Western flowing ephemeral rivers and their importance to wetlands in Namibia

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ABSTRACT

One of Africa's most arid regions, the Namib desert, is crossed by several west-flowing rivers, ten of which reach the sea, but none of which flow for more than a few days or weeks at most. The four largest rivers, the Kuiseb, Swakop/Khan, Omaruru and Ugab, provide water for human populations as well as wildlife and some show unexplained decreases in flow frequency or amplitude. Almost all those that reach the sea support rich wetland areas, typically at their mouths and further upstream. Each wetland area acts as a linear oasis supporting mammals and birds typically only found in high rainfall areas. I present data on the use of wetlands by indigenous people and suggest that not only should the present conservation areas be augmented by IUCN designated zones, allowing multiple use by man and wildlife, but suggest that future planning should be centered around the idea of catchment units.

INTRODUCTION

Wetlands are amongst the world's most important and productive ecosystems. Once viewed as useless obstacles to agriculture and industrial interests, they are now recognised for their great value for chemical and biological materials, waste-water cycling, flood attenuation and especially for their rich diversity of life. Despite their importance, their loss through natural events is insignificant compared to that caused by human actions. Deterioration may result from such factors as accelerated soil erosion, reduced water flow, or species extinctions leaving no options for future conservation or the existence of wild and domestic plant and animal species (Prescott-Allen 1984).

Most of Namibia is arid or semi-arid and is subject to the risk of combined factors such as low rainfall, and changing soil and vegetation conditions with increasing human and animal pressures (World Resources 1987). Bearing in mind that many critical survival issues are related to uneven development, poverty and population growth, all of which occur in the country, all the above place unprecedented pressures on wetland ecosystems, one of this country's rarest natural resources.

Indeed, all water supplies, while renewable, are both limiting and limited (Davies & Day 1986) and the continued development of the entire southern African sub-continent will ultimately be limited by water. With 44% of Africa affected by drought and land being lost in Namibia due to excessive livestock herds and accelerated erosion (Myers 1987), the impact on our ephemeral rivers through dams that limit flow, could close options for large surrounding areas while accelerating desertification.

Here I provide an overview of the ephemeral west-flowing rivers in the most arid (western) portion of Namibia by describing their phenology, some of the wetland habitats and fauna associated with them and their use by the indigenous people of of the area.

RESULTS

The importance of such wetlands centers around functions such as effective flood-attenuation and natural filters, which trap sediments, nutrients and bacteria (Davies & Day 1986). Most such wetlands while not extensive are permanent along the lower gradient courses of such Namib rivers. Along with the extensive riparian woodlands dependent on underground waters (Ward & Breen 1983), these wetlands form viable linear oases within the Namib (Huntley 1985) and consequently support most of the biota in these hyper-arid regions. Almost all the rivers which reach the sea during the summer floods support wetlands at their mouths, comprising simple botanical units dominated by *Phragmites australis* and in some of the deeper permanent pools, *Typha latifolia* spp. Wetlands along the Ugab, especially at the mouth, and the five fingered delta of the Uniab are particularly extensive and support a large and diverse avifauna which is somewhat unexpected in a desert region which averages about 10 mm of rain annually (Ryan et al. 1984a; Braby et al. 1987)

WESTERN FLOWING EPHEMERAL RIVER SYSTEMS

Each of the western flowing rivers are ephemeral, exhibiting dry sandy or rocky riverbeds for most of their length and for most of the year (Plate 3). However, due to sub-surface flow, all rivers contain a number of wetlands, defined here as shallow, swampy or marshy areas with little or no water flow. They fall under the general wetland description of water-logged soils dominated by emergent vegetation (Davies & Day 1986). Each river is shown in Figures 1 and 2.

The four largest rivers, rising in the Highland Plateau, with tributaries in the adjoining escarpment zone are the Kuiseb, Swakop/Khan, Omaruru and Ugab, collectively forming the major discharge into the Atlantic of all non-perennial rivers. These four large systems provide substantial volumes of underground water for human use and water from the Swakopoort storage dam is used for mining, industrial and domestic needs.

Collectively their catchments cover an area of 80 000 km^2 (Stengel 1966). Proposals to dam the Ugab River are at present uncertain, while impoundments on the Omaruru, are imminent, in order to boost underground reserves currently being depleted in the delta area.

In the southern Namib, the Koichab, Tsauchab and Tsondab Rivers, covering a run-off area of 80 000 km^2 collectively, feed the Koichab Pan, Sossusvlei and Tsondabvlei respectively. In years of above average rainfall these vleis fill and form dramatic ephemeral wetlands in the Namib sand sea. These periodic events are important in providing habitat for birds and mammals, while replenishing groundwater which sustains localised woodlands.

The north has as its major systems, the Huab, Hoanib, Hoarusib and Khumib followed in size by the Uniab and Koigab Rivers,

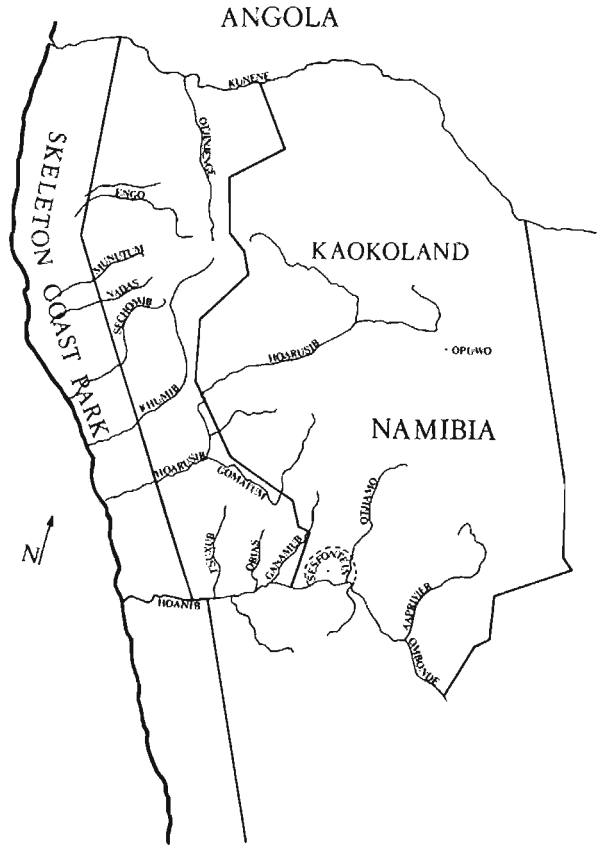

FIGURE 1: Ephemeral west-flowing rivers of Kaokoland, from the Hoanib to the Angolan border.

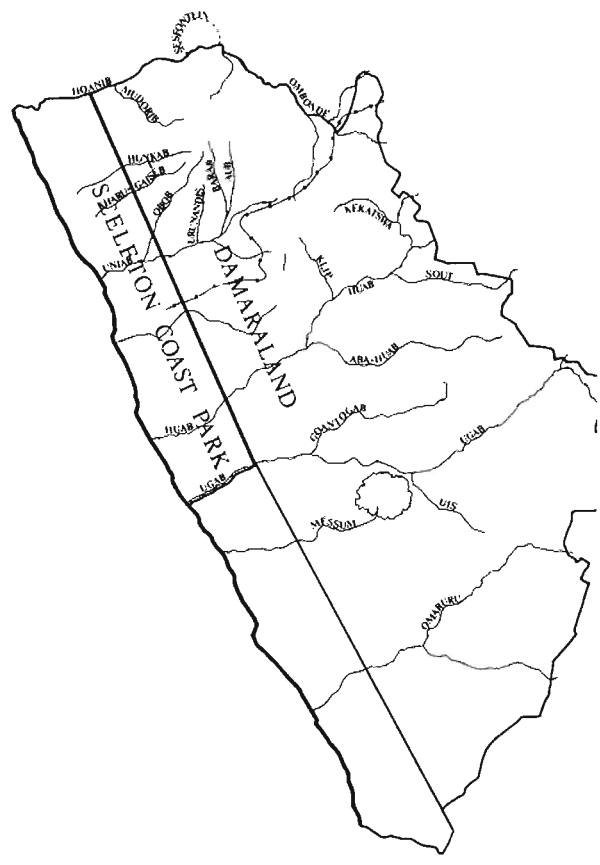

FIGURE 2: Ephemeral west-flowing rivers in Damaraland from the Hoanib to the Omaruru

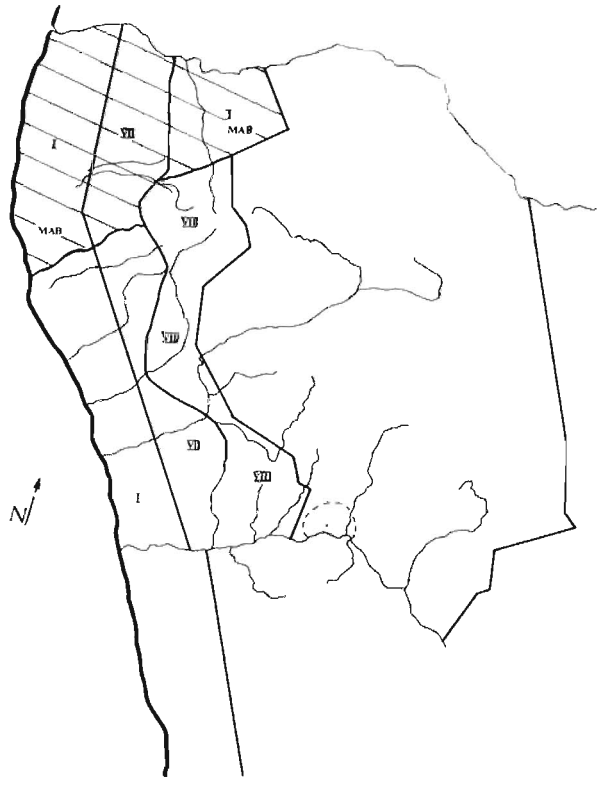

FIGURE 3: Proposed IUCN land-use zones for Kaokoland: zone I. Undisturbed natural habitat for the maintenance of of biological diversity, controlled by central government; zone VII. Natural biotic area or anthropological reserve, designed to conserve natural areas in which man is a component. Management is aimed at maintaining habitat for traditional societies; zone VIII. Multiple use management or resource area, designed to conserve natural resources while simultaneously contributing to social, economic and material needs. For further details see McNeely & Miller (1984) and Loutit (1990).

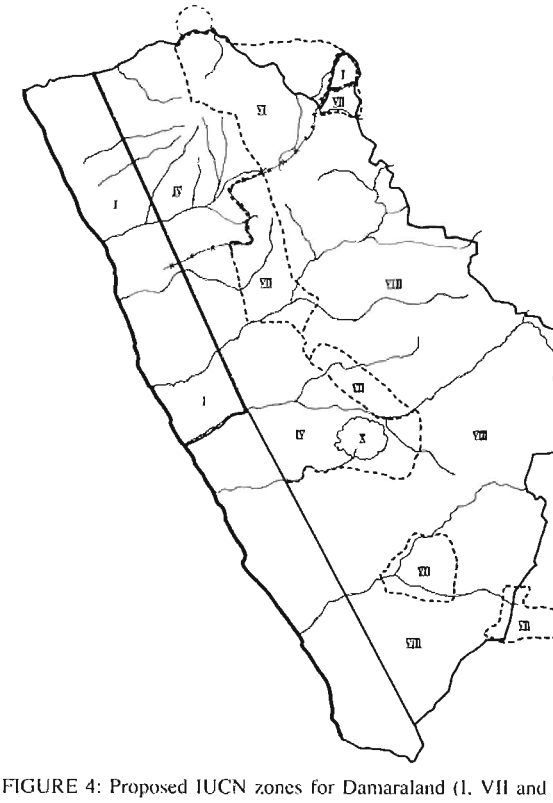

FIGURE 4: Proposed IUCN zones for Damaraland (I, VII and VIII explained in Figure 3): zone IV. Nature conservation reserve known as a "natural resource management area" - critical regions in which manipulative management techniques can be applied to guarantee stability of endangered populations of plants and animals; zone VI. Resource reserve - providing protection for currently unprotected land in which only indigenous people may exploit the natural resources; zone X. World heritage sites - e.g. Cunene estuary, Uniab delta and Hoanib floodplain, so designated because they are unique areas of outstanding international ecological, biological or geological importance. Strictly legally protected and owned by government.

all capable of annual flow to the sea. These rivers collectively have an estimated catchment of 80 000 km² Stengel 1966). A further nine lesser rivers flow from west (desert-side) of the escarpment to within the Namib, all being episodic by nature. Five rise within Damaraland and four within Kaokoland. In the south the Orawab and Messum Rivers rise in the Brandberg, while the Samanab, Kharu-gaiseb and Hunkab have their origins on the Kharokhaob-vlakte, south of Sesfontein. The Sechomib, Munutum and Engo Rivers rise west of the Otjihipa mountains and south of the Hartmann valley in northern Kaokoland. They have not reached the sea in living memory.

The Hoanib River with a catchment of 11 000 km is the only system which has a large floodplain. It is 90 km² in extent and is capable of forming fairly extensive wetlands within the Namib following years of medium flow. Large dunes act as a natural barrier, preventing flood waters from reaching the mouth. Associated with, but not directly connected to, the Hoanib are two productive wetlands with permanent fresh/ brackish water and abundant emergent vegetation. Both Auses and particularly the Oasis support a rich avifauna, including breeding populations of ducks and cormorants.

RAINFALL AND RIVER FLOW

Rainfall

Stengel (1964, 1966) details the rainfall averages (100 - 400 mm) from the past 15 to 60 years, for the larger rivers crossing the Namib to the Atlantic. Most of these have the largest portion of their catchments on the plateau. In years when river flow reaches the sea, most localities within the highlands or escarpment receive well above average rainfall. Few localities receive less than the long term average in flow years. However no rainfall of significance was produced from localities within the Namib, for such rivers e.g. Uis and Sorris Sorris.

Within the Namib, only localised cloud bursts produce run-off sufficient to produce flow in tributaries of the larger rivers or in the small rivers rising west of the escarpment e.g. Zerriesenes hills/Gemsbok River to Ugab (1981); farm Rooiberg /Aba-Huab River to the Huab (1986), and Grootberg mountain down the Uniab River to the sea in 1989. Flow patterns can be affected by unusually intense rainfall in the Namib portion of rivers; for example the lower Khan rainfall destroyed the railway bridge at Swakopmund and the lower Omaruru floods emanated from rain at Schwarz Spitzkoppe in 1962/63 (Stengel 1966).

The unpredictability and widely fluctuating rainfall received in all western flowing river catchments has been discussed by Huntley (1985), as has the long-term average rainfall for the Kuiseb catchment (Hattle 1985).

The last, above average rainfall period over most of northwestern Namibia, was in the mid 1970s, followed by a prolonged dry period to 1984, and thereafter increasing rainfall annually from 1987 to 1989. Rainfall data in the north west is minimal and our knowledge of historical weather trends in deserts are too speculative to permit conclusions about climatic contributions to present day lower rainfall and desertification.

River flow

Despite the implementation of numerous measuring sites on rivers from the Kuiseb to the Hoarusib, flow patterns are difficult to interpret due to fluctuating rainfall, the effects of vegetation cover on run-off, flow dissipation downstream and lost data at measuring stations. It is evident, however, from reasonably long term statistics, and the establishment of a monitoring baseline for the Kuiseb (Huntley 1985), that periods of low rainfall produce minimal run-off. This allows little room for analysis on aspects such as flow dissipation, sediment yield and rainfall - run-off relationships (Hattle 1985).

In years of exceptional rainfall, (especially following droughts when vegetation cover is reduced), major flooding occurs, as was the case in 1933/34 in the Swakop/Khan, Omaruru and probably the Ugab, Huab, Hoanib and Hoarusib Rivers (Stengel 1966), resulting in changes of topset bedding and river mouths. This in turn re-disperses some wetlands or re-shapes more permanent ones, through changes in vegetation, surface water areas and underground or surface flow patterns. This was observed in the Hoanib River following the dramatic floods in 1982/83, where the wetland at the mouth was re-shaped entirely. Similar cases occurred in the Hoarusib in 1982/83 and 1986/87, effecting changes to coastal wetlands at the mouth.

During the 1985/86 flood in the Ugab River, flooding continued for six weeks, followed by permanent flow from the wetlands for up to twelve months following cessation of run-off flow. The approximate flow volume into the sea during this period in 1985/86, was 100 million m³ (P. Heyns pers. comm). Stengel (1964), records a similar volume in the Kuiseb River, dammed up behind the coastal dune barrier during the floods of 1963. Similarly, the Uniab River dammed up in the dunes in 1982, and swept the road, water development schemes, vegetation and wildlife into the sea when it broke through. There had been no flow since 1976, coinciding with drought in the region.

Most river flows are ephemeral (hours and days) but in exceptional circumstances continues for weeks. The Kuiseb experienced an average annual days of flow of 22,6 days from 1962/ 63 - 1982/83 (range 0 - 102); four years had no flow in this 20 year period (Ward & Breen 1983). By comparison the Omaruru had an average annual days of flow of 16,5 days from 1965/66 - 1985/86 (range 0 - 55); three years had no flow in this 21 year period (P. Heyns pers. comm.).

The Omaruru river reaches the sea every second year and is thought to replenish the ground water on average every 10 years (Heyns 1990). The flows of the other two major rivers, the Swakop and the Kuiseb have become less frequent in recent decades and are cause for concern. For example the Swakop River since the turn of the century has flowed at Swakopmund approximately two in every three years. In the 1960s this pattern became less regular and fell drastically thereafter with only three events since the large 1972/73 flood. This is probably due to the building of two large storage dams, the von Bach and Swakopoort dams, on this river (Heyns 1990). The Kuiseb is more worrisome since as the largest of the ephemeral rivers in the Namib it has shown a downward trend in flow amplitude since the largest flood on record in 1962-1963. The reasons are unknown (Heyns 1990), and cannot be accounted for solely by decreased rainfall. The effect on trees hundreds of years old has already been documented (Ward & Breen 1983).

FLOODING

Floods not only produce huge quantities of water, but sediment, organic matter and nutrients for dispersal from source areas in each catchment, through to wetlands en route to floodplains, mouths and near shore zones. Seeds of plants are carried and distributed to re-establish species and vegetation in situ. Percolation of water and nutrients into ground waters of the rivers, feeds riparian vegetation along the river's course. Upwelling of underground seepage water, recharged from floods, allows

small wetlands to occur where geological barriers force water to the surface. Such surface waters are usually well vegetated areas and often provide running water year round.

Aspects such as flow period, the frequency of flow and inter-flood periods, run-off volumes and different quality of run-off waters from the desert all influence quality of water and sediment loads. The surface covering of fine silt deposited by flooding, is a natural barrier to evaporation, which can be over 3 000 mm per annum in the desert.

Limited flow often fills salty marshes at river mouths in the Namib. Such ephemeral lagoons (e.g. Ugab and Huab lagoons following 1983 floods) are extremely productive systems and provide migratory birds and especially waterfowl, habitat and nutrition (Ryan et al. 1984a & b).

Certain unwanted effects occur from flooding rivers, namely the influx of alien invasive plants which are deposited in seed banks along the entire length of rivers. These plants compete directly with indigenous species for both nutrients and water following flooding (Tarr & Loutit 1985). High intensity floods restructure substrata in rivers and can obliterate small wetlands and related vegetation and fauna. Valuable vegetation can be removed by floods which reduces the viability of wetlands in the vicinity, e.g. 1982 floods removed mature *Acacia albida* trees utilized by ovaHimba as fodder trees near Purros, Kaokoland. Such trees were in close proximity to a perennial wetland in the Hoarusib River, which provided water for humans, stock, wildlife and irrigation of crops.

WETLAND UTILISATION

Reasoning that in a world that will take 50 to 70 years to stabilize its human population growth, water will possibly be the most sought after natural resource. All these rivers will undoubtedly suffer growing pressures and some, already marked for damming require timeous baseline surveys as exemplified by Huntley (1986). It can be argued that the time has come when the emphasis should shift to comprehensive land and water planning, treating land and water as an integrated whole, rather than water planning per se (Petts 1984). Below I discuss some of the uses made of the water which occurs in these systems.

Pastoralists

Wetlands in these western flowing rivers have been and still are important to Herero/Himba and Damara pastoralists, in moving their herds or splitting herds, to ensure preservation of stock during droughts, disease epidemics and raids by neighbours (Malan 1974). Simple furrow irrigation is practiced in rivers to cultivate mixed crops. In the past Tjimba, ovaHimba Herero in Kaokolandand and Dama (Damaraland), followed hunter-gatherer economies, reliant on these rivers and wetlands for animal foods, hunting and seasonally, fishing in the Ugab River following floods (Steyn & du Pisani 1984).

Wetland utilisation includes communal domestic stock farming, small mining enterprises, small scale gardening or rural community developments and health or educational schemes. A variety of tourism development schemes, both inland and at the coast make use of wetlands for resources and recreation.

Wildlife

Wildlife use wetlands for water, food and cover throughout the northwestern region (Viljoen 1982). Elephant *Loxondonta africana*, Rhinoceros *Diceros bicornis bicornis* and Hartmann's zebra *Equus* zebra *hartmannae* all make continuous use of wetlands throughout central and northern Damaraland and western Kaokoland. Both elephant and rhinoceros are endangered and vulnerable species, and Hartmann's zebra is an endemic species. All are legally specially protected. A further 81 species of mammals occur throughout Damaraland, Kaokoland and Skeleton Coast Park (M. Griffin pers. comm.). A total of 128 species of amphibians and reptiles occur in the northwestern region, of which 14 reptile species are endemic (six of which are associated with ephemeral wetlands: M. Griffin pers. comm.). Decreases in large mammal fauna within Kaokoland and Damaraland over the last twenty years have been large (Viljoen 1982), but appear to been recovering since 1986 (Loutit 1990). Had there not been any western flowing rivers, providing food, cover and watering points in the desert, it is quite probable that local extinctions would have occurred.

Accounts of the avifauna, particularly the wetland species are given by Ryan et al. (1988a, b) and the wetlands are constantly atlassed by nature conservation officials. Densities of breeding and wintering birds however, are not known.

Conservation problems and wetland utilisation

Many wetlands are periodically used by man, depending on the availability of artificial water points and grazing, throughout Kaokoland and Damaraland. This leads to interactions with wildlife and requires monitoring to prevent illegal hunting of specially protected, rare and endangered species. Elephants were shot in the Hoarusib River and near Sesfontein during the 1980 - 1983 drought following crop damage. At the time of writing, three of the four or five remaining coastal lions *Panthera leo* have been shot by Herero farmers claiming that the lions threaten their livestock. As has been suspected for sometime, the narrow wedge of national park which comprises the Skeleton coast Park (30 - 40 km) is not a viable ecological unit for the nomadic lions which roam the length and breadth of the parks' rivers. For this reason, multiple use areas are planned for Damaraland and Kaokoland (see below and Figs. 3 and 4).

In riverine areas grazing is over utilized at wetlands in times of drought. At inland wetlands, communal land tenure does not restrict recurring settlement with resultant over utilization of grazing. Vegetation in the form of sedges and reeds is also burnt off, causing loss of habitat and the associated avifauna.

Several other problems that can cause destruction of arid-area wetlands include small mining enterprises which make use of and provide access to wetlands, pollution and littering at wetland sites, illegal hunting by staff becomes a probability, especially in dry periods when wetlands attract wildlife for food and water and excessive local water use which reduces recharge of wetlands. Many other sources of degradation from the unintentional to the deliberate occur which are too numerous to list.

PROTECTION OF REGIONS WITHIN DAMARALAND AND KAOKOLAND THROUGH IUCN ZONES

The portions of each river system contained within the park vary from south to north, and are very limited relative to the entire lengths of the rivers themselves. For example, the Hoanib, Uniab, Ugab and Huab in the southern Skeleton Coast Park each have approximately 40 km protected, while the rivers further north such as the Hoarusib (35 km) the Kumeb (35), the Nadas (25) and Engo (10) have much smaller protected status. As noted, these linear oases are not ecologically viable units for some of the larger mammals. To alleviate this and to minimise

impact of over-development outside the park, zones according to IUCN categories are planned to ensure any developments are harmonised with Namibia's natural and cultural assets (Carter 1990).

A wildlife survey of the Skeleton Coast Park, Damaraland and Kaokoland, North West Namibia was the first phase in this project and was carried out in May and June 1990 to identify those areas which require complete or partial protection. Census data for large birds and ungulates, including cattle and goats are given by Loutit (1990). He showed that in Damaraland and Kaokoland there has been an "appreciable increase since 1986 in all major species except giraffe". Wetland dependent animals such as elephant increased about 5%, despite losses to poaching (17 animals) and natural mortality. The proposed IUCN zones to sustain these population growths are given in Figures 3 and 4; each zone is described in the figure legends. It is heartening to note that wetlands have themselves been given special status as World Heritage sites, and are thus recognised as areas of outstanding international importance. Thus the Cunene mouth, Hoanib floodplain and the Uniab delta up to the Palmwag wetlands, are each specially protected areas.

DISCUSSION

Envisaging the future

Best scenario

To ensure no further degradation of wetlands in ephemeral rivers, one must implement a multi-objective programme, with specific aims which take account of flood plain, riparian and catchment problems. Such problems include the uncontrolled drilling of bore holes and small dams which together are likely to have a major effect on river flows in the near future. This would involve a conservation strategy for western flowing ephemeral rivers acceptable to the people under the prevailing socio-economic conditions, based on an appraisal of cultural, political, ecological and socio-economic factors that can balance resources policy with local human needs in both the short- and the long-term (Lusigi 1984). This scenario should be integrated into a National Conservation Strategy, and receive appropriate legislation under the proposed Natural Resources Act.

Worst scenario

The worst scenario contemplates failure to identify rural interest groups and regional and central government, and make them aware that wetlands are a renewable but finite resource (Ekins 1989). In identifying interest groups we should consider the people who live there, work there, visit there and include those who exploit natural resources. Included in such plans should be those as yet unborn who will one day fall into these groups and the present-day traditional and political leaders. Naturally all non-human living things are also seen as among the most important of these groups. The research and monitoring initiatives described in the best scenario will surely fail if the above interest groups are not stimulated to become environmentally aware.

RECOMMENDATIONS FOR CATCHMENT CONSERVATION

In order to conserve Namibia's west-flowing rivers and wetlands in areas in which most of the human population is concentrated in the upper catchments it is perhaps wise to promote the concept of catchment conservation or the catchment region as a planning unit. In this way the damming or over-utilisation of tributaries which are a small but integral part of the entire system can be controlled. To do so efficiently we must understand in considerably more detail things such as: the water requirements of riparian woodlands and wetlands in each catchment; the extent of ground water reserves in each catchment and set appropriate pumping limits for present and future boreholes; and avoid large scale unlimited storing of water, provided in reservoirs and close down existing installations in degraded areas; initiate problem-oriented agricultural extension in each catchment; and re-plan watering points.

I advise that baseline monitoring should continue of semi-nomadic movements in the region and stock numbers, rainfall patterns as indicated from transects along each catchment, pod production of riparian *Acacia albida* trees, phenology of riparian woodlands and movement patterns between catchments of wildlife species. Changes in wetlands should be monitored through fixed photo point, and aerial photography and satellite imagery.

Finally the concept of wilderness areas and related non-consumptive utilisation in the form of tourism e.g. trails should be promoted. Economic benefits must to be passed to the resident populace and not merely to local or central government.

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