Dryland Networks Programme

ISSUES PAPER

Wetlands in Drylands: Key Resources for Agricultural and Pastoral Production in Africa

Ian Scoones

IIED
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT

Paper No. 38
December 1992

Dr Ian Scoones is a research associate with the Drylands and Sustainable Agriculture Programmes of the International Institute for Environment and Development (IIED), London. His PhD work examined the economic and ecological linkages in livestock production in the communal areas of Zimbabwe. He is coordinator of the collaborative research project on 'Wetlands in Dryland Africa' supported by SAREC. This paper is a summary of the main report of this project's first phase. A list of collaborators can be found on pages 22-23. An earlier version of this paper appeared in *Ambio* Vol 20 pp 366-371.

Wetlands in Drylands: Key Resources for Agricultural and Pastoral Production in Africa

Ian Scoones

Wetlands in Drylands: Key resources for agricultural and pastoral production in Africa

Ian Scoones

Issues Paper No 38
December 1992

Dr Ian Scoones is a research associate with the Drylands and Sustainable Agriculture programmes of the International Institute for Environment and Development (IIED), London. His PhD work examined the economic and ecological linkages in livestock production in the communal areas of Zimbabwe. He is coordinator of the collaborative research project on 'Wetlands in Dryland Africa' supported by SAREC. This paper is a summary of the main report of this project's first phase. A list of collaborators can be found on pages 21-22. An earlier version of this paper appeared in *Ambio* Vol 20 pp 366-371.

Wetlands in Drylands: Key Resources for Agricultural and Pastoral Production in Africa

Ian Scoones

Valley bottomland wetlands are of major importance in agricultural and pastoral systems in savanna Africa. They act as 'key resources' for cultivators and pastoralists, providing a source of arable land or grazing during droughts or the dry season. As well as sustaining rural livelihoods and increasing food security, wetland patches allow the opportunity for diversification of crop production and the provision of a wide range of direct and indirect benefits. Wetlands are central to resource management strategies that make use of catenal variations and seasonal and interannual changes in resource availability. Such wetland patches are also of major importance in land tenure regimes and resource access conflicts. With increasing resource pressure in Africa's drylands, wetlands are becoming even more valuable components of agroecosystems. Land management policy needs to take account of wetland areas' significance and develop effective economic techniques to assess their value, appropriate technologies for their sustainable use and land use and tenure policies that recognise the importance of wetlands in dryland areas.

INTRODUCTION

This article explores the biophysical, economic and social relationships between wetland areas and dryland toplands in savanna areas of Africa. The paper deals in particular with valley bottomland wetlands; it is not concerned with the large river delta and floodplain wetlands of the savanna zone. Although valley bottomland wetlands are individually small in area, they constitute perhaps five to ten percent of total land area of Africa's savannas (Scoones, 1991; Andriesse, 1986).

The paper demonstrates how such wetlands are of major importance in agricultural and pastoral systems in dryland Africa. The first section provides a brief overview of the major properties of wetland areas and their interactions with dryland components of savanna agroecosystems. The next section examines wetland agriculture, pointing to the importance of wetlands in providing off-season and dry year food. The trend towards diversification of wetland agriculture and the link with marketing opportunities is also explored. Finally the trade-offs between wetland and dryland use are discussed. Livestock use of wetland patches is the subject of the following section. Case studies from Sudan, Nigeria, Tanzania and Zimbabwe show how important wetland areas are for grazing and how serious the consequences of reduced access are. The following section examines the implications for land management policy. Economic valuation techniques for assessing wetland importance and evaluating impacts on wetland outputs are emphasised. Appropriate technologies, notably water harvesting and soil management systems, are also discussed. The vital issue of land tenure and access policy is also explored.

WETLAND PATCHES IN DRYLAND AREAS

This paper is concerned with certain types of wetland; these include the range of valley bottomland areas found in savanna landscapes. These are called by a variety of names: fadamas in northern Nigeria, bas fonds in the Sahel; wadis or khors in the Sudan; dambos in southern Africa. This range of wetland types found in dryland landscapes have a number of features in common (Box 1).

Wetlands are found in a range of forms and positions in the landscape. In general they occur in 'receiving sites' in terms of soil, hydrological and slope processes. Their soils generally represent lower catenary members, whilst in terms of hydrological process they are positioned so as to be respond to upstream water inputs, and to influence patterns of downstream flow (Ingram, 1991).

The spatial and temporal patterning of resource availability influences the patterns of use for both agriculture and livestock production. The following sections examine this in some detail, drawing on case studies from across Africa.

Box 1: What are 'valley bottomland wetlands'?

* Areas that act as drainage pathways or sinks for the surrounding dryland catchments (ie. headwater depressions, inland valleys, drainage basins or sinks).

* Areas with higher levels of soil moisture than the surrounding topland during the dry season and in droughts.

* Depositional areas where organic matter and soil nutrients accumulate, making the soil heavier and richer than the surrounding topland.

* Areas with higher per area grassland or crop productivity per area, although not necessarily higher returns to labour, than topland areas.

* Areas that are generally small in relation to overall available area, but have the potential for extended seasonal use and provide the opportunity for diverse usage.

* Areas that are often key components in sustaining rural livelihoods, both in agricultural and pastoral systems, as complements to topland, dryland use.

UPLAND AND LOWLAND AGRICULTURE

Farming in savanna areas makes use of the variable patterning of resources across slopes. Lowland, wetter areas are often key in understanding interactions in such catenal farming systems. In areas where rainfall is a constraint, the value of wetlands agriculturally is largely due to the fact that they remain wet far into, and sometimes throughout, the dry season. The problem in evaluation of the potential of these areas is the dynamic nature of water availability, since water tables fluctuate over several metres during one year and in differing patterns between years. It depends on the entire watershed, as well as the topographic situation of the wetland, as to whether it will receive sufficient water during the dry season to produce a viable crop (Ingram, 1991).

The use of different areas may change historically. In Burkina Faso an increased intensity of bas fond use has been observed in the past two decades (Hottinga et al, 1988). During the wetter period up to the 1970s and when population densities were relatively low, extensive rainfed cultivation was sufficient for food in both good and bad years. Relative land abundance made shifting cultivation feasible; the bas fonds were generally avoided as sites for cultivation as the effort involved in clearing and weeding was too great. Under these conditions, the bas fonds were left for animal grazing, plus wood, fruit and water collection. However since the 1970s, bas fonds have increasingly been cultivated with maize, sorghum, rice and market garden vegetables. As populations have increased and rainfall declined, cultivators have moved down the catena to exploit the more productive and stable bas fond resource.

This pattern of increased wetland use, coinciding with intensified resource pressure and/or decreased rainfall has been reported from other savanna areas (Kolawole, 1991; Sammani, 1991; Fre, 1991; Kokwe, 1991). However trends are not always in the direction of intensified wetland use. In western Zambia, farmers are increasingly leaving the wetlands in order to farm maize under rainfed conditions (Kokwe, 1991). This relates to a desire to engage in more commercial maize production close to market centres, infrastructure and agricultural support services and a response to changes in land pressure and wetland desiccation. In Zimbabwe, legal restrictions, dating from colonial times, still restrict wetland cultivation (Scoones and Cousins, 1991).

The use of different portions of the landscape varies seasonally; wetland use often holds a particular seasonal niche. In northern Nigeria the harvesting of upland crops takes place in the early dry season. Following this there is a limited period of four to five months when labour is redeployed to work in the low lying fadama farms (Turner, 1984). The use of different parts of the landscape for farming during different seasons acts to even out labour demands across the year; this may be very important in a highly seasonal dryland agricultural system. The pattern of labour activity may have a gender dimension also. In Zambia and Zimbabwe dry season gardening of dambos is an important income earning activity for women (Priestley and Greening, 1954; Dambo Research Unit, 1987).

Farming of wetland patches requires fine-tuned management of water flows, slopes, field surfaces, soil fertility, microenvironments and temporal variation. Within a wetland patch different zones of varying soil water and nutrient levels exist. Dambos in southern Africa can be divided into areas of different agronomic potential (Dambo Research Unit, 1987; Acres, 1985; Mackel, 1974;

Prior, 1983). For instance, in northern and central Zambia, the central swamp area may be suitable for rice, the drier zone appropriate for wheat, the central seepage zone for maize-rice intercropping and the seepage zone margin for vegetables requiring lighter soils (Ferreira, 1976). Similarly in western Zambia, a complex system of different field types (eg. Sitapa, Lizulu, Sishanjo, Nitongo) with different uses and management strategies is observed (Kokwe, 1991).

Field level variation within dambo areas requires a range of micro-level management strategies. Box 2 details a case study from one 2.5 ha dambo farm in dryland southern Zimbabwe; it is similar to many small scale farms across dryland Africa, where a wetland patch is used to complement surrounding dryland areas.

Access to wetland patches offers the opportunity of diversification into crops that cannot be grown in nearby dryland areas. The production of high value market garden vegetables is a feature of wetland farming in many areas (Scoones, 1991; Kolawole, 1991; Sammani, 1991; Kokwe, 1991; Dambo Research Unit, 1987). In Nigeria, fadama lands are the site of extensive market gardening with regional concentrations of different cash crops according to market and transport access (Turner, 1977; 1986). Close to the urban centres of Kano, Zaria and Kaduna, intensive cultivation of vegetables is practised. In areas close to the towns, perishable crops such as lettuce, cabbage and peas can be grown. Further away onions, tomatoes, peppers and okra are grown.

In dryland areas, where topland cropping is very vulnerable to failure, the use of wetland patches to complement dryland farms is vital. Wetland farming increases food security by providing crops when other plots fail and opens up opportunities for cash cropping of vegetables and other products in the off-season.

A complex pattern of trade-offs exist in wetland-dryland farming systems. Understanding the role of wetland patches requires an examination of the interaction between topland and bottomland, between dryland and wetland within the whole farming system. Table 1 examines the comparative returns from dry topland and wet bottomland areas in terms of returns to land and labour from four studies.

Box 2: Dambo field management in Zimbabwe: the case of Z. Phiri Maseko's 2 ha farm, Runde communal area (average annual rainfall 570 mm) (see Figure

Water flow management. Water storage is enhanced in the farm with the constructi of a pond in the upper part of the dambo. This retains water through most of the d season, with slow seepage extending the period of wetness in areas adjacent to t pond. Pond water and a series of dambo wells opens up possibilities of small sc irrigation through canals to drier areas of the farm.

Slope and field surface management. Natural changes in soil moisture and nutri availability across the farm's slope are further manipulated by the construction of ear bunds and soil pits. Soil bunds along the contour increase the conservation of water soil, while field ridges may act to divert surface flow or decrease waterlogging effe in wetter areas.

Soil management. In the central dambo area, heavier soil with high nutrient and orga matter content exist. These soils retain water and provide the best sites for dry sea and drought cropping. High density maize stands are planted; these may provid double crop in good seasons. Limited fertility inputs are required in these areas. areas further away from the central dambo, the drier, sandier soils have a lo nutrient content. These are suited to groundnut, sorghum and millet planting. Additio of manure, termite soil and inorganic fertiliser are concentrated here.

Space management. During the cropping season of 1988-89, 23 different crop speci 26 different tree species plus bees fish reeds and grass fodder were harvested from t Mr Phiri's 2.5 ha plot. The identification and creation of spatial niches to maint diversity is an important part of his strategy. Complex intercropping and relay cropp systems are employed that exploit the environmental heterogeneity of the area.

Temporal variation. Micro-management varies seasonally; the complex patterning crops, trees and grasses is a result of a set of sequential management decisions t emerge through the season. The observed pattern is a result of a complex agricultu 'performance' played out by different actors - men, women and children (18). T dambo area is used differently between seasons. In drier years, there is less sequent cropping, less rice and less maize planted. In wetter years, multiple cropping of greater diversity of annual crops is possible, although waterlogging may occur in so parts of the farm.

Figure 1: Dambo farm in southern Zimbabwe (2.5 ha)

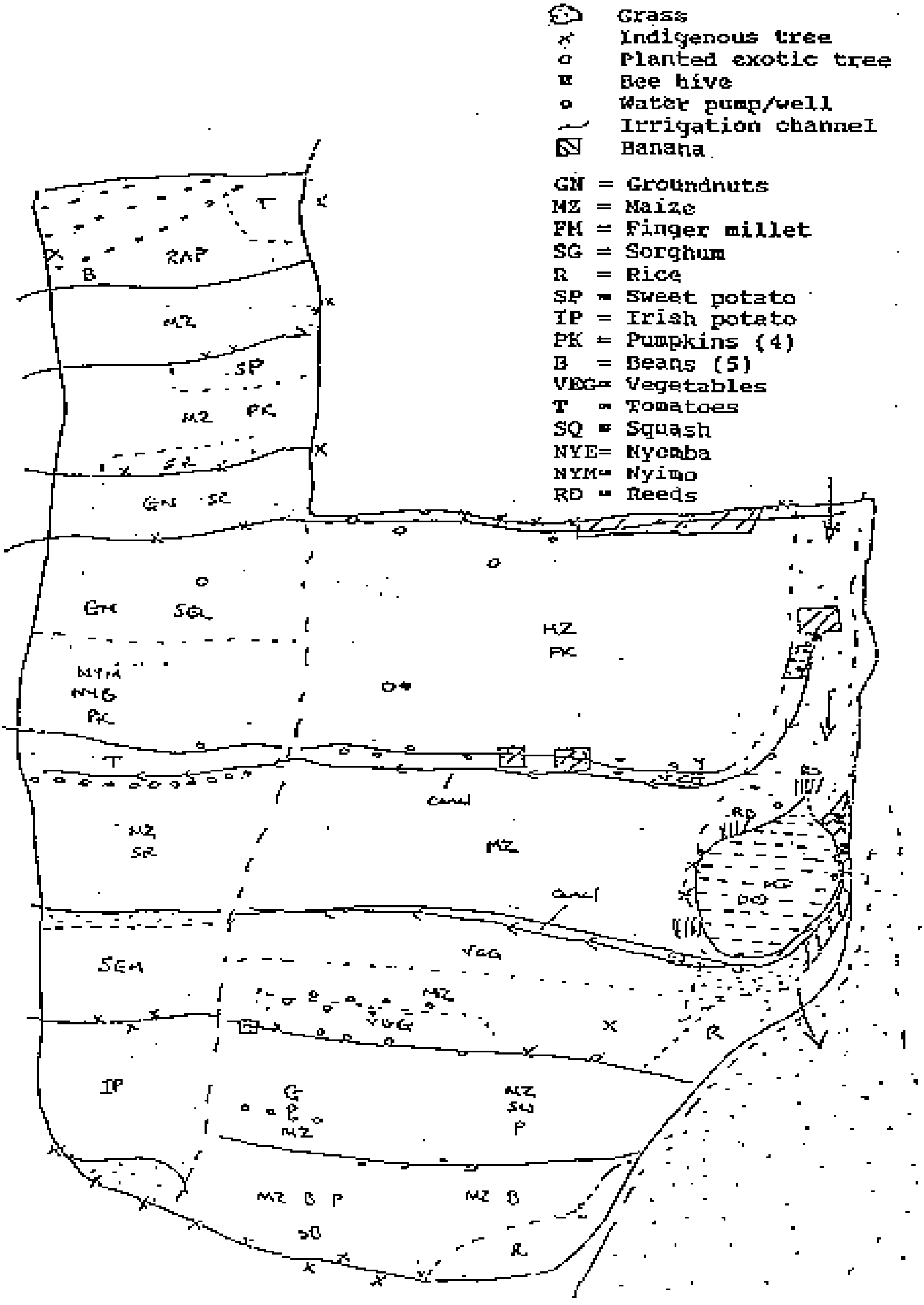

Table 1: Comparative returns from dry topland and wetter bottomland in four African case studies

Study	Average production/ha in wet compared to dry	Labour input in wet compared to dry
Zaria, Nigeria (Norman, Simmons, Hays, 1992)	3.2	1.7
N. Darfur, Sudan (Martin, 1985)	1.75-3.75	1.5
Yatenga, Burkina Faso (Dugue, 1989)	2	2
Chiota, Zimbabwe (Dambo Research Unit, 1987)	2-3	2-13

The Nigeria study compared the cash value from dryland cropping and fadama cropping (including high value vegetables and sugar cane) over several seasons in the late 1960s. The Sudan study contrasted the potential yield returns from millet and sorghum cropping on dryland (goz) and wadi land; however the data do not take account of the potentially high returns from vegetable gardening in wadi areas and so underestimate the comparative advantage of wetland agriculture. The Burkina Faso study compares potential millet yields in topland sandy soil sites and bas fond areas. The Zimbabwe study estimates the cash returns from the different areas, with maize the major crop on the topland and maize and vegetables important in the dambo.

In all studies, the labour invested per unit area in farming the bottomland areas is higher than that invested in topland sites. Heavy soils, high weed growth and the labour requirements of water control are all contributing factors. Examination of returns to labour show that wetland cultivation is less advantageous than returns to land. However labour scarcity may be offset by seasonal shifts in labour allocation, with the most intensive wetland cultivation occuring in the dry season and through divisions of labour within the farm household. In areas where land is scarce, or at least where the availability of wetland patches is limiting, high labour investment in wetland cultivation pays off due to the high returns to land.

Choices between investment in topland or bottomland areas is thus dependent on a variety of factors. This includes potential yield productivity and its variation between years, the market value and potential of different products, the seasonal variation in labour requirements in different areas, the availability of family and hired labour and the gender division of tasks and the risk perceptions of farmers. However, over time, in the context of the environmental variation found in dryland Africa, access to both dryland areas and wetland patches will be central to the survival of farm households.

WETLANDS AND LIVESTOCK MANAGEMENT

The survival of livestock in semi-arid environments is highly reliant on adaptive movement in response to the spatial and temporal variability of the resource base. The role of wetland patches in livestock management strategies is often vital, as these areas produce high grass biomass which is available at strategic times. Movements may take the form of long distance migrations in search of fodder (Breman and de Wit, 1983) or more local scale movements to key resource patches within the landscape (Scoones, 1989). Flexible movement responses to wetland patches help to offset the seasonal and interannual variability of fodder quantity and quality.

Case material from across dryland pastoral Africa demonstrates the importance of wetland patch grazing in livestock systems. The grazing of Khor Baraka in eastern Sudan and Eritrea is a vital component in the migratory livestock management strategy of the Beja pastoralists of the Red Sea Hills. Continued dry season access to the khor grazing means that the pastoral option is retained for the Beja, despite decreased grazing productivity in the surrounding hills due to prolonged drought (Fre, 1991).

By contrast, the pastoral system in northern Sudan is being undermined through changing patterns of resource use. The wadi areas of northern Kordofan used to be at the centre of pastoral livestock movements of the Kababish. Today, the traditional grazing patterns no longer operate and the wadi areas have become sites of pastoral settlement where livestock are grazed year round. Intensive use of the wadi grazing lands, and competition with agriculturalists, has resulted in environmental damage to the wadi grazing. This undermines the long term sustainability of the pastoral system (Sammani, 1991).

The fadama of northern Nigeria are important grazing resources for Fulani pastoralists. However access to fadama grazing land is being increasingly restricted as agriculture expands in the fadama areas. This has been fuelled by government and donor sponsored 'development' programmes that have encouraged wheat production and the use of pumps to irrigate fadama land (Kolawole, 1991). Agricultural entrepreneurs have expanded areas under cultivation, reducing dry season grazing access dramatically. These conflicts over wetland resource access have resulted on occasions in bloodshed (Cline-Cole, 1988).

In other cases key grazing resources are removed through the imposition of state run and donor supported agricultural schemes. This may threaten the sustainability of the livestock production system. In Hanang district, Tanzania, a major commercial wheat farming project has removed the essential bottomland grazing areas (muhajega) from the Barabaig pastoralists; the 'traditional' users of the land. This has disrupted their complex grazing rotation, resulting in major losses in livestock productivity. The impacts have been far reaching, including the loss of direct economic benefits to the pastoral population, indirect costs of environmental damage resulting from changed patterns of land use, and other costs including the destruction of important Barabaig burial sites by the expansion of the wheat farms (Lane, 1990).

A detailed understanding of the patterns of use by livestock is an essential prerequisite for the planning of any livestock intervention, or any agricultural project that potentially impacts on livestock use. The identification of 'key resource' areas is an important stage in this assessment; in many cases these are wetland patches that provide fodder at key periods and so sustain livestock production in the area. In Zimbabwe a number of studies have explored the use of the grazing landscape by cattle (Scoones and Cousins, 1991; Scoones, 1989). Table 2 shows the results of one study from Mutakwa area in Zimuto communal area which investigated patterns of livestock use through a cattle following study (Scoones and Cousins, 1991).

The data shows how the dambo and drainage line habitat patch is preferentially used by cattle during all seasons, especially the late dry season. This is because of the relatively high grass availability at this site, compared to what is available in the topland areas during the dry season. Despite the relatively small overall area (c. 10% during the dry season), the dambo is clearly a key grazing resource. Local management strategies recognise this, and a system of regulated use and reserved grazing of the dambo is practised by the local community; regulated and enforced by the 'traditional' leaders in the area. The advent of a paddocked grazing scheme in Mutakwa, the result of external donor financing and government land-use planning directives, has disrupted the grazing management centred on dambo use and political conflicts over approaches to grazing management have split the community (Scoones and Cousins, 1991).

Table 2a: Seasonal habitat patch use by cattle in Mutakwa, 1989
(expressed as a percentage of total feeding time)

Habitat patch	Cropping season	Early dry season	Late dry season
Fields	0	27.2	5.0
Reverted arable	28.8	12.1	3.0
Contours	0	18.8	4.4
Home sites	10.2	10.0	17.5
Toplands	17.5	12.3	18.0
Dambos and drainage lines	39.1	19.6	39.3
Riverine	4.4	0	12.8

Table 2b: Foraging preference index (FPI), Mutakwa 1989
(where FPI = % feeding time in habitat patch x / % of available area as habitat patch x in that season)

Habitat patch	Cropping season	Early dry season	Late dry season
Fields	-	0.97	0.18
Reverted arable	0.99	0.63	0.16
Contours	-	9.89	2.3
Home sites	1.76	1.30	2.27
Toplands	0.37	0.40	0.58
Dambos and drainage lines	2.41	1.83	3.67
Riverine	2.0	0	8.53

Developing grazing management schemes requires a detailed understanding of the rationale behind existing local resource management strategies. The cases from Sudan, Nigeria, Tanzania and Zimbabwe show that these are often based on seasonal key resource use of wetland patches. Recognising the central importance of wetland patches in pastoral management is thus vital for effective development planning.

IMPLICATIONS FOR LAND MANAGEMENT POLICIES

Recognising the importance of wetland patches within dryland agroecosystems has various implications for land management policy formulation. This section will consider economic valuation approaches for use in land-use, project planning and investment decisions; the design of appropriate technologies for sustainable wetland use and policies to ensure tenure and access rights for different users of wetland patches.

Economic valuation

The case studies presented in previous sections have demonstrated the importance of wetland patches in dryland agroecosystems. But how important are they? What are the economic benefits they produce? What are the costs of their removal from use? What are the costs of wetland degradation? These are important questions in the context of development planning. Economic valuation techniques may help in the answering of some of these questions (Barbier, 1989).

Wetland patches have direct benefits, such as livestock or agricultural use, indirect benefits, such as influence over stream flow and water storage, and non-use benefits, such as their aesthetic or religious value. Assessment of the economic value of wetland areas requires the analysis of this whole range of benefits. This is particularly difficult with wetland patches whose value is only realised in the context of the wider dryland agroecosystem.

Direct use benefits of wetland patches relate to a range of outputs and services. For instance in Zambia, the dambos of Luapula province provide agricultural outputs (including market garden vegetables), livestock graze, fish, domestic and livestock water supplies, cassava soaking pits, wild products for food, thatch and fuel (Kokwe, 1991). Valuation of these direct benefits can be assessed by attributing adjusted, shadow prices to marketed outputs or proxy economic measures, such as replacement costs, for non-marketed products (Barbier et al, 1991).

Some assessment of the sustainability of the direct use benefit stream is desirable. For instance, in northern Nigeria fadama use for wheat production may prove unsustainable in the long term. If a collapse in production levels occurs, then benefits calculated on present output levels will overestimate fadama value (Barbier et al, 1991). A sensitivity analysis of economic benefit streams under different scenarios of future impact is one way of tackling this issue (Barbier et al, 1990).

Indirect use benefit assessments, including the value of the wetland ecological functions, present many more problems for the economic analyst. Continued uncertainty surrounds the technical debate about wetlands' soil and water processes (Ingram, 1991). In southern Africa, the debate about the role of dambos in stream flow regulation remains unresolved. One argument suggests that wetlands control downstream water flows due to their water storage properties. Another argument suggests that dambos have no influence on stream flow and possibly reduce it because of high evapotranspiration rates from the catchment and dambo surface during the dry season. There is evidence for both arguments; the dambo's ecological function depends on the type of dambo, the type of catchment and the relative balance of evapotranspiration losses from different components of the whole catchment (Ingram, 1991; Bullock, 1988). It is thus difficult to predict the impact of agricultural development in dambo areas or assess the value a dambo has for catchment level hydrological processes without very site specific information on both the dambo and surrounding catchment.

The costs and likelihood of environmental degradation resulting from agricultural and livestock use of wetlands similarly remains uncertain. Wetlands may be degraded in two ways: either through lowering of the water table, leading to drying out, or through an increased rate of erosion leading to destruction through gullying or removal of deposits downstream. For instance, in Zimbabwe, the causes of desiccation and gullying within dambos are yet to be established, as it is difficult to judge whether climatic changes, agricultural or livestock use have a greater impact (Stocking, 1978, Whitlow, 1985). However most research points to intensive grazing as a major cause of dambo gullying in Zimbabwe, although 'natural' erosion, resulting from rainfall impacts on particular soil types are also noted as important (Whitlow, 1989).

Changes in the water balance of wetland patches may be due to changes in infiltration rates, both of the wetland and surrounding catchment; changes in evapotranspiration levels or changes in the storage capacity of wetland and catchment area (Ingram, 1991). Infiltration rate changes are the result of changed soil properties or changed plant cover. Decreased infiltration increases run-off resulting in soil erosion, temporary flooding and longer term drying out of wetland areas. Changes in evapotranspiration, through changes in plant type or cover, may have complex impacts on catchment hydrology. Reduced tree cover in the catchment may increase wetland water levels, but change their seasonality (Hough, 1986). Conversion of wetland areas from dense grassland to crop land may result in increased erosion risk, but crop cover throughout the year combined with good land husbandry limits this. Wetland cropping probably results in a lower erosion risk than if the wetland was under intensive grazing use with a short grass sward (Ingram, 1991).

A catchment level approach to the assessment of wetland ecological functions, costs of land degradation and impacts of agricultural or livestock use is needed. Site specific, detailed ecological information is required before any economic assessment of wetland use can be made.

As key wetland patches come under increasing pressure due to high levels of water extraction, as in the fadamas of northern Nigeria (Kolawole, 1991), or through heavy grazing as in the wadis of northern Kordofan (Sammani, 1991) or the dambos of southern Zimbabwe (Scoones, Cousins, 1991) or through the expansion of agricultural use as in Burkina Faso, Zambia and elsewhere in dry Africa (Scoones, 1991; Hottinga et al, 1991; Kokwe, 1991), effective approaches to economic and ecological impact analysis will be needed to avoid serious reductions in the direct use, indirect use and non-use benefits of wetland areas.

Appropriate technologies for sustainable wetland use

Research on the development of appropriate technologies focuses on both physical and management measures for improving production from wetland patches; most research has concentrated on agricultural usage.

Appropriate technologies for physical measures include a range of water harvesting techniques and water control measures for wetland patches (Reij et al, 1988). In the Sanmatenga region of Burkina Faso a number of different options have been tested. These include: large dams with irrigation plots, small impermeable earth bunds and small, permeable rock bunds. Examination of their financial returns, physical demands, the requirements of self-help and community participation, their ecological impact and their compatibility with existing systems, highlights the benefits of the small scale options. Simple rock or earth bunds can easily be built by community groups or individual farmers, they result in significant increases in yield returns with the option for diversification of production, they have minimal ecological impact and require limited capital inputs (Hottinga et al, 1991).

Wetland production requires skilled micro-level management of soil and water processes (see Box 2). Wetland areas often present some serious soil management problems to the farmer. In different types of wetland these may include: soil drainage and waterlogging, root penetration of clay soil layers or ferricrete deposits, surface organic matter accumulation, soil alkalinity due to downslope translocation of bases, soil acidity due to redox reactions, ferrolysis and leaching (Ingram, 1991). Research on appropriate agronomic management practice in wetland soils has provided some site specific recommendations. For instance, in northern Zambia the research and extension service suggests options for land preparation, fertility applications, drainage and water control and micro-nutrient and acidity management in dambo areas (Kokwe, 1991).

Access and tenure rights

Key resource wetland patches are central to the understanding of land tenure and access issues. Conflicts over land resources usually focus on areas of high value, especially if such areas provide a seasonally critical output. Such conflicts increase with heightened resource pressure (eg. through population growth) or with interannual variations in resource scarcity (eg. in drought). Resource management strategies, both private control and common property regimes, tend to be centred around the control of access to key resources, such as wetland patches. Local institutions, rules and regulations concentrate on the regulation of use of such resources (Scoones, 1991).

In northern Nigeria inadequate assessment of development policy impacts has altered tenure rights to fadama land, increased land-use conflict and undermined the sustainability of wetland production systems. The Hadejia valley fadamas have been affected both by river impoundment by the Tiga dam, designed for large scale irrigation projects upstream, and by the promotion of small scale irrigation pumps on a massive scale. This has drastically altered the land-use pattern of the fadamas along the Hadejia valley (Kolawole, 1991; Barbier et al, 1991). The interventions have resulted in a number of conflicts between those farmers who can afford irrigation technology and those who cannot; between agriculturalists, who are extending cultivated areas in response to changed water flows due to upstream daming and as a result of pump technology, and pastoralists, who are increasingly being excluded from their dry season grazing lands and between agriculture and fisheries, with upstream daming reducing fish production levels in the fadamas (Kolawole, 1991).

In north Darfur, western Sudan, high value alluvial wadi land is part of a private property market with an established system of individual tenure. Fencing, land sales and hiring systems reinforce this. Ownership of alluvial land appears to be related to the length of residence in an area; more recent immigrants are excluded unless through hire or purchase of wadi land (Martin, 1985). Wealthy and politically influential people have been able to appropriate large areas for the irrigated production of vegetables, limiting the opportunities for other resource poor farmers. This pattern of increased individualisation of tenure with inequitable distribution of resources is also reflected in changes in tenure patterns in wadi grazing land in south Darfur (Behnke, 1985). Settled agropastoralists have enclosed prime wadi grazing land, excluding nomadic pastoralists from entering during dry season grazing migrations. The degree of enclosure appears to be dependent on the level of resource pressure; in good years with abundant grass the investment in fenced wadi patches decreases, but in drought years this investment pays back and the practice is widespread (Scoones, 1991).

Similar tensions and conflicts over wetland access are noted elsewhere in Africa. Development of effective land use and tenure policies requires an understanding of the central role of key resource wetland patches in dryland agricultural and pastoral systems.

CONCLUSION

Understanding the role of wetlands in drylands requires an understanding of the whole agroecosystem - the interactions between topland and bottomland, between agriculture and pastoralism and between ecological and economic processes. This requires multidisciplinary analysis that sets economic and ecological processes in a spatial and temporal context.

In order for development strategies for wetlands in drylands to be more effective and to avoid unsustainable interventions, appropriate economic assessments of the value of wetlands for local livelihoods are essential. Full economic appraisals that encompass impacts on direct, indirect and non-use benefits can feed into effective development plans.

Wetlands are often key resources for sustaining production of both agricultural and pastoral systems. Access to and rights over such areas are vital for sustaining livelihoods. Consideration needs to be given to the role of wetlands in dryland tenure policy. Successful interventions for sustainable wetland use thus require an integrated approach to research and development in partnership with local farmers and pastoralists.

References

Acres, B. 1985. African dambos: their distribution, characteristics and use. Z für Geomorph. NF. Suppl. 52, 63-68.

Andriesse, W. 1986. Areas and distribution. In: Juo, A and Lowe, J. (eds.). The Wetlands and Rice of Sub-Saharan Africa. IITA, Ibadan.

Barbier, E. 1989. The economic value of ecosystems: 1. Tropical wetlands. LEEC Gatekeeper 89-02. IIED, London.

Barbier, E, Adams, W and Kimmage, K. 1991. Economic valuation of wetland benefits: the Hadejia-Jama'are floodplain, Nigeria. LEEC Paper DP 91-02. IIED, London.

Barbier, E., Markandya, A. and Pearce, D. 1990. Sustainable agricultural development and project appraisal. European Review of Agricultural Economics, 17, 181-196.

Behnke, R. 1985. Rangeland Development and the Improvement of Livestock Production, South Darfur. Western Savanna Project, Darfur, Sudan.

Berton, S. 1988. Le maitrise des crues dans les bas fonds. Petits et microbarrages en afrique de l'ouest. Dossier no. 12. GRET, Paris.

Breman, H. and de Wit, C. 1983. Rangeland Productivity and Exploitation in the Sahel. Science, 221, 1341-1347.

Bullock, A. 1988. Dambos and Discharge in Central Zimbabwe. PhD thesis, University of Southampton.

Cline-Cole, R. 1988. Sowing Seeds of Discord: Induced Wet Rice Cultivation and Fadama Land Use Conflicts in the Hadeija Valley, Nigeria. Paper presented to the African Studies Association conference, Cambridge, September 1988.

Dambo Research Unit. 1987. The Use of Dambos in Rural Development with Reference to Zimbabwe. DRU, WEDC, Loughborough University and University of Zimbabwe.

Dugue, P. 1989. Possibilités et limites de l'intensification des systemes de cultures vivriers en zone soudano-sahélienne; Le cas du Yatenga (Burkina Faso). Documents systèmes agraires, 9. DSA, CIRAD, Montpellier.

Ferreira, R. 1976. Dambos: their Agricultural Potential. Part 2. Rice Production. Farming in Zambia, 10, 39-42.

Fre, Z. 1991. Khor Baraka - a Key Resource in Eastern Sudan and Eritrea. Part 3d. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Hottinga, F, Peters, H. and Zanen, S. 1991. Potentials of Bas-fonds in Agropastoral Development in Sanmatenga, Burkina Faso. Part 3b. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Hough, J. 1986. Management Alternatives for Increasing Dry Season Base Flow in the Miombo Woodlands of Southern Africa. Ambio, 15, 341-346.

Ingram, J. 1991. Soil and Water Processes. Part 2. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Kokwe, M. 1991. The Role of Dambos in Agricultural Development in Zambia. Part 3c. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Kolawole, A. 1991. Economics and Management of Fadama in Northern Nigeria. Part 3a. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Lane, C. 1990. Barabaig Natural Resource Management: Sustainable Land-use under Threat of Destruction. UNRISD Discussion Paper, 12.

Mackel, R. 1974. Dambos: a Study in Morphodynamic Activity on the Plateau Regions of Zambia. Catena, 1, 327-365.

Martin, A. 1985. Farming Systems in the Kebkabyia Area, North Darfur Province. The Role and Potential of Small Scale Irrigated Gardening. Unpublished Oxfam (UK) report.

Norman, D, Simmons, E. and Hays, H. 1982. Farming Systems in the Nigerian Savanna. Research Strategies for Development. Westview, Boulder.

Priestley, M. and Greening, P. 1954. Ngoni Land Utilisation Survey, 1954-55. Government Printer, Lusaka.

Prior, A. 1983. Dambos in the High Rainfall Areas. In: Proceedings of the Seminar on Soil Productivity in the High Rainfall Areas of Zambia. IDP, Agricultural University of Norway, Occasional Paper, 6.

Reij, C., Mulder, P. and Begemann, L. 1988. Water Harvesting for Plant Production. World Bank Technical Paper, 91. World Bank, Washington.

Richards, P. 1989. Agriculture as a Performance. In: Chambers, R., Pacey, A. and Thrupp, L. (eds.). Farmer First: Farmer Innovation and Agricultural Research. Intermediate Technology Publications, London.

Sammani, M. O. 1991. Wadis of North Kordofan, Sudan - Present Roles and Prospects for Development. Part 3c. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Scoones, I. 1989. Patch Use by Cattle in Dryland Zimbabwe: Farmer Knowledge and Ecological Theory. ODI Pastoral Network Paper, 28b.

Scoones, I. 1991. Overview: Ecological, Economic and Social Issues. Part I. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Scoones, I. and Cousins, B. 1991. Key Resources for Agriculture and Grazing: the Struggle for Control over Dambo Resources in Zimbabwe. Part 3f. In: Scoones, I. (ed.). Wetlands in Drylands: the Agroecology of Savanna Systems in Africa. Drylands Programme, International Institute for Environment and Development (IIED), London.

Stocking, M. 1978. The Relationship of Agricultural History and Settlement to Severe Erosion in Rhodesia. Zambezia, 6, 129-145.

Turner, B. 1977. The Fadama Lands of Central Northern Nigeria: their Classification, Spatial Variation, Present and Potential Use. PhD thesis, University of London.

Turner, B. 1984. Changing Land Use Patterns in Fadamas of Northern Nigeria. In Scott, E. (ed.). Life Before the Drought. Allen and Unwin, London.

Turner, B. 1986. The Importance of Dambos in African Agriculture. Land Use Policy, October 1986, 343-348.

Whitlow, J. 1985. Dambos in Zimbabwe: a Review. Zeitschrift für Geomorphol. Suppl. 52, 115-146.

Whitlow, J. 1989. Gullying Within Dambos with Particular Reference to the Communal Farming Areas of Zimbabwe. PhD thesis, University of London.

WETLANDS IN DRYLANDS: THE AGROECOLOGY OF SAVANNA ; SYSTEMS IN AFRICA

Edited by Ian Scoones, Drylands Programme, IIED, London, 1991

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 I 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.

These are available from the Drylands Programme, IIED at the following prices: Part 1 £4.00, Part 2 £3.00, Parts 3a-f £1.50. A limited number are available free of charge to applicants from the South.

Dryland Networks Programme
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMEN
3 Endsleigh Street, London WC1H 0DD, England
Tel: (44-71) 388.2117 Fax: (44-71) 388.2826
Telex: 261681 EASCAN G