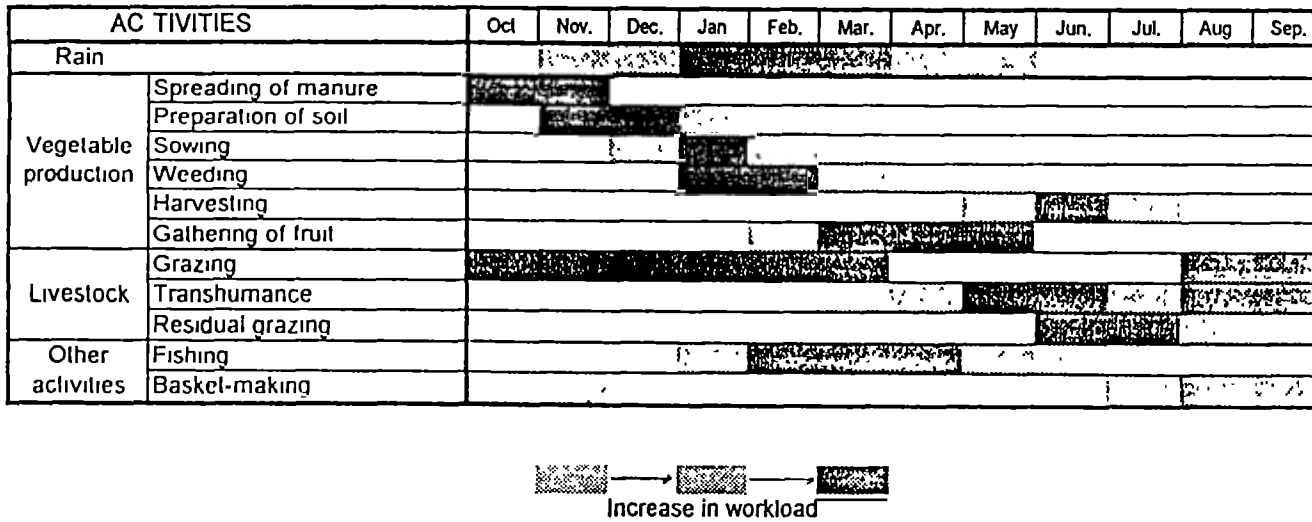
If present overstocking is allowed to continue, the long-term result will be complete degradation and finally destruction of grazing lands and grass resources. Possibilities to improve the situation are e.g.. the following:

1) To increase offtake and to reduce stock numbers in accordance with the carrying capacity of each area, and to introduce effective control of herd sizes.

2) To improve the system of transhumance and pasture rotation.

3) To improve pasture management and to introduce cultivation of fodder trees and improved varieties of grass and fodder as well as hay collection and storage.

Figure Farming calendar



4.9 An Overview of Environmental Degradation

Issues related to environmental degradation have been presented in different connections in previous sections. This section presents a summarized overview of these questions.

The different population groups of Ohangwena region have during a long historical period developed agro-silvo-pastoralist farming systems, that have been reasonably well adapted to the semi-arid climatical conditions of the region. As long as the population density was low and communities were surrounded by large forest and woodland areas, ways of living and economic activities did not significantly conflict with sustainable use of natural resources.

Alarmingly rapid growth of human and livestock populations since the 1960s has however radically changed the picture. Today it is widely recognized, that ecological sustainability has become seriously endangered in many parts of Ohangwena region, particularly in central and western areas. It is now evident, that the natural resource base for human life in Ohangwena as well as many other parts of former Owambo region will be seriously depleted already within the lifetime of one generation unless population pressure on the land can be reduced, more sustainable ways of crop production and livestock husbandry are developed, and the economic activities in urban and semi-urban areas are diversified and able to provide income opportunities for rural people suffering of land scarcity

Before analyzing the problems of man-made environmental degradation, it ... sum up those **main constraints and limiting factors of the natural environment in Ohangwena region**, which define the ultimate limits for human life in the region. These are:

* Lack of perennial surface water resources within the area.

* Relatively low and often erratic rainfall (on average 400-550 mm per annum, increasing from west to east)

* A very long (5-6 months) dry season

* High potential evaporation rate

* Most arable areas covered with sandy soils with low fertility, low water-retaining capacity, low content of organic matter and deficiency in some important nutrients.

* High salinity of soils in many seasonally flooded oshanas and pans.

* Limited resources of potable groundwater.

* High salinity of deep groundwater in the Cuvelai basin area.

Although Ohangwena region is a semi-arid area with agriculturally rather poor soils, the population density in the western and central parts of the region is rather high, up to 100 people/square km. This high density within the Cuvelai basin area is made possible by the oshana drainage system with periodic surface water flows, which recharge groundwater, renew grazing and bring fish into the area. Thus the sustainability of the oshana drainage system as a whole and the safeguarding of undisturbed flow within the system is a question of life and death for the inhabitants of the region.

The most essential natural resources that people depend on are: fresh water (rainwater, ephemeral surface water and groundwater), grazing, suitable soils for crop cultivation and trees, which provide edible fruits, palatable leaves, firewood and poles for fencing and house construction etc. At present there are numerous indications that these limited natural resources are overexploited, and that future prospects for the inhabitants are bleak unless strong corrective measures are taken urgently on a broad front

The processes of man-made environmental degradation are cumulative results of interlinked activities causing over-exploitation of the natural resource base. These processes can be summarized under following 7 main headings:

1) Deforestation of existing forests and woodlands and decrease of tree biomass and density in the Cuvelai basin area (densely populated areas)

2) Accelerating deforestation due to agricultural expansion in the eastern less populated areas

3) Extensive degradation and depletion of grazing land and grass resources

4) Soil erosion and declining soil fertility in cultivated croplands

5) Changes and disturbances to surface flows in oshanas due to infrastructure developments

6) Unsustainable utilization of groundwater resources in some areas

7) Contamination of surface waters from human and animal waste

These environmental problems and degradation processes are presented and discussed below:

Deforestation

The deforestation process has a rather long history in Owambo. Some early documents from the late 19th century (Hugo Hahn in 1866 and Hans Schintz in 1886) describe vast forests and woodlands stretching out between the different kingdoms and communities, and give also indications of rapid deforestation in some localities. Government reports from the 1930's and 1960's paid attention to deforestation, and considered it to be one of the greatest economic and environmental problems in the region. Many Owambo people who returned in 1990 from long periods of exile, have expressed their astonishment and disappointment of the disappearance of vast forests and woodlands they had known before leaving for exile.

The main causes behind this massive and accelerating deforestation process are twofold:

a) Conversion of forests and woodlands into farmland, grazing land and settled area

b) Overexploitation of the resources combined with lack of management and replacement planting

Population growth and resulting demand for more cropland and grazing land has already for many decades forced people to settle in the woodlands wherever they have managed somehow to secure a minimum water supply. Thus the forest boundary in the eastern part of Cuvelai basin has continuously moved eastward. This has been clearly documented from satellite images from the 1970's and 1980's. These images show also continuously growing openings within the eastern forests and woodlands.

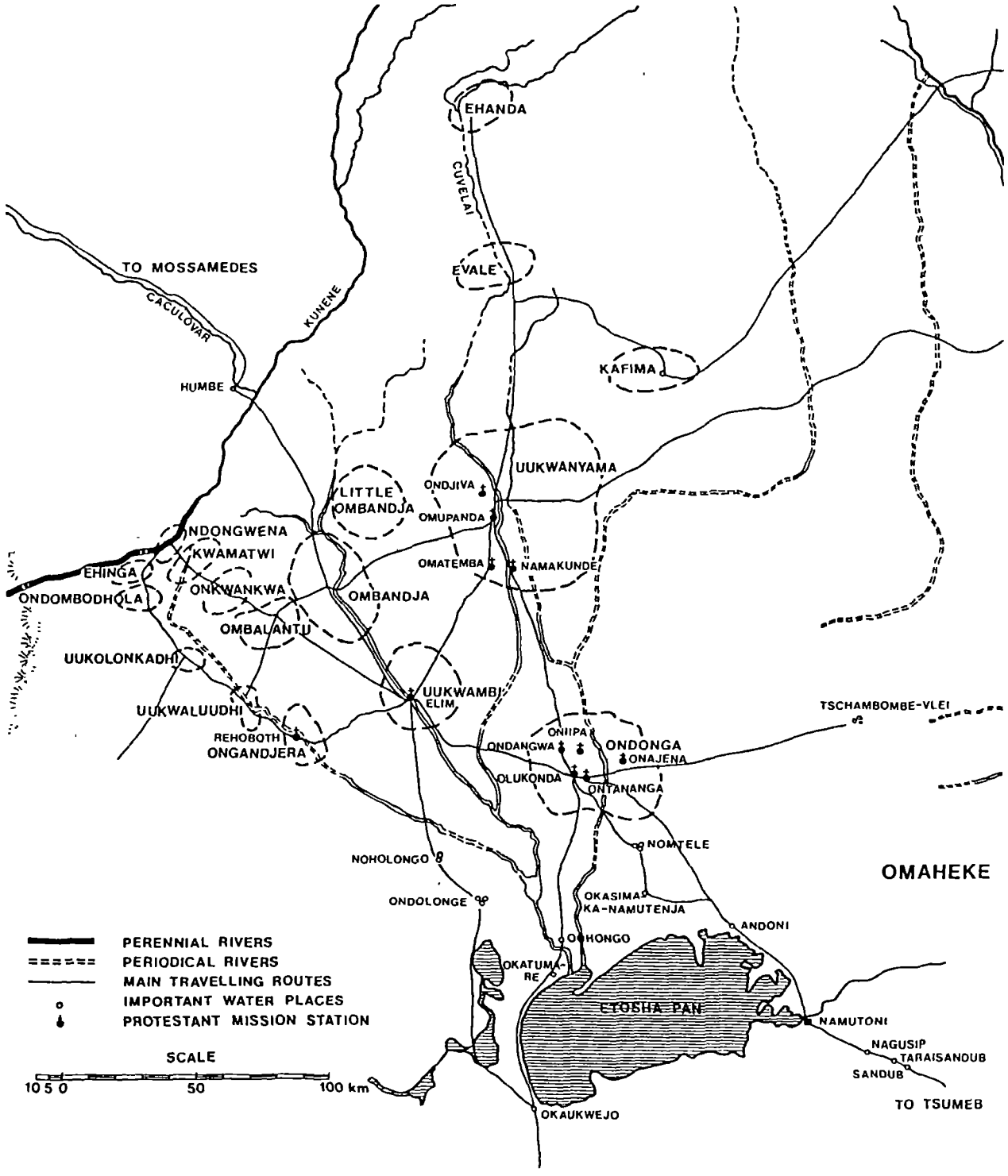
Today the demand for new agricultural land is growing faster than average population increase (about 3,1 % annually), due to declining fertility and productivity of older croplands and due to agricultural mechanization on more affluent farms. This growing demand for farmland can be limited only if job opportunities are created in urban areas for those rural people willing to move into towns and give up agriculture in favour of urban employment.

Overexploitation of trees is caused both by wasteful use of fencing poles and firewood and the present unclear and uncontrolled resource tenure systems.

Woodlands have traditionally been communal land and a free access resource for the members of the community. This opportunity has been recently much utilised by commercial loggers, who cut firewood and poles in communal woodlands free of charge and take them to the towns for sale.

Especially endangered by increasing illegal logging and woodcutting are valuable construction and polewood trees, such as mopane, kiaat, Zambezi teak and Terminalia sericea. Mopane and Terminalia are also much used as firewood.

Officially commercial logging and woodcutting requires a permit issued by the Directorate of Forestry. Legal restrictions on cutting of trees do however not seem to have much practical effect as long as no effective control system exist. The present period is an interim period when traditional local authorities are losing power and traditional control mechanisms are breaking down, but no new mechanisms have been established to replace them. The Directorate of Forestry is in principle responsible to control logging and tree cutting, but the task is impossible to carry out effectively with present manpower resources. Close cooperation between the Directorate of Forestry and local communities is essential if excessive illegal logging and woodcutting is to be prevented.



MAP 13. LOCATION OF OWAMBO COMMUNITIES IN THE 1850'S

FROM: ERKKILÄ & SIISKONEN, 1992

In order to decrease the pressure on remaining natural forests it is also of utmost importance to promote different forms of tree cultivation within the settled areas. The traditional tree management component within the farming system should be strengthened by introducing modern agroforestry methods as well as farm and community forestry activities to satisfy the needs for firewood, fencing and construction poles, edible fruits and livestock fodder, material for household items, medicinal products etc. Particularly important is introduction of leguminous nitrogen-fixing tree species, such as Acacia albida, Leucaena leucocephala, Ziziphus mauritania and Casuarina species, which can contribute to restoration of soil fertility on cropland

Research on agroforestry methods has already for some years been undertaken at Ogongo Agricultural college with promising results. Small tree nurseries have been established in some locations by government institutions and different NGO's, e.g. the Rural Development Centre, church organizations, Green Namibia project and DAPP. These organisations are also providing training and advice in agroforestry and gardening practices as well as trying to promote the use of fuelwood-saving stoves and cookers. However, in order to yield substantial results, these activities and services have to be multiplied and introduced all over Owambo.

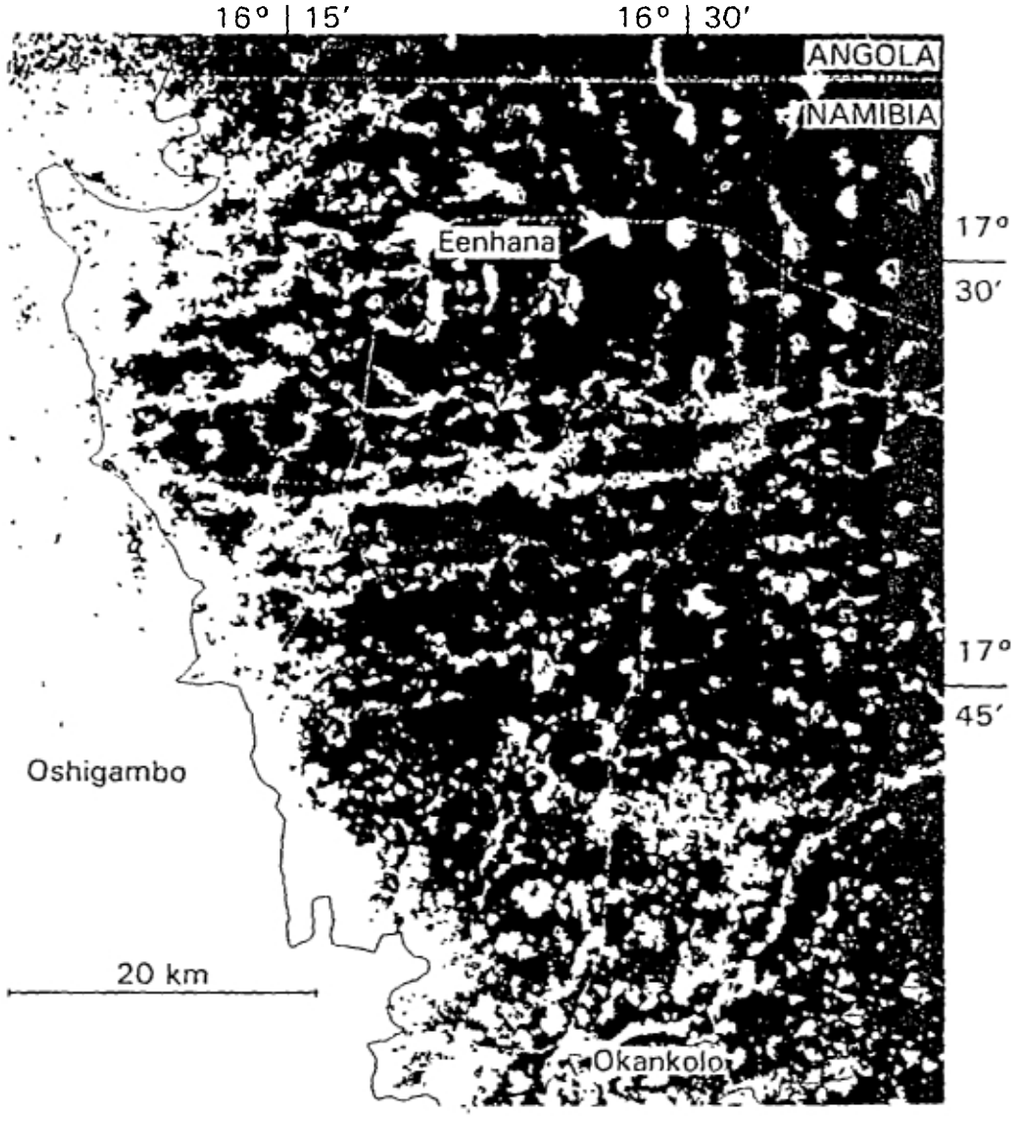
Water supply plays an important role in the establishment of tree nurseries and promotion of tree cultivation. These activities are possible only in places where sufficient water supply is available. However, an important use of household waste water from washing and food preparation should be watering of tree seedlings and young trees within or nearby the egumbo.

The most important issues in the prevention of waste and overexploitation of trees is to introduce wood saving methods of fencing and house construction. Especially use of live fences (f.ex. Euphorbia species) has in many cases proved to be a viable solution. Trials with fuel-efficient stoves have been carried out in many parts of Namibia, and many different stove types have been tested. However, in Ohangwena region these stoves have not yet been widely accepted by housewives.

Antti Erkkila and Harri Siiskonen (1992) have studied the extent of deforestation in Ohangwena and Oshikoto regions in the 1970s and 1980s by comparing recent Landsat satellite images with topographical maps in scale 1:250 000 published in 1975. Their study shows that the forest boundary has been steadily moving eastwards, and that open clearances within the woodland areas have grown considerably (See Map 14).

Fabrice Renaud and Hannu Pelkonen (1994) have recently studied deforestation in a 10-15 km broad corridor between Omafo and Eenhana south of the Angolan border along the Omafo-Eenhana water pipeline. They found that deforestation in the study area was rather limited in the 1970's and 1980's, since people were reluctant to settle there during the wartime due to safety reasons. After independence forest clearing in the area has accelerated, and it can be assumed, that settlement of people will rapidly increase when the new water pipeline (which at present is under construction) becomes operational.

Monitoring of changes in population density and settlement patterns in the study area should be carried out after the new pipeline has been taken into use.



MAP 14.

Deforestation of dry deciduous forest in Owambo

Source:
Former forest border (solid line): South West Africa 1:250 000 topographical sheet 1716 Eenhana, second edition 1975.

Forests (black areas): Landsat MSS image of 1989. Interpreted at the University of Joensuu

FROM: ERKKILÄ & SIISKONEN, 1992.

Degradation of grazing land

The system of livestock husbandry and pasture management as well as causes for overstocking and overgrazing is described in section 4.8. The problem of overgrazing is clearly visible all over the densely populated western parts of Ohangwena region, especially in the vicinity of livestock watering points (ponds, dams, wells, boreholes and piped supplies). When overgrazing and extensive trampling goes on continuously for long periods without sufficient recovery periods for grass growth, the result will be that less palatable annual grasses replace good quality perennial grasses and toxic and impalatable types of vegetation start to invade the land. The most destructive animals are the goats and the donkeys. A recommended grazing land recovery period should according to the SARDEP project be 130-140 days annually.

Degradation of grazing land is further escalated if grasses are eaten before seeds have set and been dispersed. This leads in the long run to depletion of the seed banks in the soil and further increase of invasive plants instead of grasses

Irreversible degradation of the grazing lands will inevitably follow unless overstocking and overgrazing can be prevented. The main means to achieve this are the following:

1) Effective community control of herd sizes in each area
2) Well managed transhumance and pasture rotation arrangements
3) Promotion of fodder cultivation and planting of fodder trees
4) Clearly defined user rights and responsibilities for community members concerning use of communal grazing lands
5) Well planned siting of livestock watering points
6) Community control of water use for livestock watering

Decline of soil fertility

Numerous studies have indicated a continuous decline of soil fertility on croplands in densely populated areas, with resulting decline of crop yields. The main reason to this problem is the shortening of fallow rotation periods due to increasing land scarcity and increase of soil erosion due to lack of trees and other protective vegetation cover. Traditional methods of fertilising croplands with livestock manure and by periodical shifts of the egumbo compound within the epya land are not anymore sufficient methods to restore soil fertility in the long run.

New methods of restoring soil fertility and protecting the land from soil erosion could be promotion of intercropping with leguminous crops, e.g. beans and groundnuts, and promotion of agroforestry methods using nitrogen-fixing tree species, e.g. Acacia albida, Leucaena leucocephala, Ziziphus mauritania and Casuarina species.

A previously unutilized source of fertiliser is fertile sediment, which is due to soil erosion filling up dams and ponds used for livestock watering. Removal of this silt would increase the water storage capacity of the reservoirs and provide natural fertiliser for cropland and vegetable gardens. High salinity of sediments may however in some cases be an obstacle.

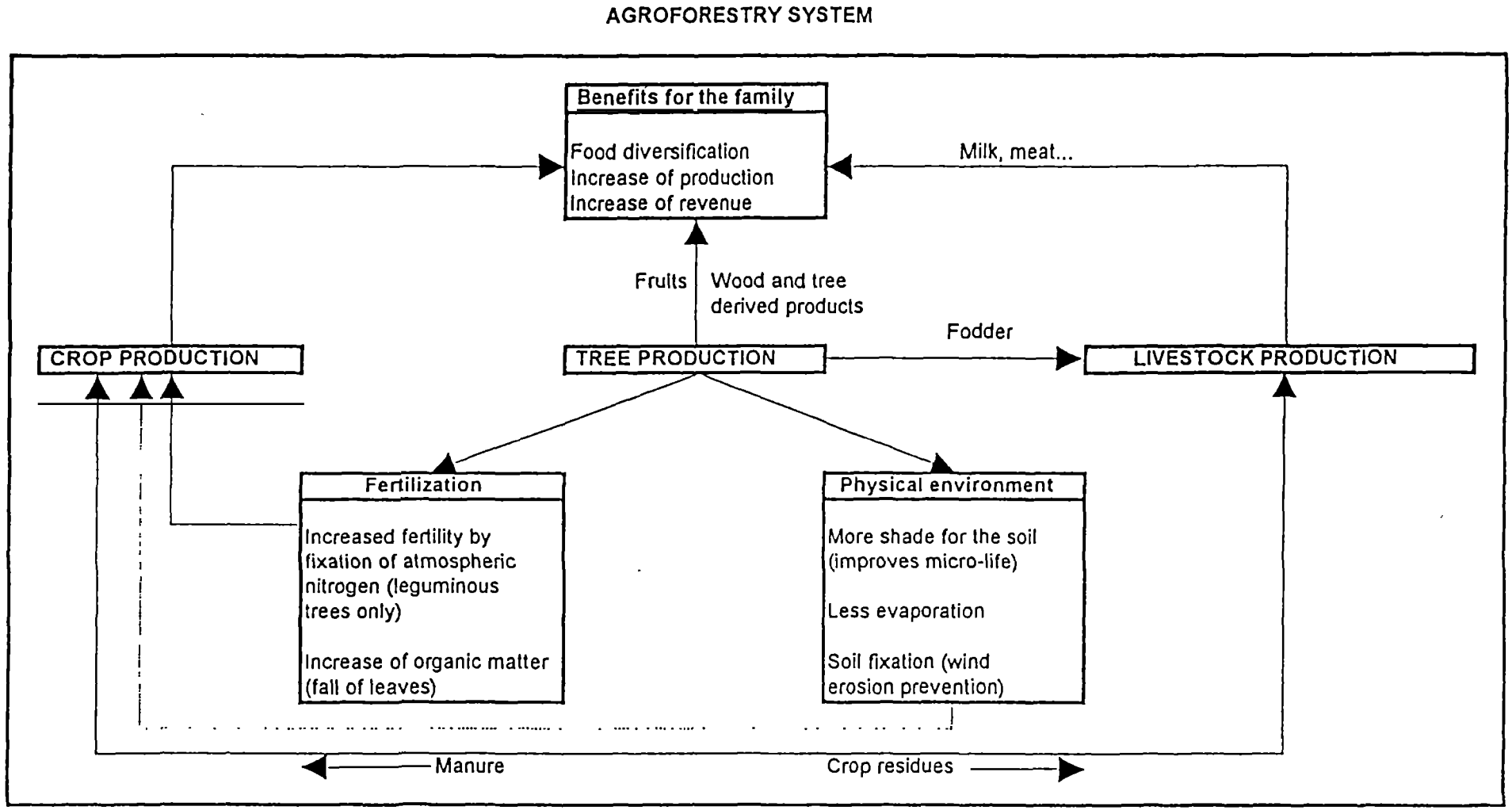


FIGURE 6. SCHEMATIC PRESENTATION OF AGROFORESTRY SYSTEM (RENAUD & PELKONEN, 1994)

Changes of surface flow in oshanas

Recent infrastructure developments in the Cuvelai basin area have to some extent changed the conditions for surface flow in oshanas with detrimental effects on grazing lands and groundwater tables in the southern and southwestern parts of the basin area. Roads and water canals built in the area between Oshakati and Ruacana since the early 1960's have to a considerable degree prevented southward surface flow in the oshanas across these infrastructure developments.

This is the case especially concerning older canals with raised embankments running across the oshana drainage system. Although the new asphalted main road has been provided with numerous bridges and culverts, it has still prevented oshana flows in some areas. The main indication for such effects is that oshanas to the south of these infrastructure lines dry up much earlier than the oshanas on the northern side. Thus the diversion of oshana flow has had adverse effects on the southern side, while people on the northern side may have had some benefit from accumulation of surface water.

The above described infrastructure developments are located outside the WSSPOR project area and do not affect oshana flows within the area. However, new developments in the northern part of the WSSPOR area may affect oshana flows unless flow regimes are carefully considered during planning and design of new developments. This applies particularly to road construction in east-west direction.

Unsustainable use of groundwater

Lowering of groundwater tables due to high pumping rates has become a common problem in many parts of Namibia. Since recharge of groundwater from rainfall and ephemeral floods is very limited due to high evaporation rates, pumping of groundwater will easily lead to lowering of the groundwater table, with resulting adverse effects on vegetation and water supply in the long run.

With the exception of discontinuous perched aquifers, which often dry up during the dry season, problems with sinking groundwater tables due to excessive pumping have not yet been recorded in Ohangwena region. However, this risk should be taken into consideration, especially in connection with the planning of boreholes for deep groundwater extraction in the eastern parts of the region. Monitoring of groundwater levels at boreholes is necessary in order to prevent over-pumping.

Surface water pollution

Floodwater in the oshanas has mostly a rather good hygienic quality, but standing water collected in dams and ponds gets easily polluted from human and animal waste. The main reasons are free access of livestock into the reservoirs and inadequate human sanitation. Domestic animals contaminate the water directly by wading and with droppings and urine, and contamination from human waste is transported during heavy rains with surface flow from nearby places used as open-air toilets.

These problems can be solved by preventing direct livestock access to the reservoirs and by improving sanitation in surrounding homesteads, schools, clinics, cuca-shops etc. All open ponds and reservoirs should be provided with fences and separate livestock watering troughs. This will also improve the possibilities for the communities to control stock watering at reservoirs.

4.10 Household Structure, Economy and Incomes

Traditionally the family structure among Owambo people is based on matrilineal principles, and descent is traced through the maternal side of the family.

Rural households are usually formed by extended families, which provides social and economic support to family members, and serves as a basis for child-rearing. Children are often raised by family members other than their own parents while these are away.

The system of migrant labour was established during the colonial period, and it is still a strong component of life in Owambo. A considerable part of the male population in working age spend part of their life working elsewhere in Namibia on commercial farms, in mines, industries, construction, transport etc. Accordingly the proportion of female-headed households is rather high. The average size of an extended family is 10-11 persons, but average sizes of households are around 7-8 members, since about 20 % of the members are living elsewhere.

Financial transfers from family members working elsewhere in Namibia are important contributions to household incomes. They may constitute as much as 15-20 % of total family incomes. Also pensions are an important source of cash income for many families. Reliable figures for the incomes of rural households are difficult to obtain. Surveys conducted in different parts of Owambo during 1990-93 give average household cash incomes between 900 and 3 000 Namibian Dollars (Rand) per annum. The main sources of household incomes in the western and central parts of the WSSPOR project have been estimated to be the following:

- wage employment
- informal sector work
- remittances from relatives working elsewhere
- pensions
- home production sales (local beer, meat, vegetables, baskets etc)

Most of the farm produce is consumed within the household, and cattle is rarely sold for cash. When livestock is transferred it is often done by barter. For omahangu, the staple food crop, there is no formal market, since most of the produce is consumed at home. With average yields of 300-400 kg/hectare, total omahangu production per family may be in the range of 700-1 000 kg annually.

Calculated return from farm labour is only about 5 ND per day while prospective salaries from off-farm labour may be between 10 and 20 ND per working day.

4.11 Social Conditions and Services

Development of social services (education, health services, water supply etc) was much neglected in Owambo during the colonial period, and the level of services still remains low.

At present there are 135 primary and secondary schools within the WSSPOR project area. The number of registered students is about 58 000, which is about half of the total population in the area. Although most of the school-age children attend school today, very few people have received education beyond standard C, which means 8 years of schooling.

Health problems in the region are often connected with poor sanitation, inadequate water supply and contaminated drinking water as well as malnutrition. The most common debilitating and frequently fatal diseases are malaria, measles, diarrhoea, dysentery, hepatitis, acute respiratory infections, plague, tuberculosis and sexually transmitted diseases, including AIDS. Table 7 presents some statistics of clinical cases in the whole of Owambo in 1989-92.

TABLE 7 Numbers of Clinical Cases of Common And/Or Serious Diseases in Owambo During 1989-92

Year/ Diseases	1989-90	1990-91	1991-92
Malaria	77 798	222 393	167 009
Measles	2 788	926	719
Plague	146	163	1 364
Malnutrition	417	242	14 150
Tuberculosis	-	-	1 500
Hepatitis	149	249	264
HIV	-	66	232
Other sexually transm. diseases	9 727	15 520	7 169

Malnutrition is well above the national average, with over 30 % of pre-school children suffering from moderate to severe malnutrition. Occurrence of water-borne and water-related diseases follow a district seasonal cycle. The incidence of diarrhoea increases with increasing salinity and contamination of water resources towards the end of the dry season, while the number of malaria cases grows in the latter part of the rainy season.

Malaria is at present the most serious health problem in the Cuvelai basin area. The presence of open standing water for long periods of time in oshanas and pans, omifima, wells, canals and dams, coupled with a long warm season, creates an ideal environment for malaria-carrying mosquitoes (Anopheles species). Furthermore, people exacerbate the problem by the indiscriminate disposal of cans, bottles, car tires and plastic containers which become breeding sites for mosquitoes. Control measures to date have largely focused on treatment in hospitals and clinics and on reduction of adult mosquitoes through an extensive homestead DDT spraying campaign that is carried out annually. Recently, authorities have started a comprehensive national malaria control programme and are promoting the use of mosquito nets as one of the methods to further reduce the incidence of malaria.

Careless disposal of bottles and cans along the roadsides and around settlements is also a serious health hazard for people walking barefoot, especially children. Broken glass bottles can be observed in enormous quantities all over Owambo on roadsides and tracks, partly hidden by sand.

The common bad habit of throwing bottles and cans all around the landscape is of course also economically wasteful. This problem should be urgently tackled by organising effective recycling systems for glass and metal cans.

Poor sanitation is a serious environmental health problem in Ohangwena region. The traditional methods of using surrounding croplands and bush as open-air toilets results in contamination of surface waters during the rainy season and an effective distribution of many water and excreta-related diseases, such as amoebiasis, diarrhoea, dysentery, hepatitis, salmonellosis, ascariasis, hookworm etc. Schistosomiasis which is all over Africa a common water-related disease resulting from poor sanitation, is not common in Owambo since most of the surface waters are ephemeral, and the water snail which is a host to the schistosome parasite, does not survive in the oshanas. However, when dams and ponds with permanent water storage are constructed, there is a risk of schistosome contamination unless sanitary conditions are improved.

Promotion of the construction of proper pit latrines and VIP's (Ventilated improved pit latrines) in schools, clinics, cuca-shops and homesteads has been since some years back undertaken by numerous projects and organizations including the WSSPOR project, UNICEF, Ministry of Health, church organisations, NGO's etc., but still it can be observed, that properly built and well maintained latrines are very rare in the rural areas of Ohangwena region.

Health services are presently being improved in Ohangwena region with assistance from Finland, France, UNICEF and various NGO's and church organisations. New hospitals are under construction in Engela and Eenhana and a health center in Odibo is being upgraded. Altogether there are at present 18 clinics in operation within the project area.

Water supply in Ohangwena region is based on following water resources, as presented in sections 4.4. and 4.5.:

1) Imported water from Kunene river in Angola, carried by an extensive system of canals and pipelines into western and central parts of Owambo

2) Utilization of ephemeral surface water flowing into oshanas and pans during floods in the rainy season

3) Collection of rainwater from roofs and ground catchment areas into reservoirs and ponds

4) Utilization of shallow groundwater from either discontinuous perched aquifers (DPA) or the main shallow aquifer (MSA) by means of hand-dug wells and water holes (ndungus and omafima)

5) Utilization of deep groundwater by means of borehole wells

All above mentioned sources and means of water-supply are connected with different problems related to e.g. seasonality, water quantities, water quality and costs of the supply system. Thus a safe and adequate system of water supply in Ohangwena region has to rely on all relevant sources of water.

The Water Master Plan for Owambo, prepared in 1990 by DWA proposes to develop the following means of water supply to meet future needs of the growing population:

* Extension of the existing system of canals and pipelines to feed water from the Caleque Dam in Angola into the interior of Owambo.

* Continued construction of storage dams which could be fed with water from local run-off or from the proposed water supply network.

* Drilling of additional boreholes in the eastern and western farming areas.

* Construction of improved wells and cisterns to serve rural schools and clinics.

The priorities determined by the Master Water Plan were to develop local water sources first, and then to import more water from the Kunene River. This principle still applies today.

5 DESCRIPTION OF THE WATER SUPPLY AND SANITATION PROJECT IN WESTERN OHANGWENA REGION (WSSPOR)

The WSSPOR project is a part of the bilateral development cooperation programme between Finland and Namibia. The project commenced in March 1992 and will continue until the end of 1996. Total project budget is about FIM 39 million, out of which FIM 34 630 000 will be financed by the Government of Finland.

The competent authorities are the National Planning Commission of Namibia (NPC) and the Ministry for Foreign Affairs of Finland/Finnish International Development Agency (FINNIDA). The Namibian implementing agency is the Ministry of Agriculture, Water and Rural Development/Department of Water Affairs (DWA). During 1992 and 1993 the project was implemented by the Directorate of Rural Development within the same ministry. Consultant for development assistance services is Finnconsult Oy from Finland. A Supervisory Board, with members from the competent authorities, is responsible for project supervision at policy level, and a Steering Committee, with members from relevant involved institutions takes care of coordination and supervision at implementation level.

The objectives of the WSSPOR project are according to the final Project Document, approved in December 1993, the following

> "The long term development objective of the project is to support the Namibian Government's efforts to secure a safe and adequate water supply as well as proper sanitation for the rural population of the project area. By achieving this objective the general health situation, standard of living and economic opportunities will be improved
>
> The objectives of the Community Development sub-project are to encourage, organize and train communities to initiate, construct and manage their water supply and sanitation systems by giving technical assistance complemented by material and financial support and by supporting the drilling programme in the area
>
> The objectives of the Construction Capacity sub-project are to develop local contracting capacity for water supply and sanitation construction and to encourage local production and supply of construction materials complemented by local transportation capacity.
>
> The objectives of the Planning and Design sub-project are to prepare development plans for water supply and sanitation for the project area and to establish a water supply and sanitation information system serving the needs of the Government and communities."

The ultimate target group of the project is the rural population of the project area. Specific attention in project implementation is given to women, who are responsible for water, hygiene and health issues in the households.

Additional specific target groups are staff of the Department of Water Affairs, working in Ohangwena Region as well as local contractors and enterprises involved in physical improvement of water supply and sanitation.

Institutional frameworks and project organization is presented in Figures 7 and 8.

THE FRAMEWORK OF THE PROJECT ENVIRONMENT

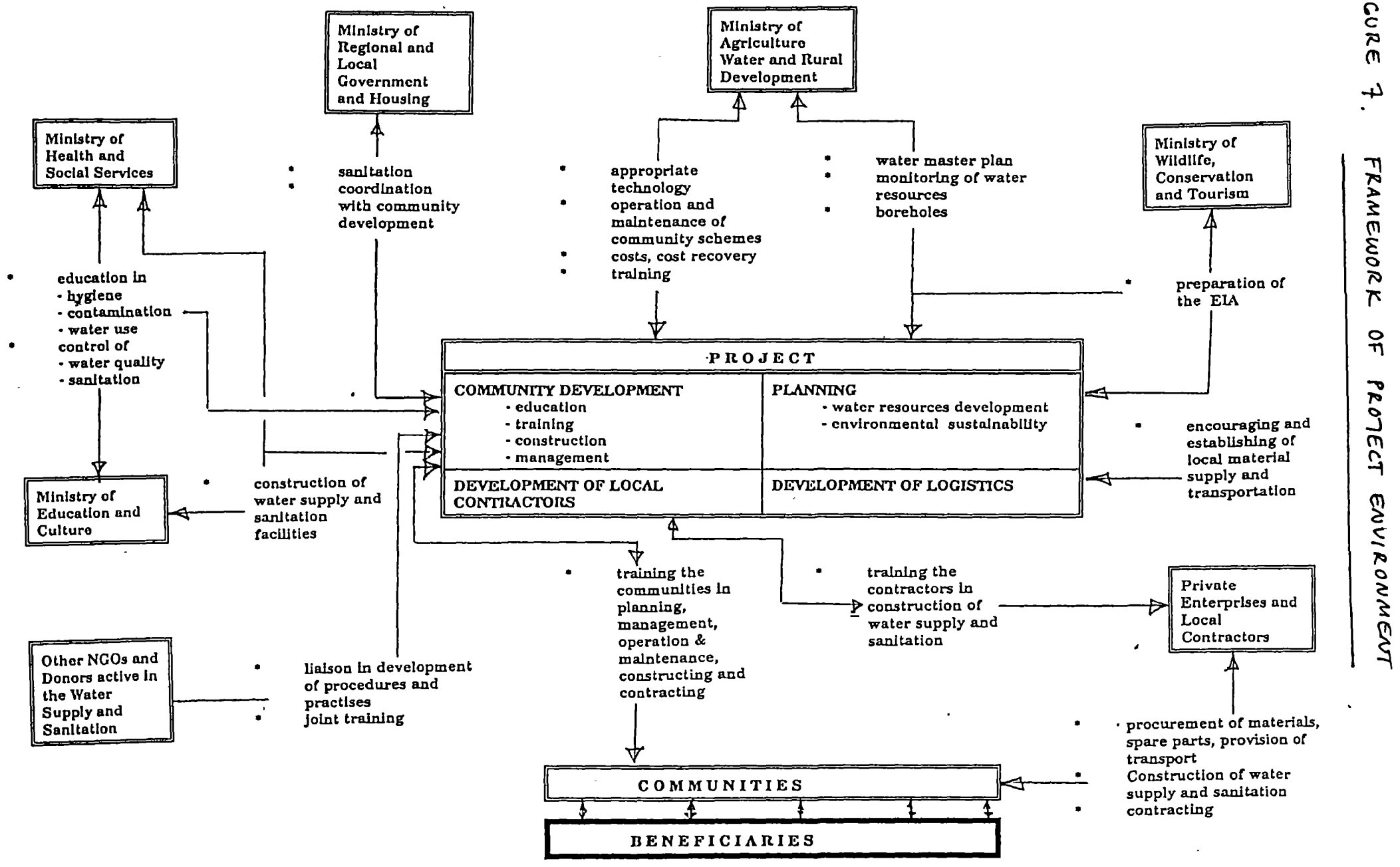
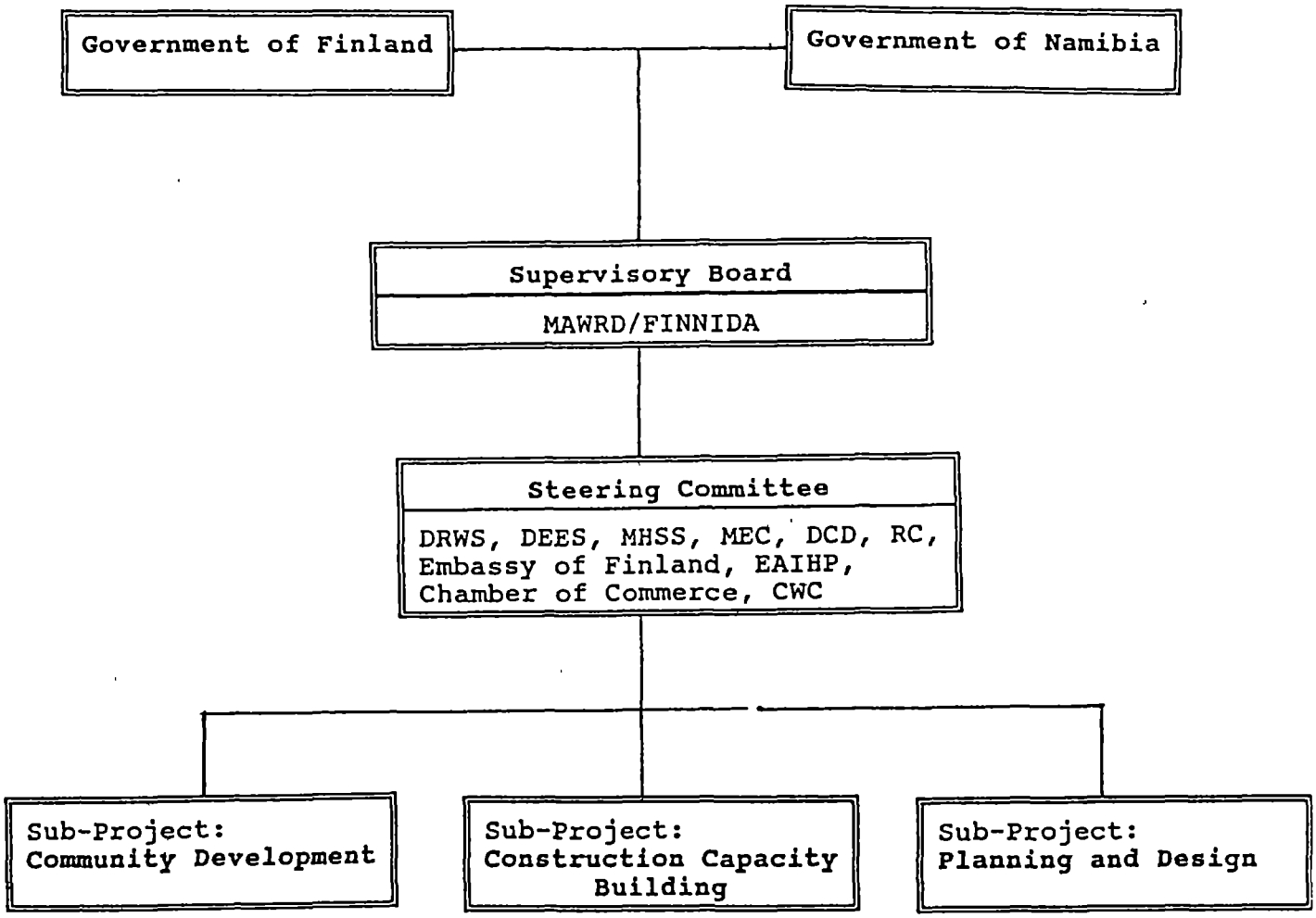


FIGURE 7. FRAMEWORK OF PROJECT ENVIRONMENT

FIGURE 8. PROJECT ORGANOGRAM



6 INSTITUTIONAL FRAMEWORK FOR WATER SUPPLY DEVELOPMENT

Overall responsibility for water supply issues within the state administration belongs to the Ministry of Agriculture, Water and Rural Development, and within the ministry to the Department of Water Affairs (DWA).

At the beginning of 1993 the responsibility for rural water supply was transferred from the Directorate of Rural Development (Department of Agriculture) to the Directorate of Rural Water Supply (DRWS) within the Department of Water Affairs. At present the Directorate of Rural Water Supply is responsible for planning, implementation, operation and maintenance of the rural water supply network.

The organogram of the DRWS has been approved by the Cabinet and Public Service Commission, but due to lack of financial resources the actual start-up of full field operations will require a period of 3-4 years. The new establishment will actually have little influence in Ohangwena Region. Maybe only 2-3 water extension officers will be appointed for the Ohangwena Region in order to facilitate and control the development of community based rural water supplies. There are no further plans for office or other facilities in the region. Therefore the implementation, operation and maintenance of community based rural water supplies will greatly depend on the activity and participation of the communities themselves as well as of the local NGO's and donors.

The Ministry of Regional and Local Government and Housing through the Directorate of Community Development in liaison with Regional Councils and Local Authority Councils and other ministries (MHSS, MEC, MAWRD) support self-help schemes and assist communities in organizing themselves. The Regional Council is responsible for planning of the development of the region with a view to:

* natural and other resources and the economic development potential
* existing and the planned infrastructure such as water, electricity, communication networks and transport system
* sensitivity of the natural environment

The various Development Committees at Regional, Areal (Constituency) and Sub-Areal (area of one headman) levels as well as the Central Water Committee play leading roles in initiating and prioritizing projects.

The Ministry of Health and Social Services (MHSS) in liaison with other ministries play the major role in environmental health planning, development, training and promotion. PHC Services and especially Health Inspectors and Environmental Health Assistants at District level and Community Health Workers and Promoters at local level participate in the implementation of sanitation, hygiene education and control of water quality in cooperation with the WSSPOR project. Close coordination and joint participation in establishment and training of health and water committees is required between the project and PHC Services.

The WSSPOR, MRLGH, MHSS and some local NGO's are actively involved in community development work in the Ohangwena Region. There are plans to establish an **intersectoral development committee network** in the Region. The participation of traditional leaders, church representatives, political party representatives and different women groups should not be neglected when development or implementation plans are discussed or executed in the area.

The informal **Water Supply and Sanitation Technical Support Committee** with members from Government offices and from NGO's, already established for Central-North Namibia, form a discussion, coordination and information exchange forum for all water and sanitation related projects, NGO's and government bodies in Northern Namibia. The committee meets when need arises.

7 ENVIRONMENTAL ISSUES IN WATER SUPPLY AND SANITATION DEVELOPMENT

Adequate water supply is a basic requirement for economic activities and human welfare within all communities. Access to potable water for people and livestock has in Ohangwena region as well as all of Owambo historically been the main limiting factor for growth and spatial distribution of human settlements.

Those areas, which up to present time have remained largely unsettled or only sparsely settled, are the only areas where larger natural forests and woodlands still exist. These woodlands are now important sources of many kinds of natural products and raw materials needed by communities in Owambo. They are also valuable grazing lands utilized within the transhumance system as well as important reserves for biodiversity. Furthermore, their role in the local climatical system is considered to be significant.

Main constraints to human settlement in these eastern parts of Ohangwena region has been lack of perennial surface water resources and major oshanas, and the fact that potable groundwater is located in deep aquifers (deeper than 70 m), which are out of reach when traditional hand-dug well structures are used.

When this deep groundwater is made available by means of modern borehole wells, or when piped water supply networks are extended further eastward, the result will be a rapid influx of farmers from the densely populated Cuvelai basin region. This will considerably accelerate the deforestation process that has taken place in Owambo already for decades.

In order to prevent such an accelerated deforestation process in eastern Ohangwena region, **a comprehensive and integrated land-use plan** should urgently be prepared to guide all future water supply developments in the region.

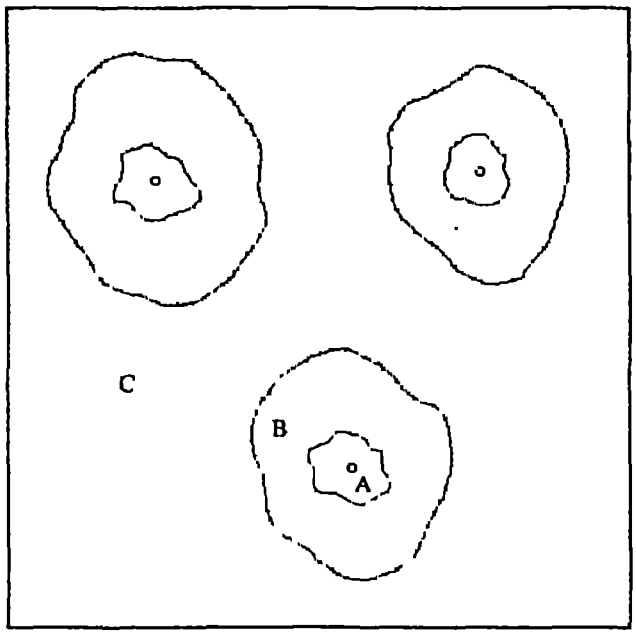
Legal and institutional frameworks for effective land-use planning are still rather weak in Namibia, and it will certainly take time before the complicated political issues associated with land tenure and land use have been fully settled on a national scale. In view of this fact it seems necessary to take initiative on the regional level in order to start the process of developing an institutional framework and professional capability to carry out the tasks included in overall land-use planning.

Since availability of water for livestock has already for along period been a major limiting factor for the growth of herds, it is evident, that the location and amount of water available for livestock is a very important issue concerning the prevention of overgrazing and land degradation.

There are numerous examples from semi-arid environments in Africa, particularly the Sahel region south of the Sahara desert, when extensive expansion of water supplies have in the long run resulted in irreversible degradation of grazing lands and depletion of grass resources, and thus also a collapse of the livestock husbandry system. Such a process is illustrated in Figure 9

FIGURE 9.

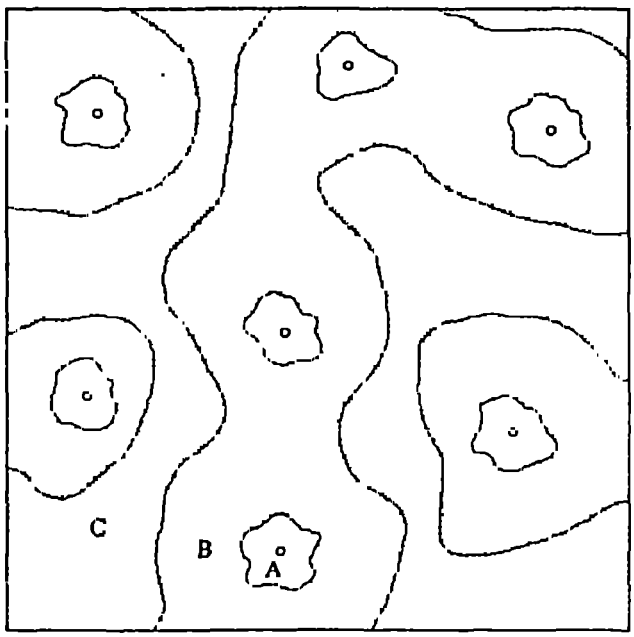
RISKS RELATED TO IMPROVED WATER SUPPLY IN ECOLOGICALLY FRAGILE AREAS WITH EXTENSIVE LIVESTOCK REARING



Situation 1

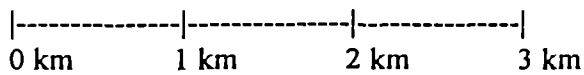
- o Abundant and healthy grass cover between water points
- o Good quality perennial grasses
- o No toxic plants and invading species

- ▫ location of well or water point
- A heavily denuded, mostly bare ground
- B overgrazed and trampled land
- C healthy grass cover



Situation 2

- o Large portion of the area bare ground and heavily overgrazed and trampled
- o Perennial grasses being replaced by low-quality annual grasses
- o Unplatable and toxic species invading the land
- o Accelerating soil degradation and erosion
- o Groundwater table falling and loss of woody vegetation



In order to prevent environmental degradation of vulnerable grazing lands, it is absolutely necessary to carefully study available grass resources and estimate the carrying capacities of each area before the location of water supply points is decided upon. This question should preferably be studied as a part of a land-use planning exercise.

The question of spacing of livestock watering points in vulnerable areas needs to be studied further. A proposal, that was put forward during the WSSPOR Workshop on Environmental Assessment in May 1994, was that in vulnerable grazing lands the distance between livestock watering points should not be less than 15 km. Thus a planning standard for such areas could be that water supply points for human consumption would be provided with about 5 km distances and every third water supply point would include also livestock watering facilities.

The risk of lowering of groundwater tables due to high pumping rates is another issue which has to be carefully considered when plans for borehole drilling are prepared. Reliable data on the groundwater reserves of the deep eastern aquifers are still scarce, and further groundwater investigations are needed before sustainable pumping rates can be established for different locations. Since groundwater recharge from rainfall is very limited due to the high evaporation rate, the risk of over-pumping should always be taken into account, and careful monitoring of groundwater levels should be carried out.

Opportunities for Environmental Enhancement

Improved water supply in Ohangwena region is connected with environmental risks as discussed above, but it can also provide opportunities for environmental enhancement, especially by improving possibilities for afforestation and farm forestry / communal forestry activities as well as for horticulture and vegetable gardening and establishment of demonstration plots in school gardens.

An important issue in this connection is: Will planting of trees and vegetable gardening be competing of the scarce water resources ? Which are the priorities of the farmers when available water is not enough for both activities ?

The issue of establishing small tree nurseries and woodlots adjacent to water points (standpipes, wells, boreholes, ponds etc.) should be introduced as part of the water supply project in cooperation with the Directorate of Forestry. The first opportunities to test the validity of this idea could be when the siting of water standpipes is discussed with the newly established Water Point Committees in the area served by the new Omafo-Eenhana pipeline. Important questions to solve will then be:

* Who will take initiative and make decisions ? The roles of the community/individuals and extension staff.

* Responsibilities in the management of the facility (Water Point Committee, Environmental Rehabilitation Committee, cooperative, private enterprise etc. ?)

* Should nurseries be located on communal or private land ?

Some experience concerning the establishment of horticultural nurseries and woodlots in connection to water points already exists in Owambo, and lessons can be drawn from this experience. Especially the utilization of used washing water for watering tree seedlings and vegetable gardens should be promoted.

Sanitation Upgrading

Improvement of rural sanitation is an activity which strives to enhance human health conditions by reducing the spread of disease vectors in the environment, and by protecting surface water resources from contamination from human wastes. Thus sanitation upgrading can in general be classified as environmental rehabilitation.

The main environmental risks associated with the use of VIP's and conventional pit latrines is the possibility of groundwater contamination when the water table is high. This risk cannot be completely avoided in the conditions of Ohangwena region. Therefore it is recommended, that the sites of the latrines should be carefully selected, and a safety distance of minimum 30 m kept between latrines and wells. Vietnamese-type two-chamber composting latrines could be a viable solution in areas with high groundwater tables.

Latrine floors should always be raised high enough in order to prevent surface water from flooding the pit during heavy rains and oshana floods. A flooded latrine becomes easily a major health hazard.

8 WATER SUPPLY DEVELOPMENT AND LAND-USE PLANNING

The need for overall intersectoral coordination and preparation of a comprehensive and integrated regional land-use plan to guide future water supply developments in Ohangwena region has been emphasized in chapter 7. The main issues to be addressed in land-use planning should include at least the following:

* Overall agro-ecological zoning and land-use classification / identification of recommended land-use types for all different sub-areas.

* Long-term development principles for settlement pattern and structure. Which are main growth areas, and which are suitable areas for new settlements ?

* Identification and spatial delimitation of forest reserves and conservation areas.

* Identification of areas in need of major environmental rehabilitation activities (area closure, afforestation, intensified soil conservation, rangelands improvement etc).

* Reservation of communal grazing land in order to facilitate necessary seasonal livestock movements (transhumance) and to safeguard sustainable rangelands management and sufficient resting periods for pastures.

* Priorities of location and time schedules for social services and infrastructure development.

Although the legal and institutional framework for land-use planning is still rather weak, there are no major institutional constraints for initiating overall land-use planning activities in Ohangwena region as a process to prepare an Interim Regional Land-use Plan. This exercise could be integrated with the preparation of regional environmental profiles, which has been planned to start by the Ministry of Environment and Tourism.

Since land-use planning is an intersectoral activity, it is evident that effective cooperation between different sectoral agencies has to be created. Different governmental and local organizations, that should be involved in the process include:

At national and ministerial levels (including regional offices):

* The National Planning Commission
* The Interministerial Standing Committee on Land-use Planning
* Ministry of Agriculture, Water and Rural Development (MAWRD)
* Ministry of Lands, Resettlement and Rehabilitation (MLRR)
* Ministry of Environment and Tourism (including the Directorate of Forestry)
* Ministry of Local Government and Housing (MLGH)

* Most other sectoral line ministries should provide specialist inputs and advice. These include:

  - Health and Social Services
  - Education
  - Transport and Communications
  - Mines and Energy
  - Industry
  - Justice (legal issues)

At regional and local levels:

* Regional Councils and Governors
* The Councils of Senior Headmen
* Community-level institutions (Development Committees, Water Point Committees, cooperatives etc.)

An important decision to be taken is to decide which ministry should have the responsibility to coordinate the planning work and act as a leading agency. Since MLRR already has a Division for Land-use Planning and is carrying out a pilot land-use planning project in the region of Bushmanland, it seems obvious that MIRR should have a leading role in the planning process.

9 COMPARISON OF ENVIRONMENTAL CONSEQUENCES AND OPPORTUNITIES OF ALTERNATIVE WATER SUPPLY OPTIONS

When alternative solutions for water supply are evaluated, it is important to consider all relevant issues throughout the supply process, from comparison and assessment of available resources to technology options. Important evaluation criteria may include the following:

* Reliability, sustainability and risks
* Costs and users affordability
* Technical feasibility
* Users preferences and cultural acceptability
* Environmental and social effects and consequences (both short- and long-term)

In the case of rural areas in Ohangwena region it is obvious that the most important environmental issue in water supply development is the spatial location and distribution of water supply facilities. Since availability of water supply is a major factor regulating the location and growth of human settlements as well as sizes of livestock herds in different areas, it will have a significant impact on environmental conditions. (See chapter 7).

Important questions to be asked are: Should water supply points be concentrated in certain areas or evenly distributed over large areas ? Which density of water supply points can be recommended in a certain area without risks for long-term environmental sustainability ?

These are important questions especially when comparing environmental effects of piped water supply systems on one hand and improved traditional supply systems on the other hand. The differences of the 2 alternatives are clear in this respect: Piped supply systems will lead towards concentration of settlement patterns while improved traditional systems can allow development of a more dispersed settlement structure.

An attempt to compare different alternatives from environmental and sustainability aspects is presented below in a summarized form.

① RAINWATER AND SURFACE FLOW HARVESTING - DAMS AND PONDS

POSSIBLE PROBLEMS AND RISKS	POSSIBLE MITIGATION METHODS
Problem of drying up during dry season	* Make pond deep enough when possible * Reduce evaporation by planting trees and bushes for windbreak and shade * Provide underground storage tanks to serve at the end of dry season
Problem of water contamination from human and animal waste and sedimentation	* Provide proper protected shallow well for household water adjacent to the pond * Improve sanitation in the area * Keep away livestock from pond by fencing and provide separate cattle trough * Plant grass strips (e.g. Vetiver grass) on pond sides and inflow areas to filter surface flow
Problem of sedimentation of pond	* Same as above (contamination problem) * Remove sediment regularly and use it as soil improvement on farmland
Malaria problem	* Locate residential houses far enough from pond (e.g. 300 - 400 m) * Introduce such fish species which eat mosquito larvae
Risk of livestock overstocking in the area	* Prepare land-use plan to guide location of dams and ponds * Improve livestock management and introduce community control for use of stock watering ponds

Possible additional benefits:

* Pond increases groundwater recharge
* Pond provides possibilities for fish farming
* Sediment can be used for soil improvement on cropland

② SHALLOW HAND DUG WELLS

POSSIBLE PROBLEMS AND RISKS	POSSIBLE MITIGATION METHODS
Small yield and limited amount of water in aquifer	* Spatial dispersion of wells, selection of favourable sites and use of alternative sites
Contamination of well water	* Develop proper design and construct carefully * Prevent children from throwing rubbish in well * Use chemical purification methods * If windlass lifting system, use clean buckets and ropes

Special benefits:

* Cheap and labour intensive, easy to operate
* Gives better opportunities to control livestock numbers

③ DEEP HAND DUG WELLS

Problems and risks as for shallow wells, but more costly and more difficult to construct. Higher risk of collapsing than with a shallow well.

POSSIBLE PROBLEMS AND RISKS	POSSIBLE MITIGATION METHODS
High salinity of aquifers	* Develop low-cost desalination facilities

④ BOREHOLES WITH DEEP HANDPUMP, DIESEL PUMP, WIND ROTOR OR SOLAR PUMP

POSSIBLE PROBLEMS AND RISKS	POSSIBLE MITIGATION METHODS
Salinity of deep groundwater aquifers	* Groundwater investigations and careful site selection * Low-cost desalination methods
Risk of lowering groundwater table	* Groundwater monitoring and control of water use
Risk of overstocking in eastern forest areas	* Improved livestock management and community control of water use for livestock
Technical problems, high cost, complicated technology etc.	* Government subsidy * Proper training of well attendants * Community responsibility, cost sharing etc.

Due to high cost of investment and operation a borehole well will need to serve at least 200 users in order to be cost effective.

⑤ PIPED WATER SUPPLY SYSTEMS

POSSIBLE PROBLEMS AND RISKS	POSSIBLE MITIGATION METHODS
Very high real cost of water	* Subsidy and cost sharing on a national level
Risk of difficulties in raw water supply from Angola (political and technical)	* Long-term international agreements (This risk cannot, however, be completely avoided.)

Adverse environmental impacts of canals in bulk water supply system	* Improved canal design or underground pipelines when crossing oshanas * Fencing and control of livestock watering
Risk for too heavy concentration of water points and human settlements and consequently increasing environmental degradation	* Effective land-use planning necessary to guide location of water supplies * Careful siting of water points * Community control of livestock watering
Tendency of increasing wastage of water	* Water charges should be increased closer to real costs
Contamination caused by sewage and waste water	* Proper waste water treatment plants to be constructed

⑥ RAINWATER CATCHMENT FROM ROOFS INTO RESERVOIRS

* This method is economical and environmentally sound, but it requires modern ironsheet or concrete roofing. Does not apply for thatched roofs.

* A 200 m2 roof may provide up to 80 m3 water annually. Reservoir capacity limits collected amount.

10 REQUIREMENTS FOR ENVIRONMENTAL MONITORING

Following issues should be monitored regularly in areas with major water supply development:

1) Settlement pattern and density, particularly in the area of the new Omafo-Eenhana pipeline.

2) Distribution of main types of natural vegetation as well as vegetation cover, particularly in the Omafo-Eenhana pipeline area. Base data will be available when the National Vegetation Atlas is ready in February-March 1995.

3) Groundwater levels at major boreholes, especially in the eastern parts with deep groundwater.

4) Incidence of water-borne and water-related diseases of the sites of major dams and reservoirs.

11 SUMMARY OF RECOMMENDATIONS

This chapter presents a summary of major recommendations of the EIA Study. Other specific recommendations are presented and discussed throughout the report in different chapters.

- *The overall strategic principle for sustainable water supply development in Ohangwena region should be to spread the risk of water source failure by maintaining sufficient diversity of water supply sources and methods.*

  Total dependency on a single source or method should be avoided.

- *An overall integrated land-use planning exercise should urgently be started in order to facilitate badly needed coordination of sectoral development activities, to provide necessary base data for siting of water supply facilities and to demarcate priority areas for WS investments.*

  LUP should be an integrated multi-sectoral activity. The initial phase of the LUP process could be preparation of a regional environmental profile. Defining of planning areas is important. Should they be administrative regions or other functional units ?

- *Further groundwater investigations should be carried out in the eastern parts of the project area, and a monitoring programme should be started to check groundwater levels and the effect of increased pumping at major borehole wells.*

- *Establishment of tree nurseries, community woodlots and/or horticultural gardens in connection to water points should be promoted. This issue should be discussed with water point committees in the Omafo-Eenhana water pipeline area.*

- *Siting of livestock watering points should be carefully studied in order to match herd sizes with the carrying capacity of grazing land and grass resources.*

  A general standard for distances between livestock watering points in vulnerable areas could be 15 km.

- *A system of community control of livestock watering should be established. This may include earmarking herds for certain water points.*

  This issue should be thoroughly discussed with newly established water point committees in areas with problems of overgrazing.

- *New major surface water ponds and open reservoirs should not be located close to homesteads in order to reduce malaria hazard. A safety distance of 200 - 400 m (depending on topography and wind directions) is recommended.*

  Fish farming in water ponds and dams should be promoted. Experiences gained by the Rural Development Centre (RDC) in fish farming should be studied.

- *Removal of sediment from ponds and dams should be promoted. Removed silt should be used as fertilizer on cropland provided that salinity is not too high.*

  Desalting large ponds could be done as community food-for-work campaigns in the late dry season.

- *Methods of rainwater catchment should be further developed. Water tanks for rainwater collection from ironsheet roofs in semi-urban areas should strongly be promoted. There is a potential for collecting up to 300 000 m^3 of rainwater annually from ironsheet roofs within the project area. Particularly important are hospitals, schools, clinics and other public, communal and commercial buildings.*

- *Possibilities for the construction of covered or underground water tanks in connection with open ponds and reservoirs, to serve for the late dry season when reservoir has dried up, should be investigated. (Ferrocement, ironsheet or plastic tanks, buried large-diameter PVC pipes, etc.)*

- *The possibilities to use small-scale low-cost desalination facilities in order to be able to use saline groundwater for household needs should be investigated. A few testing plants should be constructed in selected locations within the project area.*

ANNEX 1

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TERMS OF REFERENCE[1]

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

1. INTRODUCTION/OBJECTIVE

According to the Second Draft of the Namibia's Environmental Assessment Policy it is to be ensured that "the environmental consequences of development projects and policies are considered, understood and incorporated into the planning process, and that the term ENVIRONMENT is broadly interpreted to include biophysical, social, cultural, historical and political components." Therefore the Consultant is responsible for preparing the required Environmental Impact Assessment.
The objective of the study is to make possible to incorporate the environmental issues into the Water Supply and Sanitation Development Plan and Annual Work Plans of the project.

2. EIA GUIDELINES

The above mentioned Namibia's Environmental Assessment Policy will be the main guideline in preparing the EIA. Also the Guidelines for Environmental Impact Assessment in Development Assistance/ FINNIDA will be used where applicable.

3. BACKGROUND INFORMATION

The Namibia-Finland Water Supply and Sanitation Development Cooperation Project in Ohangwena Region commenced on 1992. The project's main objective is to improve the water supply and sanitation services in the rural area in the Western part of Ohangwena Region and to prepare the Water Supply and Sanitation Development Plan for the project area. The project has been implemented by the Directorate of Rural Development under the Ministry of Agriculture, Water and Rural Development. Development assistance Services have been provided by Finnconsult. The Project Document was revised during 1993 and approved 1.12.1993 and in the new document the Directorate of Rural Water Supply under the Department of Water Affairs took over the implementation responsibility.
During 1992-1993 the project has carried out experimental construction and the basic inventories and studies for the formulation of the water supply and sanitation development plan.
The project area covers 3880 km2 having a population of about 125 000 people. Majority of the rural population is collecting water from open shallow water holes (Ndungu, Omifima). These holes are unprotected and will usually dry up end of the dry season. During the rainy season open holes are filled with rain water having high concentrations of solids and bacteria. The livestock (mainly cattle, goats and donkeys) is watered through dams during the rainy season and end of the dry season most of the cattle is moved to the cattle posts East of Ohangwena Region.
According to the inventories that project area is having about 2 200 ndungus and omifitus and about 300 protected wells. The Herringbone piped water system operated by DWA is providing water to the population in growing points and along the main roads.

Most of the rural population are without proper sanitation facilities. Only 7 % of the rural population is having some kind of sanitation facilities and only 3 % is having VIP latrines of flush toilets.

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The following projects are active in the area:

* Diocesan Water Project:
  Construction of shallow wells with concrete rings equipped with hand pumps.
* Development Brigade Corporation
  Construction of dams equipped with handpumps for human and livestock consumption separately.
* Rural Development Centre
  Construction of shallow wells with concrete rings and equipped with handpumps. Construction of dams for livestock watering. Drilling of shallow boreholes and equipped with hand pump. Selling of VIP latrines.
* UNICEF with WSSPOR
  Construction of roof catchments equipped with ferro-cement water tanks and VIP latrines.
* DWA
  Drilling of boreholes through the Drought Relief Programme. Operation, rehabilitation and construction of rural water piped schemes.
* Food for Work
  Construction of small community dams
* WSSPOR
  Protection of communal shallow wells equipped with bucket lifting system. Drilling of shallow boreholes equipped with hand pump. Construction of VIP latrines for institutions and private.

The studies and reports available have been listed in ANNEX 1.

The Water Supply and Sanitation Development Plan proposal will be ready end of March 1994. The proposal will contain all background information and overall guidelines and technology choice of the proposed construction methods for the project area.

4. SPECIFIC EIA GUIDELINES

Under the supervision of the Water Supply and Sanitation Project and Department of Water Affairs and in cooperation with the Ministry of Wildlife, Conservation and Tourism will prepare the EIA report consisting of the following:

* Executive Summary
* Contents
* Introduction
* Methodology of the EIA including:
  - identification and interviews of interested and affected parties
  - identification and summary of available data basis.
  - possible site visits (expected to take time about 2-3 weeks)
  - analysis of field data and comparison with existing literature
* Assumptions and limitations
* Description of the proposed projects including:
  - need and justification of the project
  - how the project fits into regional development plans
  - contributions of other sectors to the proposed development
  - how the project will enhance or constrain future development options

* Existing Environment
  - conditions in qualitative and quantitative terms of the physical, biological and socio-economic environment before the implementation of the project and prediction of the environmental development if NO PROJECT implementation is carried out.
* Development Alternatives
  - utilization of perched ground water by developing existing water points
  - utilization of deep ground water
  - utilization of surface water through pipelines
  - utilization of surface water through storage dams
  - desalination of groundwater
  - use of alternative construction materials and methods
* Positive and negative impacts including:
  - impact on groundwater table
  - impact of lowered groundwater table
  - impact in land use around water points
  - impact on water related diseases
  - impact on cultural elements
  - impact on water pollution and quality (salt water intrusion)
  - economic impacts
  - impacts during the construction
  - impacts on public service
  - impact on local populations using natural resources
  - short term and long term impacts
  - direct and indirect impacts
  - cumulative impacts
* Possible mitigation
  - describe possible mitigatory measures, to reduce negative impacts and enhance positive impacts
* Monitoring and Evaluation
  - Consider and propose appropriate parameters to be monitored for assessing the actual impacts during the project's operation and beyond
  - Consider the required long term monitoring resources and possible responsible organization(s)
* Environmental guidelines
  - propose guidelines for the forest and oshana areas required in water supply construction
* Recommendations
* Sources of data and information
* Terms of Reference

5. TIME SCHEDULE

The time schedule is presented in ANNEX 2.

ANNEX 2

List of Persons and Organizations Consulted

List of Persons and Organizations consultanted during the EIA Study

Name	Organization	Position
Arto Suominen	WSSPOR	Project Coordinator (1992 - April 1994)
Markku Leppavuori	WSSPOR	Project Coordinator (May 1994-)
Arto Hurtta	WSSPOR	Field Manager
Hilma Kapweya	WSSPOR	Junior Community Development Officer
Kent Libiso	WSSPOR	Business Development Adviser
Helena Martin	WSSPOR	Junior Community Development Officer
Khosrow Rostami	WSSPOR/DWA	Design Engineer
Martin Shikongo	WSSPOR	Assistant Field Coordinator
Lazarus Naudili	WSSPOR	RWS Extension Officer
Arja Vainio-Mattila	WSSPOR	Senior Community Development Adviser
Toivo Shilumbu	WSSPOR	RWS Extension Officer
Anu Eskonheimo	WSSPOR	Short-term Consultant
Pita Nghipandulwa	DWA	Director, Rural Water Supply
Harald Koch	DWA	Chief, Rural Engineering Services
I. Eysselein	DWA	Chief, RWS North
Willy Iyambo	DWA	Chief,
Asteria Shoopala	DWA	Civil Engineer
Matty Hauuanga	DWA	Civil Engineer
I. S. de Wet	DWA/Research	Director of Research Division
Shirley Bethune	DWA, Research Division/Ecol.	Acting Head
Kevin Roberts	DWA,Research Division/Ecology	Researcher
Tshiponga Negumbo	MAWRD, Ongwediva	Deputy Director, Extension
Jim Ingram	MAWRD/RDC Ongwediva	Director
Dominique Mas	MAWRD/French Coorperation Ongwediva	Team Leader
Martin Embundile	MAWRD Ongwediva	Chief Agric. Ext.Officer

Emily Handunge	MAWRD Ongwediva	Chief AEO
Christopher I.Brown	Ministry of Environment and Tourism	Chief of Environment Directorate
Bjorn Finne	MOET/Directorate of Forestry	Development Director
O.Mulita	"	Acting Head
Antti Erkkila	"	Forester
Anneli Shishome	"	Forester
Gunnar Bendelin	"	Forester
Martinus Gelens	"	Research Officer
Andre Koopmans	MOET/National Remote Sensing Center (NRCS)	Coordinator
Harry Tsipueja	Ministry of Lands, Resettlement and Rehabilitation (MLRR)	Deputy Director for Lands
Mr D.J. Sheya	MLRR Ondangwa	Regional Control Officer
Flemming Larsen	Ministry of Health and Social Services/EAIHP	Project Coordinator
Mr Eloby Amundaba	MOHSS	Chief Control Officer
Tom Kroll	SARDEP	Project Coordinator
Gotpen Hamweenye	SARDEP	Extension Officer
Erkki Putkonen	Ogongo Agric. College	Forestry Teacher
Carlor Salinas	"	Lecture
Osman Hamid	"	Lecture
Pirjo Saramaki	"	Project Coordinator
Erik Madsen	OHSIP,Oshakati	Project Coordinator
Mary Seely	Environmental Evaluation Associates of Namibia	Researcher
Wabomba Singoro	VWL Namibia Inc	Civil Engineer

Markku Aho	FINNIDA	Counsellor
Markku Laamanen	FINNIDA	Desk Officer for Namibia
Eero Kontula	FINNIDA	Advisor (Water Supply)
Jukka Uosukainen	FINNIDA	Advisor (Environment)
Juhani Toivonen	FINNIDA Embassy of Finland,Windhoek	Counsellor
Veli Pohjonen	University of Joensuu	Professor

ANNEX 3

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ANNEX 3
1 (10)

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ANNEX 4

Itinerary and Work Programme

ANNEX 5

Photographs