WETLANDS IN DRYLANDS:
THE AGROECOLOGY OF SAVANNA SYSTEMS IN AFRICA

PART 3e:
The role of dambos in agricultural development in Zambia

by Misael Kokwe

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Edited by Ian Scoones, Drylands Programme, IIED, London.
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This review project was supported by the Swedish Agency for Research Cooperation with Developing countries (SAREC) and was coordinated by IIED, London. The review is a collaborative effort, drawing on the wide experience of researchers based in Europe and Africa.

The review is in three parts and is aimed at providing a broad overview of the role of 'valley bottomland' wetlands in savanna agroecosystems in Africa. The role of spatial heterogeneity and farmers' and pastoralists' responses to patchiness is often ignored by researchers, planners and extensionists. The review aims to map out the key issues and suggests a new way of interpreting savanna agroecosystems with important implications for future directions in agricultural and pastoral development in drylands areas.

Part 1 by Ian Scoones: Overview - ecological, economic and social issues.

The overview provides an introduction to the case studies (part 3) and the detailed assessment of biophysical aspects (part 2). It attempts to highlight key issues that run through all analyses of patch use within dryland agroecosystems. Bottomland agriculture and pastoral systems are investigated with a series of case studies. Questions of environmental degradation, land tenure and appropriate economic analysis are also explored. Part 1 concludes with a discussion of the implications for agricultural and pastoral development.

Part 2 by Julie Ingram: Soil and water processes

The review of soil and water processes examines the literature on soil processes by looking at interactions between topland and bottomland in soil formation and movement. Bottomland wetland areas are placed in a landscape context by reviewing catchment level processes. In situ soil and hydrological factors are also examined. Part 2 concludes with an assessment of the potential impact of land use change on patchy wetland areas.

Part 3: Case studies

Part 3a by Are Kolawole: Economics and management of fadama in Nigeria.

Part 3b by Folkert Hottinga, Henk Peters and Sjoerd Zanen: Potentials of bas-fonds in agropastoral development in Sanmatenga, Burkina Faso.

Part 3c by Mohammed Osman El Samanni: Wadis of North Kordofan - present roles and prospects for development.

Part 3d by Zeremariam Fre: Khor Baraka - a key resource in Eastern Sudan and Eritrea.

Part 3e by Misael Kokwe: The role of dambos in agricultural development in Zambia.

Part 3f by Ian Scoones and Ben Cousins: Key resources for agriculture and grazing: the struggle for control over dambo resources in Zimbabwe.

Contributors

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PART 3e: THE ROLE OF DAMBOS IN AGRICULTURAL DEVELOPMENT IN ZAMBIA

Misael Kokwe

Contents

THE ROLE OF DAMBOS IN AGRICULTURAL DEVELOPMENT IN ZAMBIA

1. Introduction

This case study reviews the role of patchy wetlands in agricultural development in Zambia using examples from Luapula and Western Provinces. The main aim of the review is to present a broad understanding of the role that these patchy wetlands play in the livelihood of the users. For Luapula Province, the review is focused on dambos, while for Western Province the Barotse flood plain is also considered.

The case study takes a historical approach, exploring the changes in use patterns over time. Information derived from field work carried out during 1990 is compared with the picture presented by authors describing the system between the 1930s and 1950s. A tradition of detailed description of farming systems existed in Zambia during this period. The studies of Trapnell, for the ecological survey of Zambia, were followed by studies with a more anthropological perspective, carried out under the auspices of the Rhodes-Livingstone Institute (eg Gluckman, Peters, Kay). These earlier works provide a valuable baseline against which to compare the present situation and derive an understanding of the dynamic changes in use of wetland and dryland areas.

After providing a background description of the agro-ecological and socioeconomic characteristics of the two study areas, the review explores the physical features of wetland areas in some more detail. Next, a discussion of access and tenure in wetland areas is included, followed by an examination of population trends and the movements between wetland and upland agricultural sites in the different study sites. Significant contrasts between areas are demonstrated which point to different social, economic and ecological dynamics prevailing. The economic value of wetland areas is also examined with a discussion of the diversity of field sites and range of uses. This leads on to concluding sections on the role of dambos in food security and the potential areas for development intervention in the two study areas.

2. Agro-ecological and socio-economic characteristics

Luapula Province

Luapula is one of the nine provinces of the Republic of Zambia lying in the high rainfall belt of the central African plateau. Its 30,600 square kilometres fall roughly between 8° and 12° 24′ south latitude and 28° 30′ and 30° east longitude. Luapula is bordered on three sides (south, west and north) by the Republic of Zaire and its eastern side by the Northern Province of Zambia.

Physically Luapula is characterised by three distinct features. First, there are two major bodies of water, Lake Bangweulu in the south eastern and Lake Mweru in the north western corner of the Province. The second physical feature is the Luapula river which drains Lake Bangweulu and flows into Lake Mweru through a winding channel which widens into a broad swampy river valley for the last 100 km. A third defining feature of the landscape is the Muchinga escarpment, a steeply sloping ridge running north to south and marking the eastern boundary of the Luapula river valley.

Heavy rainfall (range: 1,000 - 1,200 mm annually) in combination with geological structure, relative relief and drainage patterns has leached the soils producing, mostly, a sandy acid soil type. According to the Provincial Department of Agriculture, "Luapula is characterised by light sandy loam and loamy sand soils". Red brown soils derived from laterites are prevalent in patches in three districts (Mansa, Mwense and Kawambwa) plateau. Humic soils rich in organic matter are found in dambos.

Of the 30,600 square kilometres, the land is classified as follows[1]:

Crop and fallow area	11,600 sq km
Lake and swamps (including dambos)	13,300 sq km
Unused woodlands and hills	2,900 sq km
National Parks	1,400 sq km
Forest estates	1,400 sq km

Lakes, swamps and their associated wetland (seepage) areas (dambos) constitute about 43.5% of the total available land.

Climatically, the year is divided into two distinct periods. The hot-wet season, from October/November to mid April has temperatures ranging between 13° and 32°C. This is immediately followed by a short cold dry season, which ends in mid August and is followed by a short dry hot season. Frost has been reported to occur in the seepage areas (dambos).

Luapula had a total population by 1980 of 420,966[2], 7.4% of Zambia's total population. Population density averaged 8.3 inhabitants per square kilometre. Population is predominantly rural and comprises ethnic groups such as the Aushi, who are essentially bush cultivators, collectors and hunters. Other ethnic groups include the Lunda, Bwile, Shila, Kabende, Ng'umbo, Unga and Chishinga.

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1 Report of the Provincial Agricultural Officer. Luapula Province for the year 1982-83, Mansa (Mimeo nd p2)

2 Central Statistical office, census of population and housing, 1980. Analytical Report volume 1. Administrative report. Lusaka Government Printer 1985

Luapula is served by good tarmac roads linking main centres. However, the rural hinterlands have gravel roads in poor condition. This negatively impacts on provision of goods and services.

Farmers are served by a number of institutions. Primary among these is the Agricultural Extension service, although there is variation in the availability of this service. Farm input and output marketing is handled by the Luapula Cooperative Union which runs a network of primary societies. Agricultural loans are disbursed to farmers through various credit agencies.

Western Province

Western Province (formerly Barotse) is situated between latitudes 13° 45′ and 17° 45 south and longitude 22° and 25° 3′ east, and marks the national borders of Zambia with Angola to the west and Namibia to the south. With a surface area of 126,386 square kilometres, it is one of the largest Provinces of Zambia (approximately 17% of total land area) (Muwamba 1988).

The notable physical features of the Province are the Zambezi river which runs from north to south and its associated broad and extensive flood plains. These plains, with the exception of some spots of higher ground, are usually flooded from January to May-June and exposed as drylands from July to December. Similar flood plains, although on a less extensive scale, are associated with the lower reaches of tributaries of the Zambezi. East of the Zambezi the landscape is characterised by undulating upland plains interspersed with scattered deflation pans (pan dambos) and dissected by lower lying river valleys and associated river valleys (valley dambos).

Although 13 soil mapping units are defined for Western Province, the soils are categorised in three major groups:

a) Soils developed over siltstones, schists, granites and basalts.

b) Soils developed in the flood plains.

c) Soils developed on the Kalahari sands.

Four climatic seasons can be distinguished. From July to September the Province is dominated by high pressure, dry weather and cold nights. October to December is a transitional period of dry and hot weather, temperatures reaching 38°C. The low pressure period is between December and April when most rain falls. The fourth season is from April to June when high pressure again builds up over southern Africa and the dry season with cool nights begins.

The rainy season usually starts in November and ends in March/April, indicating a strong seasonality of rainfall in Western Province. There is a gradient running from north to south. The areas in the north (eg Lukulu district) receive an average of 1020 mm rainfall per annum, while the areas in the south (eg Sesheke district) receive 730 mm. In all areas, the rainfall is variable between years.

Night frost occurs frequently in the south in June/July and only rarely in the north. It has also been observed that night frost occurrence may be observed on the windward sides of dambos in the upland, but less so in the Zambezi flood plain.

On the basis of the 1980 census the projected population for 1990 was 573,400 persons with a male:female ratio of 1:1.2. Approximately 85% of the population lives in the rural areas and relies on traditional farming.

The population is comprised of many ethnic groups. The major group are the Lozi, who live mainly along the flood plain. Other groups include the Mbunda of the Wiko group who migrated from Angola. The Nkoya and Luvale are concentrated more in the east, while a large number of small ethnic groups are found throughout the Province.

Transport and communication are poorly developed due to the unstable nature of the Kalahari sands which render the construction of more permanent roads problematic. During the flood season large areas are inaccessible.

Farmers in the province are served by many institutions. Agricultural Extension services are organised at various levels. The veterinary camps are concentrated in areas of high livestock population. Input distribution and formal marketing of produce is handled by the Western Province Cooperative Union (WPCU).

In discussing the role of patchy wetlands it would be incomplete to discuss dambos only, as the flood plains also have a big role to play in the agro-pastoral systems of Western Province. Therefore the discussion will cover both dambos and flood plain. However, the situation is different for Luapula Province where the dambos are the major patchy wetland resource. Here dambos will be the exclusive focus.

3. Dambo Characteristics

Upland dambos in Luapula

Ferreira (1981) defined a dambo as:

> "an area of land where the water table, either seasonally, or permanently, is located in the upper 20 cm of the soil, often reaching the ground surface itself and occasionally rising up to 1.5 m above the surface during the rainy season."

Four main types of dambos have been identified in Luapula.

Upland Dambo	Located on the main plateau, Mansa, Samfya Mwense, and Kawambwe districts, characterised by swamps.
Valley Dambo	Located in the Luapula valley and the lake Bangweulu basin.
Hanging Dambo	Close to Lake Mweru, Nchelenge district.
Sand dune Dambo	Confined to the shores of Lake Bangweulu Samfya district.

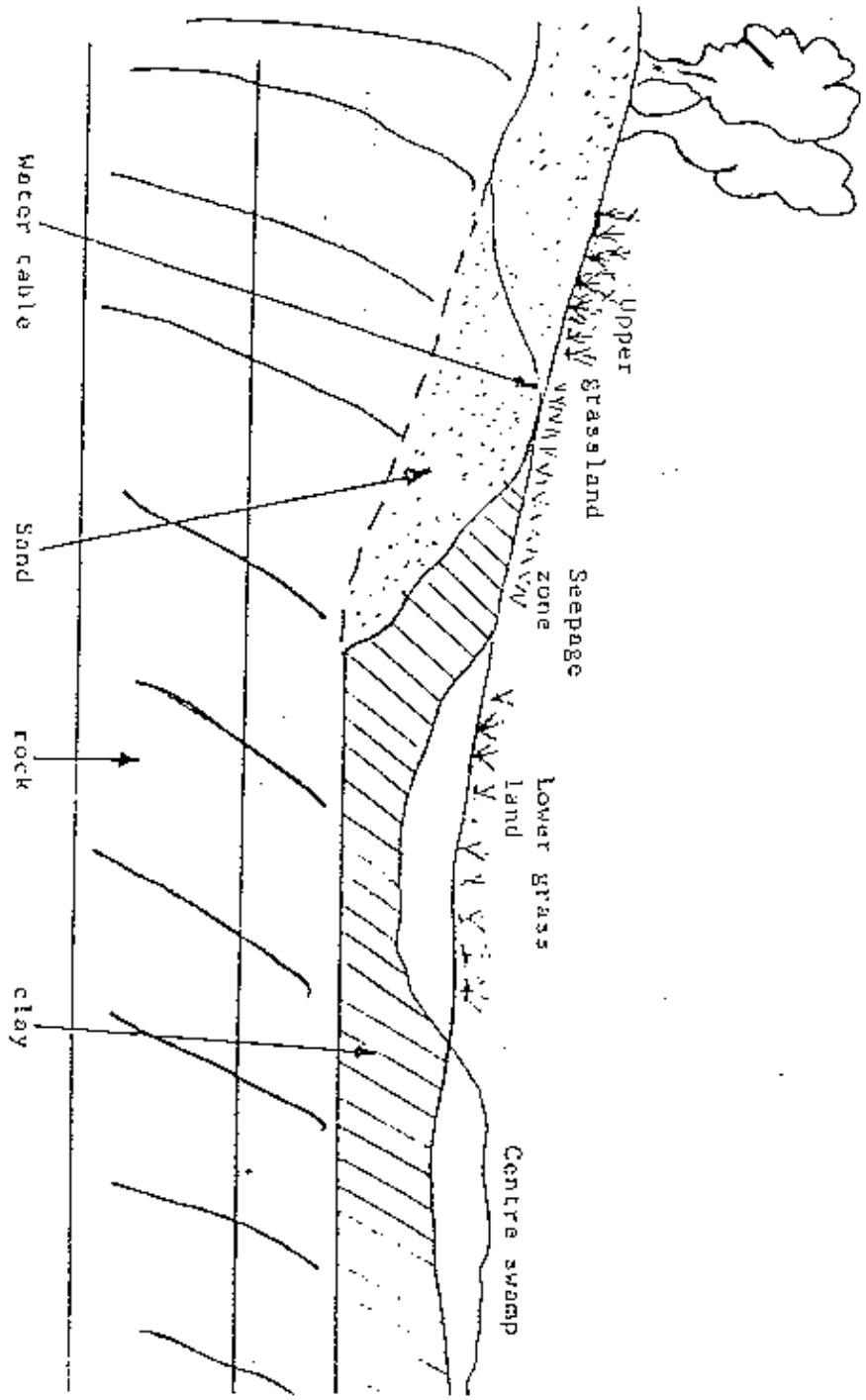
Upland dambos are the most widespread dambos in Luapula. These are the main focus of the case study and the site of most of the work done in wetland agricultural research in the province.

The two main ecological features of the upland dambo are the presence of a seepage zone and the relatively constant water level of the central swamp (see Figure 1). Ferreira (1981), characterised the three main areas of the upland dambo (see Box 1).

Wetland fields in Western Province

A variety of dambo types have been identified and described in Western Province. There seems to be a difficulty in differentiating dambos from some of the field types on the floodplains. Perhaps the difficulty is understandable since both dambos and floodplain fields are dependent on permanent seepage following major river systems. Local names often refer to types of fields with particular characteristics that may be found in either flood plain or dambo areas. Box 2 describes the main dambo types found in Western Province.

Figure 1: Transverse section of an upland dambo (Source: Dougnac, 1987)



Box 1: Upland dambos - Luapula

The upper grassland is relatively dry; its width can vary from only a few metres on a very wet main dambo to as much as three to four hundred metres on a tributary dambo. The soils are sandy or sandy loam, usually with a thin humus layer at the top of the sequence. The underlying sands can be a metre or more in depth extending to the bedrock, which is commonly granite or quartzite. The phosphorus levels are low (2.5-5.5 ppm) and the soils are mildly acid (pH 5.5-6.0) with acceptable levels of calcium, poor nitrogen availability and potassium as a limiting factor.

The seepage zone appears in the field to be a homogeneous unit, but a detailed survey indicates that there are three divisions. Firstly the narrow upper seepage zone which has relatively shallow peat (15-18 cm thick) overlying a coarse sand. Secondly, the main seepage zone where deep peat (a metre or more in depth) overlies loamy sands and thirdly, the lower seepage zone where deep peat overlies heavy clay. The soils are strongly humic with a pH range of 5.3-5.7, low phosphorus (2.5-5.0 ppm) and potassium levels but with acceptable levels of calcium and magnesium. However, there are some seepage zones which are flushed by nutrient rich spring water which increases the pH and improves phosphorus, potassium and nitrogen status. The lower grassland is wet and forms a belt of varying width between the seepage zone and the central swamp. It always has more moisture than the upper grassland throughout the year. The soils are usually friable peats, up to 60 cm depth overlying a varying thickness of coarse sand at the base of the profile.

The centre swamp with tall swamp grassland occupies the central strip of an upland dambo. The swamp has the principle clays of the upland dambos, normally with a narrow layer of dark grey to black humus rich clay at the top of the horizon, below which are thick dark clays grading downwards into pale clay sands that overlie the bedrock. The pH range (5.5-6.0) is only mildly acidic, with the highest phosphorus figures on upland dambos and reasonably good potassium status. The water level ranges from about 25 cm to well over 1 metre depth. Its water level is permanent throughout with slight rise during the rainy season.

Box 2: Wetland types in Western Province

Pan dambos are more or less circular and near water divides. Typically they have a diameter between 0.5-0.6 km; chains of pan dambos may join away from the water divide into a clay bottomed drainage system referred to as valley dambos. Pear shaped heads of smaller drainage systems are called headwater dambos.

Linear dambos are straight depressions with internal drainage in between parallel low sand ridges and occur in Western Province only in the Shekela area (Gils 1988). Seepage valleys often follow tectonic patterns and are referred to as valley dambos (eg Lui river system).

The wet Litongo are found at the edges of river plains in the perennially wet seepage zones. Peters (1960) describes the Litongo as a field made in the sandy soil on the slope between the edge of the bush and the perennially wet seepage zone at the edge of the plain or in the dambo. These sites contain a high proportion of humus, as well as an admixture of peat at the lowest extremity. Gils (1988) described wet Litongo as having a mucky or peaty top over sandy subsoil. The total area of wet Litongo soils in Western Province may be 10,000 hectares. The wet organic soils are laborious to work. The are covered by sods of stoloniferous grasses and sedges which require tough cultivation and burning to eradicate weeds.

4. Access and tenure in patchy wetlands

Residency and land rights in Luapula Province

This section concentrates on access and tenure to land by the Aushi people, who dominate the areas around the upland dambos of Mansa.

The Aushi migrated from the Lunda-Luba empire now part of Zaire (Kay, 1964). Any person with sufficient following could settle a new area and rights of occupation and usufruct were granted to the first settlers. This was reaffirmed during interviews in this area. It was summarised by one of the elders who claimed that:

> "This is a free world [referring to the village] and we operate on the same principle of "One Zambia, One Nation" meaning that anybody is free to come and settle as long as they will abide by our traditional rules, be productive contributors to the area's welfare and unoccupied land is available" (Interview, 1990)

The principles of land tenure are well summarised by Kay (1964) who wrote that:

> "With no apparent shortage of either land or trees and no vested agricultural interests in any parcel of land for an indefinite period, principles of land tenure have not been clearly defined. Such principles as do exist are, in fact, elementary and simple, but they refer to the rights of an individual to live and earn a living in the village rather than to property rights; they are concerned with the use of land rather than with land ownership."

Our interviews also revealed that being a resident in a village confers rights for one to work the land and exploit other natural resources in the surrounding area. No resident is precluded from holding land. Men, women and even children, may have their own dambo gardens. Owing to increased population pressure and a wave of development through agriculture, more land disputes are prevalent at present in contrast to the 1960's when Kay did his study. Consequently, the garden sites tend to be situated in areas further away from the homesteads. This is however less so with dambo gardens which are mostly close-by.

However, even with these changing aspects of population pressure and increased agricultural activity the land tenure principles lie within traditional norms. Most farmers utilising dambos when asked how they acquired the rights to the pieces of land casually responded that since they were residents of the village they were free to choose any unoccupied land around the village. If there is claim to the land, then they would seek clarification and guidance from the chief. It seems therefore that the cultivation of land gives rights over the use of the area cultivated for as long as it is used. The rights are preserved even whilst land is fallowed. However, if the land is left for longer than the customary fallow period (which is shorter now due to population pressure and increased interest in cultivation), it may be regarded as abandoned land.

Since the Aushi migrated to their present environs, villages have become more numerous and smaller. A village often appears as a series of sections, each under an elder who in turn recognises the official village headman. Small units are economically viable and socially acceptable. This is further reaffirmed by Chiluvumbo's (1979) study of rice growing regions of Northern and Luapula (dambos). He found that the household has become the basic social unit of production. Though land tenancy is communal there is a clear absence of collective rights of use. The right of use for any developed plot remains within the household.

Patterns of customary rights in Western Province

Land rights in Western Province are characterised by multi-level control and multi-purpose access (Gils, 1988).

As reported by Gluckman (1943) the paramount chief is "the owner of the land" of Western Province (Barotseland at that time). His subjects, whether Lozi or not, all have rights to as much land for cultivation and for building on as are needed. Once they have been granted land, their rights are protected even against the paramount chief himself.

The administration of land rights are organised from the Litunga (the king or paramount chief) down to Ngambela (the district chiefs), Silalo Indunas (the district councillors) and the elected village headmen. There is no mention of any distinction in the administration of land rights based on whether the land type is upland or wetland. Control and access to land are both inherited and can come either with a given title (eg Induna) or with residence of a certain village. Consequently, as soon as the holder of the land rights leaves the village or looses his title, the control and access to the land of that village are also lost. In such cases the title reverts to the one who originally granted him the land.

Women can only obtain land as rights to production from their fathers but never through divorce. On attaining maturity, a woman is given land by her father and she retains rights to this land even after she leaves the village on marriage and goes to settle at her husband's home. Her husband also has to give her land, but she may work her old gardens if they are sufficiently close and the produce from her own land is hers. If she is divorced or widowed, she may return to her village and claim either her old garden back or other land in lieu of it (Peters, 1960).

Different rights of production such as grazing of cattle, picking fruits or cultivation can be attached to the same parcel of land and subject to rights vested in the different persons at various times. The land cannot be sold or mortgaged; it can be leased but not for a reward (Gils, 1988).

In the past, the paramount chief had the power to move people and it was a common occurrence for him to do so. Such people undoubtedly received new land in exchange for their former holdings, and in fact many such movements appear to have been made with the express objective of settling hitherto uncultivated areas (Gluckman, 1943; Peters, 1960). This power of removal has now been lost and in recent years the people have well protected rights to both cultivated, resting and even abandoned land (Gils, 1988).

Zambia, like most African countries, has a dual law and court system, a relic of the colonial past when different laws were applied to crown land (now state land), reserve and trust land (now reserve), and to white settlers and indigenous people.

Customary law is still applicable in reserve land, but is guided by statutory law. According to the Land Tenure Act (1970) all the land was vested in the President, however, customary law still prevails in matters concerning land rights in reserves. This fact was clearly substantiated by the number of respondents of our interviews (settlers around wetlands) whose emphasis on the customary procedure for land acquisition or land settlement problems far surpassed those who mentioned statutory law procedures.

5. Population trends in the wetlands

Luapula Province: increasing dambo use

Available data on population growth in the Province demonstrates that, since 1969 there has been increase in migratory flows into the area, coupled with increased fertility and gross reproduction rate. Data from this survey of dambo settlements indicate that there have been more people settling around these areas in recent years. More people are utilising the dambos especially for cultivation purposes. Several reasons were put forward by those interviewed to explain the increased influx and usage of dambos in this area. The underlying force is the market economy. Dambos have recently been used for growing high value vegetable crops and green maize. It is the people's belief that as the need to earn cash increases, people who depend on agriculture for cash earnings will exploit this resource to meet their needs. The building of the Mansa-Samfya road has further encouraged settlement and increased marketing opportunities.

The domestic advantages of increased ease of access to drinking water and water for soaking of cassava (the major starch staple of the area) cannot be underestimated according to those interviewed. The economic and nutritional advantages of being able to produce cash and food crops by owning a field on the upland and in the dambo were also strongly alluded to as contributing factors to the influx of people around the dambos. This situation enables the farmer to cultivate the upland field during the rainy season and the dambo provides a second field for cultivation in the dry season. However, the cash returns from dambo cultivation, especially vegetables, seems to be the most popular reason for the increased influx to the dambo areas. The people now even boast of other people (middlemen) from Mansa town travelling all the way to these dambo areas to buy vegetables in bulk for resale at the markets in urban Mansa.

Western Province: Movement from wetland to upland

Data presented by Peters (1960) based on a quantitative traditional land usage survey (1948/49), shows that there were more people living in the flood plain than by the upland pan dambos. The inhabitants of the Zambezi floodplain favour this environment as they are able to cultivate a wide variety of garden types. These gardens, with different hydrology and soil fertility, help to spread the risk in relation to rainfall distribution and flooding. At the same time, they spread agricultural work out during the year, as gardens are cropped at different times.

The number of inhabitants of Western Province was 487,988 according to the last census in 1980, with a projected increase estimated at 573,400 by 1990. The recommendation domains which cover the wetland areas of Western Province have an estimated rural population of 200,000 people (Muwamba 1988). Close to half the rural dwellers live in and around the wetlands.

The settlement pattern in the wetlands of Western Province show two distinct features. The first are the homogeneous and concentrated settlements in the floodplain where the Lozi tribe dominates. The second are the relatively heterogeneous and scattered settlements in the upland dambo areas. There are two types of dambos in this area, distinguished by hydrological characteristics: wet and dry dambos. The settlement is scattered around the dry dambos, but around the wet dambos (matunda) found in the Lui river system the concentration of settlement is higher.

Peters (1960) emphasises the stability of the Lozi settlements who dominate the fertile wetlands, but a pattern of out-migration is observed:

> "All Lozi villages in the plain were originally sited where they are found today. This traditional prominence of the village site distinguishes the Lozi from other tribes of Northern Rhodesia (Zambia). Though the village site is maintained for ages its population is subject to fairly frequent change. The village resources remain limited and as population grows, there must be an exodus of part of the inhabitants, often accompanied or caused by quarrels. Divorce is also a frequent cause of the change in the inhabitants and divorce is easy and frequent. It follows that the economic unit of the 'garden family' can therefore be even more unstable than the household about which it is built."

The crucial trend in the wetlands population dynamics (both flood plain and dambos) observed in recent years is the people tending to move to and utilize the upland areas more than the wetlands for their agricultural activities. This contrasts with observations of relative stability by Peters forty years ago. Several reasons were put forward by people interviewed in the wetlands.

Maize is the preferred staple among the farmers and urban dwellers in Western Province, as is the case in Zambia as a whole. This has meant that farmers gear themselves to securing maize. The yields of maize on the wetlands is very low averaging 400-630 kg/ha, compared to a potential yield of 3320 kg/ha that can be obtained on the upland (ARPT Western Province, 1988). The low yield of maize on wetlands is attributed to a number of reasons by the inhabitants. These range from soil fertility problems to soil acidity, limited arable wetland and water control, depending on the field type. A detailed account of crop production constraints is given in a later section on traditional use of wetlands.

There is increased pressure to earn money to enable farmers to afford things like school fees for their children, school uniforms and essential food ingredients like salt. Farmers are getting engulfed by the national money economy and find it necessary to produce not just for subsistence, but for much needed cash as well. This situation, according to the farmers, is forcing them to look at alternative high value cash crops like tobacco or cotton, which are easier to produce in the uplands than in the wetlands. Even for low value crops, there is more room for extensive cultivation on the upland compared to the wetlands. The wetlands in Western Province cover only 10% of the land, although supporting one third of the population, compared to the upland which cover the remaining 90% of the land. In addition, not all of this wetland is suitable for agricultural activities.

Peters (1960) mentions the migration of male labour from the wetlands in the early part of the 20th century to work in the urban centres where wages being offered were far higher. The consequence of the continued migrations since then have an indirect effect on the movement of people from the wetlands to the uplands. A good number of these migrants already had land rights in the wetlands. The first observation by the farmers interviewed is that these wetland areas abandoned by the migrants are rarely taken over by somebody else and this therefore creates an artificial shortage of land on the wetlands through absentee land ownership. Secondly, on their return from their job in the urban sector, these migrants prefer to settle in the urban periphery of the Province where they can find social amenities or services such as those they enjoyed in the urban areas. They also want to be involved in more commercialised agricultural activities requiring improved marketing and infrastructure. The result is that they tend to settle in the upland areas where these services are more developed. The remaining members of that family may then follow the migrant to share the advantages in the upland settlement.

A complex system of agriculture has been developed in the wetlands; one of the main features of agriculture is the use of waterlogged peat soils, rendered cultivable only by means of extensive drainage works. This is only possible with the cooperation of many people and only an organised system has the means of securing this. According to the local people,

the technologies and practices used in older times are the ones employed today, although the socio-economic and, to some extent, the ecological conditions in these wetlands have changed.

Lack of appropriate technology for the utilization of the wetlands was alluded to as a possible contributor to the movement of wetland inhabitants to the uplands. This situation was mentioned by villagers and agricultural staff on the floodplain. Without the research support for alternative agricultural technologies for wetland areas, farmers have looked to the upland areas where opportunities are greater. Although there have been some donor sponsored rice projects, farmers see a lack of effort on the part of the authorities to improve wetland productivity.

Experiments with rice production occurred in the 1970s. Rice expanded to the upland valleys and dambos, partly because of rice research and extension initiatives in Kataba valley and NE Mongu. However these projects did not address the full range of agricultural problems faced by farmers in the wetlands. A bias towards rice was shown by researchers and field staff (Ndiyoi and Heermskerk, 1989; Chileya et al, 1989).

Ecological change may be a further factor encouraging the movement of cultivators out of the wetlands. Many dambos in Western Province are in the process of drying up. This is deduced from the invading trees at the fringes and from interviews with people living around them.

A range of factors have influenced the movement of people out of the wetlands. A desire to engage in more commercial maize cultivation, a migration to be closer to services and infrastructure, a response to changing environmental circumstances of land pressure and desiccation and a reaction to the lack of technological, research and extension support for agriculture in wetland areas have all combined to affect the current pattern. The relative stability observed by Peters in the late 1940's has been altered.

6. The economic value of wetlands

Dambo use in Luapula Province

Agriculture and gardening

Historically it seems that very little use has been made of dambos for crop production. For instance, Kay's (1964) detailed description of field types of the Aushi people, who settled near the dambos, makes no mention of a field type situated in the dambo.

Rice growing seems to be the earliest crop production venture associated with the dambos. Scalia (1987) reports that rice farming received Government attention for the first time in 1969 when a three year rice development project was initiated in Luapula Province, with European donor support. However, prior to this time, rice was grown by small communities along the Luapula and Chambeshi rivers, on the shores of Lake Tanganyika and on the Bangwelu flats. Rice in the dambos of Luapula (Mansa district in particular) is directly planted on the relatively drier parts of the dambo (ie upper grassland and seepage zones). The land preparation is done around early October or earlier depending on size of area to be cultivated. The grass is burnt and the land is then ploughed, narrowed and levelled with hand hoes. The seed is broadcasted, the weeding is done by hand pulling and fertilizer is broadcast over the area.

In recent years vegetable growing on the fringes of the dambo has begun. The growers grow vegetables using the water in the dambo for watering in the dry season. Also found is the growing of vegetables on the few anthills found along the fringes and sometimes in the inner parts of the dambo, again using water from the dambo. The vegetables grown include tomatoes, irish potatoes, cabbage, rape and beans (Phaseolus sp). Bananas are also increasingly being grown in similar areas. Sugarcane is another crop being grown. Gaining more popularity is the growing of maize during the dry season for harvesting of fresh maize as the rains set in. Fresh maize, according to the growers, fetches a favourable price at the markets during the beginning of the rainy season.

Fishing

The main fishing areas on the upland dambos is the central swamp. The information we collected on the methods and timing of use of each method tallies very well with Kay's accounts from his study of the Aushi (in 1960). Four principle methods are employed for fishing in the dambo.

Weir fishing is a method in which a basket (Umono) and a weir or fence (Ubwamba) is made of mud in the dambo (usually built on the lower side of the dambo slope). The basket is set between the fence and people drive fish into the basket from the upper side. Kay's study (1960) points out that weir fishing was virtually the only method employed by men and it occupied nearly all of their fishing. This observation remains true. The catches are usually small resulting in the "serious" fishermen preferring to use this method in shallow stream and river channels rather than the dambo.

As pools and hollows fill with water around January, conditions favour the use of fish poison (Ububa). The people block an area of shallow water and scatter pounded, soaked poisonous leaves or roots into the water. This poison will kill the fish within two to three hours and the fish are then scooped from the surface in baskets. Although efforts are

being asserted by the village and fisheries authorities to discourage this indiscriminate fishing method, it still is being employed by the people. This method is commonly used by women (Imai 1985).

Line fishing is a method in which a single hook is set on a line. The hook is attached with a bait, usually worms dug from the dambo edges. The people will then wade into the water up to waist deep and dangle their bait. This method is used in the months after January as water levels rise slightly.

Basket fishing is the last common method that was reported to us by those interviewed. A selected stretch of shallow water is either surrounded or a line formed at one end by the people. They then move forward, stirring up the water and mud with their feet and scooping up the baskets which will contain some fish trapped in the close weave of the basket.

The fishing period over which these methods are employed is from August to May. However, some of those interviewed showed concern over the dwindling population of the fish (extrapolated from the small amounts caught) in the dambos and attributed it to over-fishing and the bad methods employed (mainly referring to fish poisoning). The varieties of fish caught include Marcusenius marcroplepidotus (Mintesa), Schilbe mystus (Ulupata), Barbel fish of genus Claria (Milonge).

Fish farming is becoming increasingly popular in the Province, especially in Mansa and Kawambwa districts. Most of these fish farmers tend to dig their fish ponds in the dambo sites where water supply is assured throughout the year.

Livestock production

Livestock play an insignificant role in the life of the Aushi. Cattle keeping, especially, is quite a new phenomenon. Earlier accounts point at sheep as being the domestic animal grazing the dambo. Kay (1964) reported that sheep usually moved as one flock, unattended and they graze at will in the surrounding bush and dambo.

However, with the government's recognition of the importance of animal production as a component of overall agricultural development, several cattle ranches, ox-training centres and dairy farms have been established in the Province. These programmes have taken advantage of the presence of dambos and use them as grazing grounds for the animals, especially during the dry season when the grass on the upland is dry. More people are procuring oxen from the programme for use as draft power and transport. These owners also use the dambos during the dry season to provide grazing pastures for their animals. Burning of grass in the dry season is used as a means of stimulating green growth of the grasses in the dambo to improve the pastures. Ferreira (1981) indicates that on the upland dambo the upper (Loudetia) grasslands provide grazing from May onwards and the lower grasslands can be grazed, usually by July, while towards the end of the dry season the

seepage zone can be lightly grazed. On the terraced upland dambos along Kalungwishi river, though, cattle can progressively graze from dambo margins (by late April) downwards to the actual river banks (by late dry season) as the dambo dries out.

Water supplies

In 1898 Weatherly (quoted by Kay 1964) found the dambos to be vital to dry season water supply; water can be obtained throughout the year from shallow wells in the sands and clays of the major dambos.

Domestic water supply is an important role that the dambos plays in the everyday lives of the inhabitants along them. Wells are dug in the dambos and are commonly used for water collection for domestic use in the households.

Cassava is the main starch staple food of the people in Luapula. The processing of cassava into a flour for use in the preparation of Nshima (a thick porridge) involves the soaking of peeled cassava for fermentation. The fermentation is done to remove poisonous alkaloids present in fresh cassava. This important phase in processing is aided by the use of dambos in which the people dig sizeable holes which fill up with water. These are used for fermenting the fresh cassava. For fermentation of cassava, the water must be standing rather than flowing. Holes in the dambo offer a very convenient facility for this purpose, even for people living further away from the dambos.

Wild products

Wild products provide supplementary food to the people of Luapula. In this respect, dambos also play a role. Available throughout the year are edible roots. The two most important roots found in the dambo, Chikanda and Imbwelenge, are dug from the dambo margin during the dry season. These roots are processed to make delicacies that add variety to the diet of the people.

Dambos also provide material for building purposes. Most of the rural houses are still grass thatched. Some of the grasses that grow in the dambo are used for this purpose. The most long lasting thatched roofs are those having the Ulweo grass which grows in the dambo.

From the preceding discussion on utilization of the dambo, it is evident that dambos play important roles in the livelihood of the people along them. However, when one looks at the expanse of the dambos in the Province and the portions that are utilized, it is evident that there still exists great potential for dambo utilization, as long as the principles and practices of conservation are adhered to.

The use of the Barotse floodplain and dambos in Western Province

In this section I will restrict myself to reviewing the traditional uses of two wetland types found in this area, namely the Barotse[3] floodplain and dambos. The interaction of wetland with upland use is critical in searching for a broad and more holistic knowledge and understanding of the role of wetlands in people's livelihoods.

The two main land units in Western Province are the grass-covered lowlands or wetlands and the wooded uplands or drylands. The uplands are a few to 50 metres above the level of the lowlands, with the lowlands covering approximately 10% of the Province and the uplands 90% (Gils, 1988).

The Barotse floodplain

Peters (1960), based on survey data collected in 1948/49, estimated the total area under production in the Barotse floodplain as being about 29,000 hectares out of a total area of 74,424 hectares. Recent data (1988/89) in the Province indicates that around 40,000 hectares are cropped (Ndiyoi and Heermskerk, 1989).

Agriculture and gardening

Two contrasting environments interact in this area, the extremely infertile dry sands and seasonally flooded valley floors with permanent seepage. This variation has resulted in the development of a distinct land usage pattern in which an exceptionally large variety of field (garden) types has evolved (Peters 1960, Shultz 1974). The more common types are described below (see Figure 2). The order of the description is that of the catena field arrangement beginning with the lowest section.

Sitapa (plural: Litapa)

This field is situated on the fertile alluvial (clay deposits) soils in depressions, old dry river beds, on valley floors and floodplains (Peters 1960, Shultz 1974). The clay and silty loams are fairly high in organic matter and have adequate bases. The seasonal floods form a thin, new sedimentary layer which renews the fertility of the soil (Shultz 1974). The application of animal manure over long periods has also been cited (Ndiyoi & Heermskerk, 1989) as another factor responsible for the fertility of these soils. They have a high moisture holding capacity as a result of a high percentage of humus.

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[3] Barotse floodplain is part of the Zambezi floodplain. It is considered the most productive along the Zambezi floodplain.

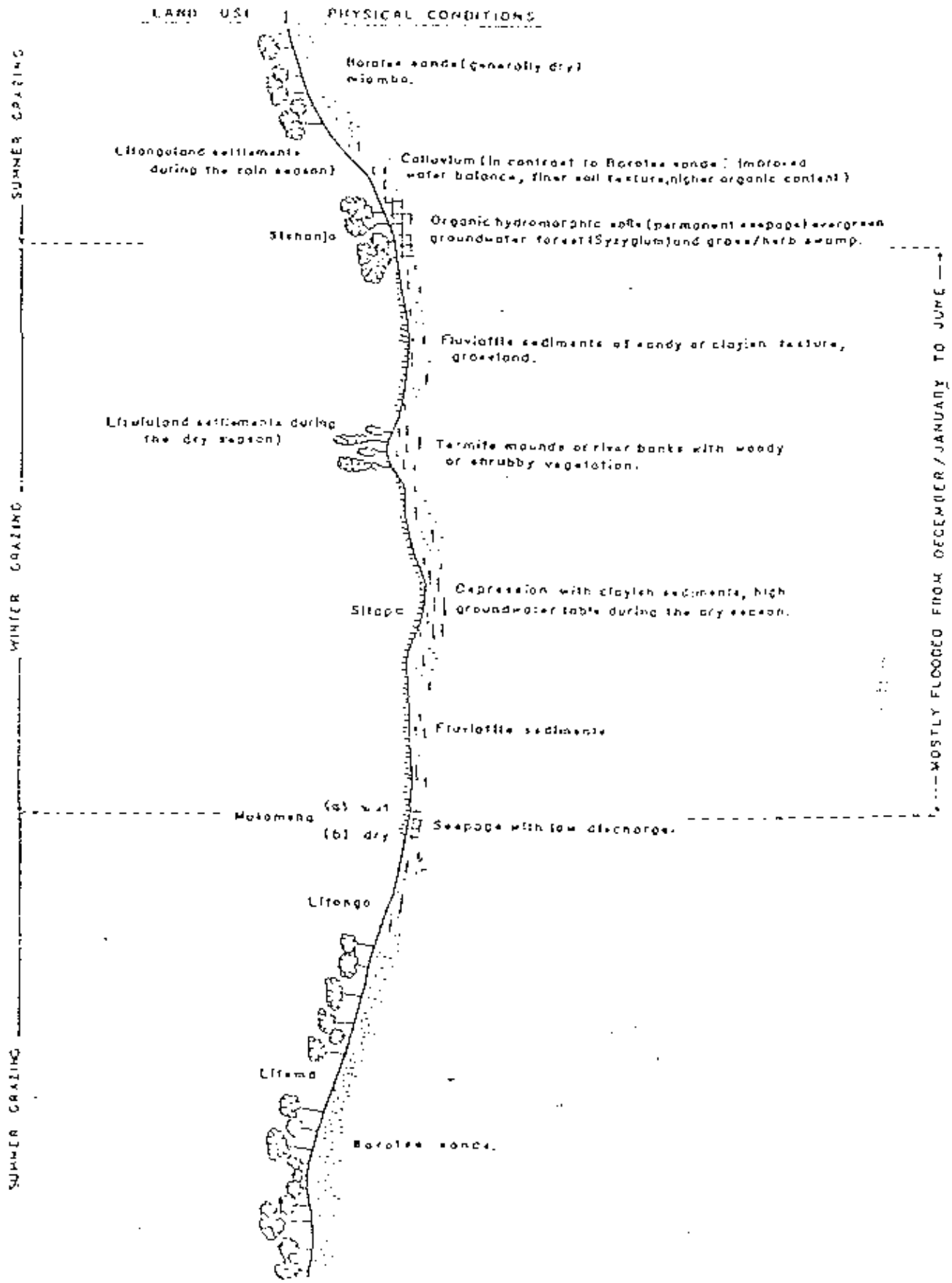

Figure 2: Profile showing distribution of physical conditions and land use in the Barotse system (Compiled by J. Schultz; sources: Trapnell and Clothier, 1957; Gluckman, 1941; Peters, 1960).

Maize is the main crop grown on the Litapa fields (Peters 1960, Shultz 1974, Ndiyoi and Heermskerk 1989). Other crops include sorghum, groundnuts, sweet potatoes and tobacco (Peters 1960). According to more recent information, cucurbits and rice are also found (Ndiyoi and Heermskerk 1989).

The receding flood normally uncovers the Litapa sites in June and they are burnt, ploughed or hoed over and planted in July. The ground water level drops rapidly in the dry season, hence the success of the crop depends on early planting before the top soil dries out too much. It is also dependent on favourable rainfall in the early part of the rainy season to mature the crop before the flood once more covers the field in January or early February. This situation demands that the fields are prepared quickly and consequently the average size of the sitapa field is limited. But certain techniques are employed to increase the area of sitapa under crops. When planting in soil that had dried out at the surface, shallow pits are dug and the seeds, previously germinated in water, are planted in the bottom. Another technique involves planting the lower lying parts of the field first, and sowing them very thickly. Then during August and September the garden is extended on to higher ground. But this ground is not planted until the first rains have fallen, when transplants from the area first planted are used. Both techniques were found by Peters in 1960 and were explained to us during our interviews with farmers in the wetlands. Crop loss is frequent in sitapa cultivation either because the period between successive floods is too short or because the early rains fail. Cropping in the sitapa is therefore relatively productive, but risky under present conditions of crop management and water control. There has been a movement away from sitapa in recent times.

Lizulu (Plural: Mazulu)

Lizulu in Lozi usually refers to a garden made on an anthill of clayish loam soils on the floodplain. On the Barotse plain the Mazulu provide the most prized gardens and the only practicable site for building. Since there are comparatively few areas in relation to the population, they are highly valued.

Mazulu are dome-shaped mounds, typically 20-150 m in diameter. Their surfaces are situated 1.5-3.0 m above the general floodplain which makes them often the site for settlements. The formation of these mounds have been attributed to sedimentation, termites or human construction.

Maize is the main crop grown on the Mazulu and it is normally planted when the rains are well set in (Oct-Nov). Early maturing varieties are used to avoid the effect of the floods. At the centre of the floodplain Mazulu are liable to be partially submerged in February or March when the flood is at its peak. Other crops found on the Mazulu are sorghum and sometimes intercropped maize (Peters 1960, Gils 1988) and millet (Gils 1988).

Mazulu are fertile and are cropped continuously for long periods. The Mazulu have loamy soil with a moderate content of organic matter and a fairly good level of bases. Unless manured by staked cattle, they must be rested for two to three years after a period of three to six years cultivation (Peters 1960). However, Gils (1988) reports that many Mazulu in this floodplain are permanently fallow. This is a result of the risk of early flooding, drought hazard after early seeding and accessibility from settlements at the plain edge, where part of the formerly transhumant floodplain population is settling permanently.

It should also be noted here that land rights play an important and crucial role in the optimal utilization of the Mazulu, as absentee owners do not readily lend out the fields as a result of their strong traditional importance, such as being burial sites of their ancestors.

Sishanjo (Plural: Lishanjo)

Lishanjo fields are made on peats derived from the decomposed remains of plant growth, with Syzygium as the dominant tree species followed, towards the plain, by a grass/herb swamp with a hanging groundwater table. These peats have frequently developed on the edge of the floodplain where there is permanent seepage.

To be able to use the peats for cultivation, drainage is necessary. The fields are made by digging deep and narrow drains roughly parallel to each other, the distance depending on the drainage necessary. Similar drains are dug more or less at right angles so that drains form a rough lattice enclosing small blocks of raised beds (called Mikomena in Lozi). Thus the fields are drained and the water level controlled by a dense, almost rectangular, system of drainage canals. The excess water runs off via culverts which are often long and follow the natural contours. This sophisticated method of utilizing the peat formations is unique in Zambia (Shultz 1974).

The Sishanjo field is prepared for cropping by hoeing to a depth of 2 to 3 inches, and leaving the turf reversed. This is done when the land is not too wet and the layer of turf is burnt when sufficiently dry (Peters 1960).

Maize is the main crop grown, but sweet potatoes are often used as an opening crop on a new or recultivated field. Cucurbits are often underplanted and occasionally small areas are used for finger millet (Eleusine coracana), grown for malting purposes. Recent authors (Gils 1988) and our interviews in the area pointed out that rice, wheat and vegetables were the relatively new crops grown on this field type.

It is estimated that roughly 40-60% of the Sishanjo soils are drained and cultivated in this way at the moment (Hennemman, 1984). However, evidence from our interviews point out that this percentage was much higher in the past (1950s-1960s). The advantages of draining, such as stimulation of plant growth through the promotion of mineralisation of organic matter and increase of air supply to the roots, are offset by numerous disadvantages. Gils (1988) states that this traditional drainage results in rapid and irreversible shrinkage and irregular subsidence of the surface, thus impeding further drainage and leading to oxidation and wind erosion of the organic top soil (see Part 2). Banks of ditched in peat are unstable and have become the starting point of land degradation. Water should be controlled so that the water level does not drop too low, otherwise most of the roots will be above the capillary level and the mineralisation of the organic material will be too fast, which would destroy the natural fertility irreversibly (Shultz 1974). Careless checks (which are rampant) result in weeds growing in the culverts which block the drainage, hampering production. Erosion deepens the culverts and excess drainage occurs.

Other problems related to the Sishanjo fields include low work ability of the soils due to being covered by sods of stoloniferous grasses and sedges. Ox ploughing is difficult in the wet earth. Low pH (3.0-3.8) makes them unsuitable for a number of crops and may result in the release of the toxic trace elements of aluminium and iron. Deficiencies of calcium, magnesium, copper and molybdenum may become apparent after a few years of permanent cultivation (see Part 2).

Ndiyoi and Heermskerk (1989) report that cassava is planted in May-July and harvested after one year. Maize (local variety) is planted in August and harvested in February (during floods). Sweet potatoes are planted in December and March and harvested after three months. All crops except rice are planted on raised beds.

Wet Litongo

Peters (1960) points out that maize was the main crop grown, especially from plantings made from July to December. Cassava, able to yield mature roots in eleven months, was increasingly being grown in areas of heavy population. Kapok, sugarcane, sorghum (often the saccharine type), kidney cotton, cowpeas, cucurbits, pineapples and local tobacco were found, grown in the dry season. Fruits such as oranges and even peaches were found in the vicinity of the town of Mongu, according to Peters. He further contends that the full range of crops cultivable on these fields has by no means yet been fully exploited. Recent authors (Gils 1988, Ndiyoi and Heermskerk 1989), report early planted maize, banana, sugarcane, wheat, rice, vegetables, cassava, sorghum and sweet potatoes as being grown, with the latter two on raised beds.

Most of these sites are cropped almost continuously with no or very little attempt at rotation. Drainage is often unnecessary due to satisfactory ground water levels and absence of flooding risk. It is on the wet Litongo that kitchen gardens are placed. These receive a good deal of refuse and droppings of small domestic animals.

Livestock production

The major livestock in the area is cattle. In 1960 Peters reported that the population of cattle was high and fluctuated about a quarter million head. Since 1964 cattle numbers have increased by an average of 2.5% per year and the population is currently approaching 0.5 million head of cattle (Gils, 1989).

Cattle in the subsistence farming system of Western Province have several functions: to supply manure, draught for ploughing, transport, milk, security, investment, cash income, and meat. It is clear that cattle play an important role in the livelihood of the subsistence farmers in this area. In the past cattle were not sold under the Lozi Kingdom but were a source of prestige, used for settling local disputes or paying dowry (Beerling, 1988). The selling of animals is therefore a new phenomenon which can be attributed to the introduction of the money economy in the area.

The seepage and the floodplain grasslands (wetland areas) are vital for cattle production. There is a transhumant system practised. This involves the seasonal movement of cattle controlled by the flooding of the Bulozi Plain and availability of water in the other parts of the floodplain (Chileya et al 1989). In the Bulozi plain animals graze from June/July until December/January when the plain gets flooded. At the time of floods the animals are moved to the plain edge and forest areas and stay there until the floods recede from the plain. Pastures used in the woodlands during the rainy season are inferior to those on the plains, and cattle lose weight until they return to the plains in the dry season. This weight cycle is the reverse of that which occurs elsewhere in Zambia, where cattle lose weight during the dry season when pastures deteriorate (Shultz 1974).

The Bulozi meander belt is the main grazing resource of Western Province and is quite resilient to overgrazing due to the annual floods, which limit the grazing period. The clay and loamy stream channels (sitapa) and especially the seasonal ponds and lakes (mulopo) produce good forage grasses (eg Echinochloa stagnina and Vossia cuspidata) vital for cattle growth during the non-flooding season. These grasses are perennials which are well adapted to the yearly burning for green regrowth necessary for effective livestock production.

Fishing

Fishing is the third most important economic enterprise of the traditional farmers in Western Province. It is a seasonal activity of the farmers, especially around the Barotse Floodplain. According to Gils (1989), the correct estimate of

fish yield from the floodplain is between 12,000 and 15,000 tons per year depending on the flood regime. This amounts to a substantial supplement of animal protein intake of the population of this area. Other wetland areas of wet dambos and the Zambezi tributaries supply a small, but essential fish protein quantity to the local people. The acidic nature of the dambos has been cited as possible reason for the low output of fish.

Interviews with fishermen revealed that the main fishing gear used are gill nets which are set overnight in standing water and landlocked lagoons. Other traditional methods used are using baskets (makuko) for trapping fish as they swim in the direction of the waterflow. The major fish type is a bream species; some tiger fish and other small species can also be found. The fish caught are for home consumption and supply to local markets for sale.

Water supplies

Wetlands or seepage areas provide drinking water for people living around them. It has been reported that the surface water in dambos and small rivers is frequently bacteriologically contaminated (Gils 1989). However our observation was that the people usually construct hand dug waterholes in the dambos for drinking water supply. Cattle also benefit from these water sources.

The post harvest processing of cassava includes a fermentation phase by soaking in water. The dambos and other seepage areas provide an easy facility for this purpose. Small pits are dug which fill ground water and are used for soaking the cassava.

Dambo use

Literature on the utilisation of dambos in Western Province seems to be limited compared to that of the floodplain wetlands, and therefore our interviews were mostly concentrated on dambos. The utilisation of dambos is very similar to that of the wet Litongo and to a lesser extent that of the Sishanjo. In the pan dambos the main crops which were grown in the past included maize and sweet potatoes. The sweet potatoes are grown on mounds and used as the starter crop for cultivation in these dambos. Maize is grown on the flat from July and harvested in February. Water control through drainage is not necessary as a result of satisfactory groundwater levels. Some of the dambos were reported as drying up. Other crops found include fruit trees such as bananas and on the drier fringes of the pan dambos, citrus, mangoes and guavas are also found. Sorghum is another crop that was found on the fringes of the dambo in the past, but its presence has diminished on these fields of late. Some of the reasons given by those interviewed include lack of a market and the labour intensity (especially bird scaring) compared to maize.

Rice is a relatively new crop. It was introduced in the early 1980s by donor agencies who provided credit facilities and technical assistance on rice production. However, as has been the case in a good number of aid projects, when the agencies pulled out there was a corresponding decrease in the cultivation of this crop. Some farmers are still however growing rice on these pan dambos. It was also pointed out very emphatically that the limited technology available to the farmers on cropping techniques is an important factor that has led to the diminishing utilisation of the pan dambos. Field visits indicated, for instance, that most farmers were still using local varieties of maize (low yielding) and fertilizer use was very limited. Related to this is the poor communication links which impede input (improved seed, fertilizer etc) distribution and acquisition, market for sale of crops, especially sweet potatoes, which are a relatively perishable item. The soils are also difficult to cultivate because of moisture and the grasses and sedges that cover these areas.

Valley dambos are common in the Lui river system. The settlement pattern also follows this river system. The Lui river itself runs from Kaoma district through Mongu district up to its delta on the Zambezi river in Senanga. Hydromorphologically two types of valley dambos can be distinguished in this river system: the dry and wet dambos. Along the dry dambos there are still people living but most use the upland for crop cultivation. It was reported that the people in the past (Nkoya) usually utilized these dambos to grow cassava (Chileya et al 1989). The wet dambos rarely dry up during the year. Crops grown on these dambos are maize, sweet potatoes and rice. Rice is also a relatively new crop, but has become the major crop in this system.

The wet dambo rice fields in the Lui river system are prepared by ox-ploughing. These fields flood during the time when rice is growing and flooding recedes for a few months when rice is about to be harvested. This offers an ideal situation for rice growing, according to the people. It was reported that even if a farmer is late in planting his rice it will do well on these fields because of adequate soil moisture availability extending beyond the growing period.

Limitations reported for rice growing on these fields include the lack of water control. The river sometimes floods destroying the crops in the field. When the soils are too waterlogged ploughing using oxen becomes too difficult.

There were indications of rice growing leading to marginalisation of other crops that were previously grown (eg maize, sweet potatoes). The increased production and importance of rice in this system is attributed to the following factors according to Chileya et al (1989):

- It fetches a very good price at the Cooperative Union (official crop marketing institution in the Province). However more farmers recently are selling locally as this is even more profitable.

- It does not compete with the growing of the staple food of the area, cassava. This is because cassava and rice have different peak periods of labour.

- There is bias towards rice extension services. It was claimed that extension officers in the area visited farmers who are growing rice more than those growing other crops.

7. Dambos and food security in Luapula

The Adaptive Research Planning Team in Luapula Province (ARPT-LP) started working in the Province in 1982. The team's responsibility is to understand the farming systems and devise trials that will help to solve small-scale farmers' constraints to increased food production. The team has an area focus which compliments the commodity and disciplinary focus of the station based research teams. ARPT therefore is multidisciplinary and examines the socio-economic, as well as the technological constraints which prevent farmers from increasing production, whether for subsistence or income generation.

From the start of its work ARPT-LP recognised that improved food production is only meaningful if it ensures the food security status of the farmers' households. A nutritionist was part of the team (until 1985) and contributed greatly in directing the team's agronomic trial programme to focus on technological interventions that will contribute positively to the food security status of the households. A second reason for adding food consumption considerations to the farming systems research programme was that consumption preferences of farm families would lead to quick acceptance of technologies developed.

Diagnostic surveys in two areas in Mansa district (Mabumba) and in Nchelenge district (Mukunta) showed that there is a problem of malnutrition in the areas under study. Analysis indicated that there is a period of six to eight months (July-January) when there is very little to eat in the farmers' households. This "hunger season" coincides with the dry season (Gobezie 1985). The survey results clearly indicated the seasonal dimension of agricultural production and consumption patterns in the area.

This seasonality of production has definite adverse effects on the nutritional well being of the farming households. As a result of this survey it became clear that strategies must be sought for filling the gap between the "hunger season" and the period of adequate food supplies. With the "hunger season" coinciding with the dry season it became apparent that water availability for food production was a fundamental constraint. The dambos with an adequate supply of moisture throughout the year presented the greatest potential for exploitation to alleviate this situation. ARPT-Luapula therefore arrived at

the strategy of extending the food production season through the utilization of residual moisture of dambos. This use of residual moisture was adopted mainly because other approaches would have included irrigation, demanding extra efforts and costs in farming systems that are known to be constrained by labour and income.

A survey was designed to explore the reasons why there is so little utilisation of dambos in the dry season. The results showed that the majority of farmers (65%) interviewed said that it was simply not possible, 15% said it was too difficult, 12% had never tried and 8% gave other reasons like shortage of labour, cash etc (Dougnac 1987). From the results obtained and dambo utilisation observations, it was evident that there was very little, if any, indigenous knowledge to build on for the formulation of agronomic practices for the utilisation of dambos in the dry season for crop production. The experimental work on dambos in Luapula thus started in 1984 with this background.

8. Agronomic research in the Wetlands

Luapula Province

During the initial stage (1984-86) the team looked at various aspects which included the following:

- Different crops' (and varieties') suitability for production in the dambos: cereals (maize, oats, wheat, barley and triticale); vegetables (cabbage, rape, kale, tomatoes, pumpkins, squashes, onion, peas, lentils, amaranthus and carrots); legumes (Phaseolus beans, broad beans, chickpeas and soyabeans); roots and tubers (sweet potatoes and irish potatoes).

- Site selection criteria was also sought using most of the above mentioned crops as test crops along some of the identified transverse sections of the upland dambo.

- Methods of land preparation as they relate to the type of crop.

- Seedbed preparation for the various types of crops, fertilizer application methods, timing, types and amounts for the various crop types.

- Liming and micronutrient effects on various crops.

- Drainage effects.

- Erosion control.

- Windbreak effects, microclimate effects, especially as they relate to temperature regulation.

- Water use, with the aim of establishing whether it is possible to completely rely on residual moisture throughout the stages of crop production on dambos.

- Identification of suitable crops for first year cultivation (virgin dambo land).

- Use of crop residues for soil conservation.

Details of results and discussions on the exploratory experiments can be found in two reports of the ARPT-LP (Dougnac 1986; 1987).

The results of the three year exploratory experimental phase, complimented with suggested ideas by independent scientists, formed the focus of the second experimental phase. This phase aimed at making appropriate modifications and verifications of the successful interventions identified. The exploratory experimental work showed that dambo cultivation is difficult. Dougnac (1987) concludes that traditional crop husbandry methods need revision to be adapted to the very special agro-ecological and climatic environment of the dambo. Soil chemistry aspects and soil and water management are key factors to be attended to, effects of wind and temperature need to be carefully observed, and the source and use of nutrients related to timing of land preparation and method of fertilizer application should be looked at more carefully. The selection of crops and varieties is an important issue to observe, while the importance of soil conservation and erosion control measures must always be kept in mind. If the cropping is well planned, with crops and varieties well selected, the temperature and water fluctuations could probably allow the supply of food, covering the whole "hunger season".

The subsequent experimental phase (1987 and 1988) then narrowed down to specific issues which resulted in the formulation of preliminary agronomic recommendations for dambo cultivation summarised in Box 3.

Box 3: Agronomic recommendations for dambo cultivation, Luapula

Site selection. The best land for crop production is the part of the dambo with a good amount of organic matter. This type of land is commonly found on the main and low seepage zones. The upper and lower grassland zones should be avoided due to the high risks involved in their cultivation, which include the low water holding capacity, low nutrient status and ease of soil erosion. Site selection should be done in-situ because of large variations of soil on very small areas within the recommended zones.

Land preparation. New dambo soils require early land preparation. Digging (ploughing) of land cannot start later than July/August. After digging, all clods are to be piled on very high seedbeds (ridges of 2 metres wide and 80 cm high are recommended). Leave about 1-2 metres between ridges to avoid the sand of the subsoils in the formation of the ridges. Before the rains start (end of October) a mulch of grass or a cover crop of Crotolaria should cover the ridges as well as the paths to protect the new cultivated soil from erosion.

In early March 200 kg per hectare of NP compound fertilizer should be broadcast and incorporated into the soil together with the mulch or green manure crop. This operation will allow a minimum nutritional level in the soil and will speed up the process of organic matter decomposition. This method of land preparation is valid for all types of crops tested.

Seedbed preparation. The seedbed preparation should start one month before planting. The level of the water table will determine the height of the seedbed. The soil should be worked to a fine tilth to ensure good soil-seed contact as well as facilitate capillarity.

Planting time. Most of the leafy vegetable crops show a wide range of suitable planting times (April-May), but the optimum seems to be crop type dependent.

Fertilizer application. Most fertilizer is recommended to be mixed, broadcast and well incorporated into the soil at least two weeks before planting. The amounts vary from crop to crop. If crops present signs of deficiencies after the initial application, dissolving the deficient element in water solution and applying it to the soil may help.

Micro-nutrients and liming. Micro-nutrients found to be very important are copper and boron in cereals to prevent the incidence of sterility. These micro-nutrients must be applied before planting, at the time of planting or soon after planting, dissolved in water and applied. Although beneficial effects have been shown by changes in soil pH and subsequent crop yields where lime has been used, it is economically not possible. Its cost and transportation costs are prohibitive.

Drainage. Drainage can be necessary especially for early planting. Channels should be built in a way that minimises the risks of soil erosion. It is recommended to block the drainage channels during the rainy season and to cover the bottom with a layer of grass. Drainage is also a method of reducing the effect of iron toxicity.

Erosion control. The planting area should be designed across the slopes. Fringes of grassland of 5-6 metres should be left between every two cultivated ridges. The grass between ridges can be controlled (by slashing) but not removed completely to leave bare soil. Crotolaria is recommended as a good cover crop (and green manure crop) to be planted on the cultivated land when fallow in the rainy season.

Windbreak. Many crops are sensitive to cool winds. It is advisable to use windbreaks made of grass or using Crotolaria. This is very important soon after vegetables are transplanted. Though this is not absolutely necessary, improved yields of vegetables have been obtained when windbreaks are used.

Water use. In general, dambo cropping does not require any irrigation. However, one initial watering will be necessary to ensure good germination and supply the newly transplanted seedlings with the initial requirement of moisture. Water can also be used to speed up the dissolving of fertilizer in the soil or as a soil coolant during the hot dry season.

Possible crops for first year cultivation. If the land has been prepared well in advance (August-September) some crops can be planted the following year in May/June. The following crops are recommended as first year crops: Irish potatoes, peas, beans and cucurbits (squashes especially).

Use of crop residue. If grass or crop residues are removed from the planted area (at harvest) they should be piled and reincorporated into the ridges. This is necessary for organic matter maintenance and build up as well as to recycle nutrients as one way of minimising the use of chemical fertilizers on subsequent crops.

In 1989 ARPT-LP started conducting on-farm tests of the packages developed to see the effectiveness of the recommendations under farmer conditions. Reactions from farmers on different aspects of crop production will also be used in the fine-tuning of these packages to make them compatible with the conditions prevailing in the farming systems for which they are intended.

Western Province

Agronomy research in the wetlands of Western Province is at the initial stage. Although research strategies have been drawn up in the past, they have not addressed critical questions, as perceived by the settlers in the wetlands. However the research branch through the Adaptive Research Planning Team in Western Province (ARPT-WP) have now recognised the crucial role that wetlands play in the agricultural systems of Western Province. They have undertaken diagnostic work to further their understanding and identify problems that limit the output from the wetland areas.

In 1989, ARPT-WP drew up a research strategy for the wetlands. Box 4 contains an outline of the general strategy as documented by Ndiyoi and Heermskerk (1989).

Box 4: Constraints to wetland cultivation: Western Province

Soil limitations

Soil acidity is prevalent on the peat soils of sishanjo. This acidity is believed to be caused by the release of organic acids in the process of decomposition of the peat. This type of acidity causes deficiencies. The suggested solution to this problem is to avoid decomposition of the peat by good water management. Liming is seen as being difficult; too much may also cause toxicities. With burning of grass on the Sishanjo, the ashes may help to raise the pH and consequently free the nutrients which would otherwise not be available. The fires would also help to kill weed seeds and rhizomes. Burning of old grass in the flood plains encourages new shoots, provided sufficient moisture is available. Due to excessive wetness of potentially fertile soils on the sishanjo the soils need to be drained if crops are to be grown.

Crop constraints by landscape position

Sitapa — Early maturing varieties of maize are needed which can escape the floods and grow on residual moisture and early rains. Some monitoring is needed on floating sorghum in order to find out how this adapted crop is performing. Development of deep water varieties are needed.

Mazulu — Appropriate maize varieties are needed for this environment to minimise losses incurred at present. Monitoring of hybrids against open pollinated varieties is required. Sorghum varieties need to be compared with the local variety Mankonge. Varieties should be earlier to avoid birds and resistant against Smut and Downy Mildew diseases. Improved sweet potato varieties resistant against the virus complex are needed. Introduction of pigeon peas as a source of fodder after floods in June/July, and green peas to improve diet and fuel after pruning can be tried.

Shishanjo Improvement of the vegetable production on residual moisture in shishanjo and also on raised beds in the rainy season, which means some drainage. Development of crops and varieties which do well in sishanjo which is not fully drained, such as rice, finger millet and taro. Some which can be drained can be developed for early maize; proper varieties are needed.

Crop livestock interactions

Negative interactions include the following:

- Competition of rice and cattle for some fields; this competition is seen in the flood plains. Methods have to be sought to reduce this competition.
- Herders care for cattle with the objective of getting manure on their fields. Time of kraaling is generally too long, especially as this process takes place in the period March-June when grazing is poor.

- Farmers bring animals as early as possible to the saana (part of the wetland cantena on the floodplains) for manuring their sorghum fields. Animals suffer from ticks when they come early.

Possible interventions include the following:

- Effective use of cattle manure should be improved. Quality of manure has to be analysed for appropriate recommendations on additional chemical fertilizer. Loss of manure through leaching and burning should be minimised

- Appropriate implements for animal draft power and improved management of animals (feeding, dipping etc) should all be improved upon.

- During the poor grazing period (February-June) use of crop residues can be improved, eg storing of maize straw on mazulu for when cattle return, increased use of rice straw by cattle.

Socio-economic constraints

Labour organisation is needed to maintain the drainage system of the seepage zone. Shortage of labour leaves no room for intensive crops and practices, hence non-labour intensive technologies should be looked into. Weeding if done by animal-drawn implements would likely shift the workload from women to men. Cattle management by women in general needs special attention. Land tenure related problems are also important. Absentee ownership causes deterioration of canals; sub-optimal use of fertile soils like on mazulu are related to absentee ownership on this type of wetland resource.

9. Conclusion

A number of issues are highlighted by this case study:

Historical change. Patterns of movement between topland and wetland cultivation differ markedly between different areas. In Luapula there is an increasing trend to cultivation of dambo areas, while the opposite is observed in Western Province. Here the availability of services and infrastructure away from the wetland zone attracts people to the urban fringe or to topland cultivation. By contrast, in Luapula the growing market for vegetables and the opportunities for dry season cultivation in dambo areas has resulted in greater concentration on these sites.

Access and tenure. Changes in use patterns result in issues of access and tenure. Increased competition for dambo sites in Luapula may result in future shortages, although this does not appear to be the case at present. In Western Province, the migration out by some households, but the retention of land rights to productive patches, results in the exclusion of those remaining from potentially important agricultural sites.

Food security. In both areas, the wetland areas are critical for food security - both through provision of subsistence food for consumption at key periods of the year and through providing opportunities for cash generation through agriculture. However the opportunities of dry season cultivation have not been fully exploited in Luapula. Agronomic research is beginning to provide guidelines for improving this practice.

Supporting farming practices. The need to provide research and extension support to farmers in wetland areas has been emphasised throughout the review. This has been lacking in Western Province, but in Luapula research has been focused to assist farmers in accommodating to changes in the agro-ecosystem. The ARPT approach combines analysis of farming systems from a multidisciplinary perspective, the identification of key issues and follow-up with detailed experimentation on farmer's field and on-station sites.

Dambos and floodplains continue to play an important role in the livelihood of the people with access to them. The potentials for gainful exploitation of these resources are many and varied. Our main concern however lies in finding alternatives for increased food production for the poor. These patchy wetlands have to be meaningfully exploited if this challenge of increased food production is to be met.

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The main fields of activity are:

- Networking between researchers, local organisations, development agents and policy makers. Networks help exchange ideas, information and techniques for longer term solutions for Africa's arid lands.

- Support to local organisations and researchers to encourage sharing of experience and ideas, capacity building and establishing collaborative links.

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