Are intermittently flooded wetlands of arid environments important conservation sites?

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ABSTRACT

A brief overview of wetland definition, functions and values and classification is presented. I conclude that wetlands of arid regions, even where the interval between flooding may be several years, can be accommodated within existing classification systems. A preliminary analysis of the return frequency of extreme rainfall events indicates that temporary waterbodies in Namibia may provide adequately for wetland processes such as breeding of waterfowl once in every five to ten years. I suggest that because of regional variations in rainfall and the wide distribution of these wetlands, suitable habitats are likely to be available for nomadic species at considerably shorter intervals. More detailed inventory and analysis is necessary before the interconnectedness of these systems can be established and evaluated. Because these systems have worldwide distribution, study of wetlands in Namibia can usefully contribute to the development the theory and practice of wetland conservation.

INTRODUCTION

In 1971, wetlands became the first and so far the only ecosystem type which has its own international convention - the Ramsar Convention. Under the Convention (sponsored by UNESCO and ratified in Ramsar, Iran, 2 February 1971) signatories agree to include wetland conservation in their national planning and to promote their sound utilisation (Maltby 1986). Although the principal concern which led to the Ramsar Convention was the conservation of habitat for waterbirds, it stimulated interest in wetlands and contributed both to the declaration of 1985 as the year of the wetland by the International Union for Conservation of Nature and Natural Resources (IUCN), and to a growing awareness of the importance of wetlands in the landscape.

Since the terms wetland and arid contrast so strongly there is a natural tendency to assume that wetlands do not occur to any significant degree in arid landscapes, and that they are unlikely to have functions and values such that 'they are essential life-support systems, play a vital role in controlling water cycles, and help to clean up our environment' (Maltby 1986). There is, therefore, an understandable reluctance to deploy limited financial resources and personnel to the study and evaluation of wetlands in arid regions. The structure and functioning of wetlands in such regions are, consequently, poorly documented, and there is little justification for the assumption that they are not important.

In this paper I present a broad overview of wetlands and suggest that although wetlands in Namibia are not likely to be unique in their structure and functioning, they are worthy of study. They are wetlands of a type which are poorly known locally and worldwide, and they may have considerable regional significance for nomadic species, particularly birds.

WETLAND DEFINITIONS

There is a continuum of variation between permanently wet and permanently dry ecosystems and consequently definitions of wetlands vary in accordance with individual interests. The Ramsar Convention, for example, defined wetlands as:

'Areas of marsh, fen, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine waters, the depth of which at low tide does not exceed six meters.'

However, since this definition incorporates a limited sector of the continuum and not the adjoining dry land ecotone and deeper water which have obvious significance for watershed habitat conservation, the Convention also provided that wetlands '... may incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands'.

This definition caters for the interests of conservationists in general and of those concerned with waterbirds in particular. As such it sets them apart from other interest groups eg. hydrologists and agriculturalists. What is required is an all-embracing definition which is based on the determinants of wetland structure and functioning rather than on those properties of sectoral interest (Breen 1988). Such a definition has been developed by the United States Fish and Wildlife Service (Cowardin et al. 1979) and states that a wetland is:

' land where an excess of water is the dominant factor determining the nature of soil development and the types of animals and plant communities living at the soil surface. It spans a continuum of environments where terrestrial and aquatic systems intergrade'.

In this definition which is the most widely accepted in the United States of America (Mitsch & Gosselink 1986), the term 'excess' implies that the soil is flooded for long enough for waterlogging to become the dominant factor determining the biogeochemical characteristics of the area. The United States Government definition is, however, stated as follows (Mitsch and Gosselink 1986):

' The term 'wetlands' means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

An important difference between the definitions can be illustrated using a local example such as Etosha Pan. Few would question that Etosha Pan has a fluviatile origin and that an excess of water was and probably still is, a dominant factor determining the nature of soil development, even though the interval between periods when excess water may be present can be very long. In the Ramsar definition it is only the temporary presence of shallow water which identifies Etosha Pan as a wetland, irrespective of the nature of soil and biotic communi-

ties.

The definition of Cowardin et al. (1979) is clearly more comprehensive and accords Etosha Pan wetland status on the basis of persistence of excess water, soil development and biota. In so doing the definition satisfies the needs of a broader spectrum of interest groups.

FUNCTIONS AND VALUES

The prevailing hydrological regime is probably the single most important determinant for the establishment and maintenance of the specific types of wetlands and wetland processes (Mitsch & Gosselink 1986). It thus determines directly or indirectly, most of the functions wetlands perform in landscapes and hence their perceived value. Value is also determined by the location of the particular wetland in the landscape and the extent of the resources. Thus whilst the values attributed to wetlands can be apportioned between resource and system values (services and values provided by the system as a whole, Mitsch & Gosselink 1986) (Table1), wetlands vary in their mix of values and hence in how their value is perceived. A logical extension of analysis of functions and values is to speculate that different categories of wetlands would have different sets of functions and values, and that these would vary from year to year. Such variation would be a particular feature of wetlands of arid regions where excess water is present infrequently.

TABLE 1: Resource and system values commonly attributed to wetland ecosystems. Modified from Mitsch & Gosselink (1986).

Resource	value	System values
Water	(storage/abstraction)	Flood attenuation
Soil	(agricultural production)	Aquifer recharge
Salt	(abstraction)	Water quality modifier
Animals	(mammals, waterfowl, fish and invertebrates)	Aesthetic attributes Social attributes (eg. education)
Plants	(pasture, timber, reed, sedge harvest)	atmospheric quality modified (eg nitrogen and carbon dioxide)
Peat	(energy)	
Endangered species	(conservation)	

WETLANDS CLASSIFICATION

It is probably true to say that whilst some wetlands in southern Africa may have unique properties, particularly in respect of species compositions, they have the same determinants as those elsewhere in the world. Consequently, our wetlands have the same, or at least very similar attributes (resource and system values) as those in other parts of the world and thus the ways in which they can be used are also similar. The implication of these observations is that there is no need for a classification system which is unique for southern Africa. In fact development of a unique system would be counter-productive since it would limit comparison and formulation of general principles relating to wetland classification, structure and functioning.

Since it is the attributes of wetlands which determine how they can be used and how they respond to perturbation, the classification system should be structured on attributes of wetlands and not on the particular requirements of users. Such a classification system has been developed (Figure 1: Cowardin et al. 1979) in the United States of America and can be applied with minor modification in southern Africa (Table 2, Morant 1983; Breen 1988). There is good reason to believe that the wetlands of Namibia would be adquately classified using this system.

Table 2: Wetland legend proposed for use in southern Africa by Morant (1983)

ECOLOGICAL SYSTEM

Estuarine = C	Lacustrine = L	Palustrine = P

ECOLOGICAL SUBSYSTEM

1 Subtidal	1 Profundal	No subsystem
2. Intertidal	2 Littoral	

CLASS AND SUBCLASS - these occur in one or more of the above ecological systems / subsystems. The class is denoted by an alphabetic and the subclasses by a numeric code:

AQUATIC VEGETATION - AV

1 Submergent algal
2 Submergent vascular
3 Submergent moss
4 Submergent unknown
5 Floating-leaved
6 Floating
7 Floating unknown

EMERGENT VEGETATION - EM

1 Broad-leaved
2 Narrow-leaved

FORESTED WETLAND - FW

1 Evergreen
2 Deciduous
3 Dead or leafless

FLAT - FL

1 Gravel
2 Sand
3 Mud
4 Organic
5 Vegetated

CONSOLIDATED SHORT - CS

1 Rock (basal)
2 Boulder

ROCKY SHORE - RS

1 Rock (basal)
2 Boulder
3 Vegetated

UNCONSOLIDATED BOTTOM - UB

1 Gravel
2 Sand
3 Mud
4 Organic

OPEN WATER - OW

(nature of bottom unknown)

WATER REGIME MODIFIERS

Non-tidal

A Irregularly flooded
B Regularly flooded
C Saturated
D Seasonally flooded
E Semipermanently flooded
F Permanently flooded
G Intermittently flooded

Tidal

H Subtidal
J Regular
K Irregular
L Seasonal

SPECIAL MODIFIERS

1 Impoundment
C Canal(ized)
F Farmed
Ir Irrigated
X Excavated
R Artificial

WATER CHEMISTRY MODIFIERS

Coastal salinity		Inland salinity	
05	Hyperhaline	30	Hypersaline
10	Euhaline	35	Saline
15	Polyhaline	40	Near-saline
20	Mesohaline	45	Moderately saline
25	Oligohaline	50	Slightly saline

pH Modifiers for all fresh water

55 Acid fresh
60 Circumneutral fresh
65 Alkaline fresh

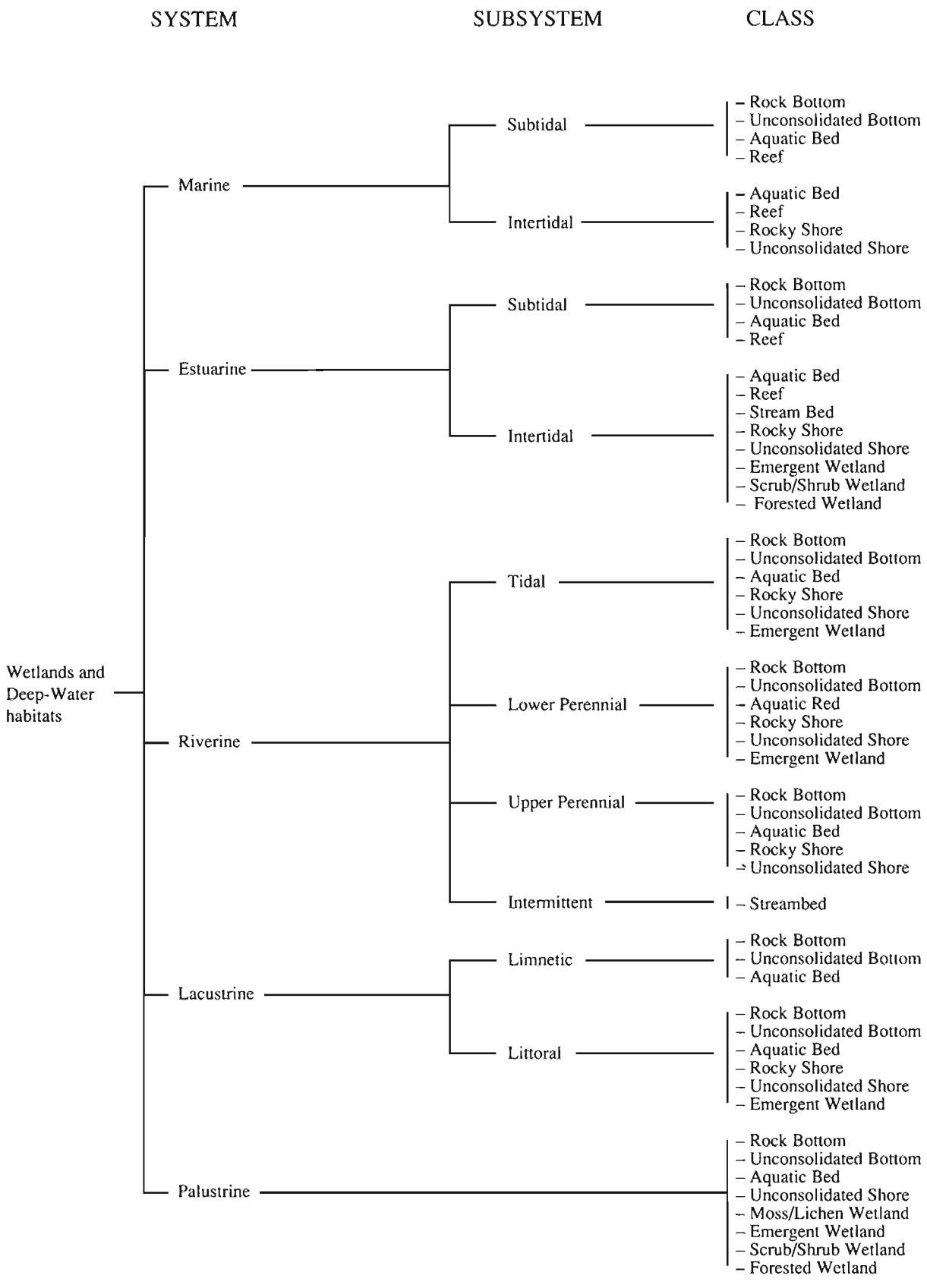

FIGURE 1: The hierarchial wetland classification scheme of Cowardin et al. (1979)

WETLANDS OF ARID REGIONS

Wetlands are azonal in the sense that the common characteristics of a free water supply and abnormally hostile root environment override climatic factors as principal determinants; consequently similar wetlands develop under widely differing climatic conditions. Coastal and estuarine wetlands, for example, are not greatly different in respect of substrata, whether they occur at Sandwich Harbour in Namibia or at St Lucia in South Africa. In arid inland situations, however, the great predominance of evaporation over water supply, and rising capillary groundwater which carries solutes to the surface, result in salt-enriched wetland habitats. Although these inland mineralised wetland systems are characteristic of arid zones, they have many characteristics in common with salt rich coastal systems. Thus neither the wetland types nor their resource values are likely to be unique to Namibia. Notwithstanding this, it is interesting to note that wetlands of arid regions in general and of arid inland regions in particular, have received scant attention in recent texts (Mitsch & Gosselink 1988; Hook et al. 1988). The opportunity therefore exists for studies of wetlands in Namibia to make a valuable contribution to the knowledge and understanding of wetland structure and functioning on a world-wide basis.

The analysis in Table 3, which is based on superficial knowledge of the values of pans (shallow inland wetlands with no obvious inlet or outlet) of the arid northwestern Orange Free State in South Africa, shows that inland endorheic pans can have high resource and system values. It must be born in mind, however, that realisation of these values depends on both the frequency and duration of inundation: in essence the predictability of the environment.

TABLE 3: Subjective evaluation of resource and system values associated with pans of the Orange Free State. Based on data from Geldenhuys (1981).

CRITERIA		VALUE
Resources		
	Water	Low
	Soil	Low
	Salt	Moderate
	Animals	High
	Plants	Moderate
	Endangered species	High
System attributes		
	Flood attenuation	Low
	Aquifer recharge	Negligible
	Water quality modifier	Negligible or negative
	Aesthetic	Moderate / High
	Social attributes (eg. education)	High
	Atmosphere quality modifier	Low

Wetlands of arid regions tend to be widely spaced and are not usually linked by favorable migration routes. Consequently, organisms which cannot travel long distances in hostile environments in search of favourable conditions have evolved survival strategies consistent with the predictability of the local environment. The biology and biogeography of resident organisms, particularly the fauna, is therefore of considerable interest.

The analysis in Table 4 shows that even in the more arid parts of Namibia (eg. Keetmanshoop), 25 mm of rain can be expected in one day every two years and more than 40 mm on one day every five years. Thus at least every two to five years the wetlands can expect to receive sufficient water to initiate wetland processes. For many species, however, the water is unlikely to persist for long enough for completion of processes such as reproduc tion. This may require a rainfall event with a return frequency of five to ten years. Thus, if an individual wetland is likely to be inundated every two to five years then extrapolation to a region suggests that for mobile organisms such as waterbirds, there is a high probability that wetland habitat will be available somewhere in the region during every rainfall season. But it may only be suitable for breeding once in every five years. This accords with observations of the pannetjiesveld (Bushmanland) when pans are rapidly colonised by thousands of waterbirds of a variety of species, many of which are considered endangered (Hines 1989). It also raises many questions.

TABLE 4: Computed one day duration extreme rainfall (mm) for various return periods and mean annual precipitation (MAP) in mm. Selected towns are also shown. Adapted from Richardson & Midgley (1979).

TOWN	MAP (mm) (approx)	COMPUTED ONE DAY DURATION RAINFALL (mm) FOR RETURN PERIODS (years) of :			
		2	5	10	20
Keetmanshoop	150	26	43	59	80
Mariental	200	30	47	63	84
Windhoek	350	41	58	73	92
Outjo/Okaukuejo	400	43	61	76	95
Grootfontein/Namutoni	450	46	64	79	97
Tsumeb	550	51	69	84	102

Where do the birds come from? How do they know where to go? What benefit do they gain from the 'migration'? What are the patterns of 'migrations' in a regional context and over what time scales do they operate? These are some important conservation questions which can be answered through the study of Namibian wetlands. By studying these wetlands it is possible to make a valuable contribution to both local and regional (southern African) conservation initiatives. In addition, since the wetlands are not unique in the global context, although they are under-researched, the principles enunciated from such studies would attract international attention.

CONCLUSIONS

I believe there is good evidence to suggest that the wetlands of Namibia have similar determinants and attributes to those in other arid parts of the world. But, because wetlands in such regions have been poorly researched, research on Namibian wetlands would attract international attention, particularly if the studies are designed to elucidate the interconnectedness of wetlands in a regional context and if the studies are related to regional rainfall patterns. It is also likely that the wetlands will be shown to have high conservation value.

It is on the basis of these conclusions that I would suggest that inventory and research work on the wetlands of Namibia would make a very valuable contribution to the theory and practice of wetland conservation.

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