WETLAND LOSSES IN SOUTH AFRICA

D C KOTZE[1], C M BREEN[2] & N QUINN[2]
[1]Grassland Science Department
University of Natal
PO Box 375
Pietermaritzburg
3200

[2]Institute of Natural Resources
University of Natal
PO Box 375
Pietermaritzburg
3200

Abstract

There is a general lack of information concerning wetland losses in South Africa. That which does exist, however, indicates clearly that the loss of wetlands has been high, with loss appearing to be greatest in the coastal belt and inland margin zones of South Africa. As wetlands have many values to society, this paper emphasises that a concerted effort should be made to collect wetland loss information for South Africa. It is stressed that in order to plan for the effective conservation and management of wetlands, quantification of wetland loss should be done in terms of wetland type, the causes of wetland loss and the physiographic features of areas where loss is occurring. The various techniques available for assessing wetland loss are also discussed and recommendations are made for a national wetlands inventory. In addition, it is considered important that the loss of specific wetland values (e g water purification) is considered and that human factors contributing to wetland loss are accounted for. Finally, it is emphasised that unless efforts to estimate wetland loss form part of a national wetland conservation strategy that gives adequate consideration to the human factors contributing to wetland loss, efforts to collect wetland loss information will be wasted.

1 Introduction

Potential threats to large and conspicuous wetlands such as Lake St Lucia have generated a great deal of public interest. However, what many people fail to recognize is that the man-induced loss of smaller, less conspicuous, but collectively no less important, wetlands has been occurring insidiously in South Africa over approximately the last century. For most of South Africa, the extent and degree of wetland loss have not been determined. However, estimates for the USA show that more than 54% of the wetland area has been lost, 87% of this to agricultural development. There is evidence to suggest that a similar trend in wetland losses has occurred in South Africa (Walmsley 1988). In the Mfolozi catchment, for example, Begg (1988) estimated that 58% of the original wetland area had been lost, which left only 2% of the 10 000 km^2 catchment occupied by wetland.

The Ramsar Convention, ratified in 1971, bound all signatories, which included South Africa, to include wetland conservation as a national policy and to promote sound wetland utilization. As is the case for many of the other countries, South Africa has not met its obligations as a signatory of the Ramsar Convention. There are still internationally recognized wetlands in South Africa (e g Nylsvlei) that have not been registered as Ramsar sites and that, consequently, do not command the commitment to conservation that is warranted. Furthermore, the myriad of smaller less obvious wetlands has largely

been overlooked and there is still no national policy and strategy for the protection of wetlands (Breen 1991).

Wetlands perform many functions that have indirect value for society, such as improving water quality, regulating streamflow and providing habitat for wetland dependent plants and animals, many of which are rare or endangered. For example, of the 108 bird species included in the Red Data Book - Birds (Brooke 1984) 36 are wetland dependent (Goodman 1987). Wetlands also provide resources, such as grazing lands (which are particularly valuable in drought years) and recreational areas (Findlayson & Moser 1991). Consequently, their loss should be viewed in a serious light.

A wetland is considered to be "lost" if it has been degraded or developed to the point that it has lost a significant amount of its natural functional values, as would occur if it was severely eroded or drained and planted to pastures. Such wetlands are sometimes described as relict. It should be noted, however, that although the term wetland loss is in common usage, it is somewhat misleading because it implies that wetland loss is irreversible. Although substantial engineering structures may be required to rehabilitate severely eroded wetlands, most wetlands are readily rehabilitated provided that the original hydrological conditions are reinstated.

The purpose of this paper is to:

(1) place wetland loss in South Africa in context, describing some of the consequences of wetland loss;

(2) discuss wetland loss in South Africa as it relates to particular geographical areas, wetland types, causes of loss and human factors contributing to loss;

(3) discuss the methods and approaches used for estimating wetland loss (including comments on a national wetlands inventory) and

(4) suggest a strategy to assist in preventing further loss in the future.

2 Wetland loss in South Africa in context

The extent and nature of wetlands are determined largely by the interaction of climate and physiography - wetlands occur where there is an adequate water supply and a place in the landscape where the water will accumulate. For example, endorheic pans, which occur in depressions without drainage line outlets, are mainly restricted to the interior plateau zone of South Africa, which is characterized by extensive areas of flat topography (see Figure 1) (Breen, Heeg & Seaman 1993). In contrast, endoheric pans are largely lacking from the inland margin zone, which tends to be topo-graphically

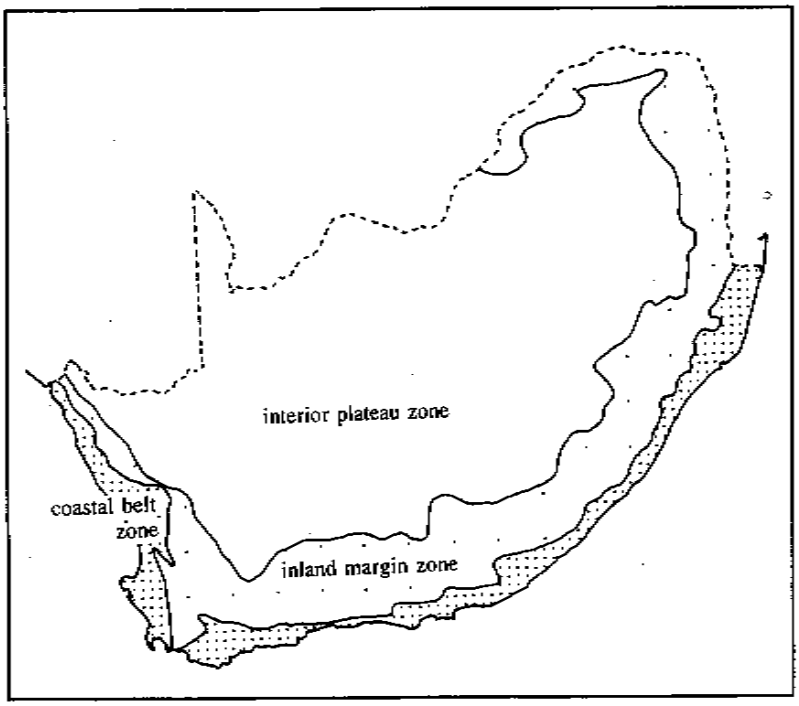

Figure 1: Broad physiographic regions of South Africa

steep and characterized by wetlands associated with drainage lines. South Africa's climate is largely semi-arid with most of the interior plateau having a mean annual rainfall of less than 500 mm (see Figure 2). The physiography of the inland margin zone is generally steep and not conducive to wetland formation. In addition, with the exception of the Mozambique coastal plain in Natal, extensive flat areas in the coastal belt are also fairly limited. Consequently, the natural extent of wetlands in South Africa is low and individual wetlands tend to be small. Climate and physiography also have an important bearing on land-use activities, which, in turn, are responsible for wetland loss. Thus, it is hypothesized that climate and physiography would provide a useful framework for examining wetland loss.

Owing to the limited extent of wetlands in South Africa, their destruction is likely to be of even greater consequence than if the wetlands were larger and more extensive, particularly when considered in the context of South Africa as a water-poor country. Breen and Begg (1989) emphasize that in a semi-arid region such as South Africa, some important consequences of wetland loss are

- lower agricultural productivity
- poorer water quality
- less reliable water supplies
- increased incidence and severity of downstream flooding
- threatened wildlife resources (e g loss of wetland habitat is cited as an important reason for the decline of wattled crane (*Grus carunculata*) in the Transvaal [Tarboton 1984] and marsh harrier: *Circus ranivorus ranivorus* [Steyn 1982] in the South-Western Cape) and
- an inevitable increased incidence of species extinction.

In South Africa, wetlands fall under three types of ownership:

(1) private property;

(2) common property and

(3) state property.

The type of ownership has an important bearing on the nature of the problem of wetland loss, which complicates the development of a satisfactory solution to the problem (see Sections 5 and 6). Broadly speaking, however, there are two kinds of wetland loss:

- deliberate loss through devel-opment (e g drainage for planted pasture production or flooding by a dam), which most commonly occurs in private property areas
- and inadvertent loss through poor management, which primarily results in erosional degradation and occurs on both private and common property. In the Mfolozi catchment, for example, the loss of wetlands to erosional degradation has been as prevalent on privately owned commercial farms as on communally used tribal areas, contrary to what is often commonly believed (Begg 1988).

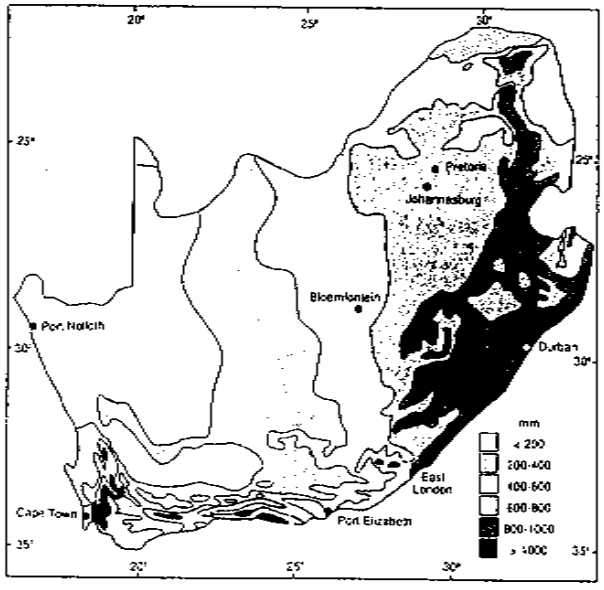

Figure 2: Mean annual precipitation over South Africa (adapted from Department of Water Affairs 1986)

3 The extent of wetland loss in South Africa

In order that the information about wetland loss be used constructively for the future conservation (wise use) of wetlands, loss should not be expressed only in terms of an overall percentage, but should also indicate

- which wetland types have been lost
- what the major causes of wetland loss are (and possibly also the extent to which they are likely to pose a threat to wetlands in the future) and
- what physical and geographical features characterise the areas where the most loss has occurred (e g wetland loss may be expressed according to individual bioclimatic regions).

Unfortunately, in South Africa there is a lack of such information. Even the Mfolozi catchment wetland inventory of Begg (1988), the most thorough of its kind in the country, does not relate wetland loss to wetland type or physical and geographical features, nor does it attempt to quantify the causes of wetland loss. Nevertheless, it has made a significant contribution toward drawing attention to wetland loss in South Africa by providing an accurately assessed case study catchment, mapped at a 1: 50 000 scale.

Assessment of the effect of wetland loss on loss of wetland functions is also lacking (e g little is known about the minimum area required by particular wetland dependent species and how they are affected by habitat fragmentation).

3.1 Extent of wetland loss as it relates to wetland type and causes of loss

Wetland loss results from both on-site activities, which occur at the wetland site and from off-site activities in the wetland's catchment. The causes of wetland loss vary in the extent to which they have been responsible for the loss of different wetland types. Those on-site causes that appear to be responsible for most of the wetland loss in South Africa are agricultural and urban development, erosional degradation and dam construction (Table 1). Erosional degradation usually results from injudicious grazing management. Other on-site causes that have considerable impacts on individual wetland sites, but that have resulted in less overall wetland loss include road construction, afforestation, dumping of solid waste, mining and toxic waste disposal.

The most significant off-site factors are those that disrupt the flow regime responsible for wetland maintenance (e g dams and water abstraction). Also important are those factors that increase the loss of sediment from the catchment and consequent increased sediment deposition in the wetland (e g injudicious grazing and crop production practices). Owing to the large size of their catchments, estuaries are particularly susceptible to off-site factors. As such, the key to conserving estuaries not only involves wise management and land-use allocation within estuaries but also depends on wise management of the overall catchment, so as to minimize off-site impacts. The loss of inland wetlands in semi-arid and sub-humid regions also serves to illustrate

Table 1: The extent to which the most important causes of wetland loss in South Africa have resulted in loss of different wetland types

	WETLAND TYPE					
CAUSES OF LOSS	Inland marshes	Bogs/ seeps	Flood-plains	Pans	Swamp forests	Estuaries
On-site causes						
Agricultural development	3	1	3	1	3	1?
Erosion	3	3	2	1	1?	1?
Dams	3	3	2	0	0	0
Urban development	2	1	3	1	2	2
Off-site causes						
Excess sediment	2	1	1	1	1	3
Input water disruption	1	1	2	1	2	3

Extent of Wetland loss
0 = negligible, 1 = low, 2 = intermediate, 3 = high

the importance of wetland catchment management. In these regions heavy utilization of natural grazing areas in the catchment reduces grass production and cover, and causes soil compaction, thereby increasing run-off peaks and forcing animals to utilize the wetland areas more heavily. These effects, in turn, render the wetland more prone to erosional degradation.

From a regional planning point of view it is important to note that the primary causes of wetland loss vary from region to region in accordance with different land-use pressures and differences in susceptibility to disturbance of the various wetlands encountered (Begg 1988). In Natal, and probably elsewhere in the country, wetlands in the coastal belt have primarily been lost to cropland and, to a lesser extent, urban and industrial development. The Mfolozi Swamps, which is the largest fluvial coastal plain in South Africa, has been reduced through agricultural development to 43% of its previous extent (Begg 1988).

In the semi-arid areas of the inland margin zone, wetlands tend to be very prone to water erosion, and erosional degradation appears to be the most important cause of wetland loss. While drawing attention to the fact that accelerated erosion results from poor land-use practices (e g heavy grazing pressure), Begg (1988) concluded that there is little doubt that erosion has been the most important factor contributing to the destruction of wetlands in the Mfolozi catchment. Another example is that given by Acocks (1953) who notes that a feature of the Karroid Merxmuellera Mountain Veld replaced by Karroo was the removal of deep, black vlei soil of the mountain valleys through erosion. He adds that the loss of this soil is, for practical purposes, irreplaceable.

In the high-rainfall areas of the inland margin zone, where soils are more leached and less prone to erosion, loss has primarily been due to wetland drainage (for planted pastures) and inundation by dams. Franklin vlei, for example, has been reduced by agricultural development and damming from 2 500 ha to 1 060 ha (Begg 1986).

A popular misconception with regard to dams that is still prevalent, even among some conservation-minded individuals, is: "the wetter the better". From a habitat perspective, this is often not the case. When wetlands are inundated by dams, the new habitat provided by dams usually benefits generalist species of which feeding and breeding areas are not threatened (e g Egyptian goose *Alopochen aegyptiacus*). In contrast, the habitat required by specialist wetland dependent species, such as the endangered white-winged flufftail (*Sarothrura ayresi*), is lost when a wetland is inundated.

Although general statements can be made about the loss of different wetland types, there is a lack of information detailed enough to assess the impact of wetland loss on biotic diversity. This can only be done satisfactorily if a national wetland inventory is conducted that not only includes wetland location and size, but also indicates wetland type. In other words, the development of a wetland classification system should form an integral part of a national wetland inventory. Such an inventory will then provide a basis on which to ensure adequate representation of each wetland type and its associated plant and animal communities. Without the overview that this inventory will provide, the conservation status of individual wetlands cannot be determined, nor can the urgency of protection be assessed. Breen and Begg (1989) note that it is evident from the literature on South African wetlands that there have been no attempts to measure either within-system or between-system diversity (i e alpha and beta diversity) and to understand the mechanisms regulating diversity (e g the effect of fragmentation of wetland habitat).

Furthermore, data on the quantification of loss are scarce at even a broad level. The database for estuaries is, however, substantially more comprehensive than for the other broad wetland types. Begg's (1978) initial survey of 73 of Natal's estuaries indicated that 28% were in a poor condition. A survey of the estuaries of the Cape and Natal (Heydorn 1986) showed that 53% of the Cape and 46% of Natal estuaries were in a poor condition. The application of a community degradation index (Ramm 1990) to 62 estuaries in Natal revealed that 44% were strongly or severely degraded. The recent development of an Estuarine Health Index (Cooper *et al* 1993) has at least provided a basis for regular monitoring of the status of South African estuaries.

3.2 Extent of wetland loss as it relates to broad physiographic zones

Owing to a lack of data, it is difficult to comment on the extent of wetland loss in the different regions of South Africa other than that given for the Mfolozi catchment and for estuaries (see Section 3.1). However, certain general observations can be made. Wetland loss has been greatest in

(1) the coastal belt, where human population densities are high and the extent of agricultural, urban and industrial development is also high. In the Siyaya catchment (Natal North Coast), for example, 93% of the wetland existing in 1937 had been lost by 1966 (Begg 1986). This loss was primarily due to agricultural development for planting sugar cane. Wetland loss has been very high in many of the coastal towns and cities. For

example, Cape Town City Square was once a wetland with hippos as was the Louis Botha Airport in Durban (Begg 1986) and

(2) in semi-arid areas of the inland margin zone, where wetlands are very prone to erosion. In the riverine-lowland (Bioclimatic region 10, according to Phillips 1973), for example, it has been estimated that over 90% of the wetland areas have been severely eroded (Department of Agriculture and Technical Services 1972). Here, rainfall erosivity and the erodibility of soils typical of wetlands in this region (e g the Rensburg form) are high.

In arid and semi-arid areas of the interior plateau, such as the panneveld areas of the Western Orange Free State, wetland loss tends to be less. Geldenhuys (1981) notes that in the Western Orange Free State, the number of seriously disturbed pans are few relative to the total number of pans. In such areas, human population densities are low and the wetlands are less prone to erosional degradation because they are not associated with channels and have depression landform settings, which lack outlets. In addition, many of these wetlands have soils that are unsuitable for agricultural development (Seaman 1971). The loss of pans in the Lake Chrissie area of the Transvaal was also found to be relatively low (Breen *et al* 1993) despite this having a moister climate.

As discussed earlier, wetland loss due to erosion tends to be low in the humid areas of the inland margin zone. However, loss due to pasture production and flooding by dams appears to have been relatively high for much of this area, particularly in Natal.

4 Methods and approaches for estimating wetland loss

From the discussion so far, the importance of collecting wetland loss information has been emphasised and recommendations have been made concerning collecting specific information such as wetland type and causes of wetland loss (i e *why* the information should be collected and *what* information should be collected). The question remains: *how* should the information be collected? The purpose of this section is to examine this question.

Owing to the large areas that need to be covered and the small size of many wetlands, measuring wetland loss is likely to be a lengthy and expensive task. In the USA, hydric (wetland) soil maps and regularly updated land-use maps are used for rapidly determining the percentage loss of wetlands. This is done by measuring the extent to which development-orientated land-uses correspond with hydric soil areas. Unfortunately, in South Africa, information on land-use and on hydric soil information is only available for limited areas. Thus, alternative means of estimating wetland loss need to be sought. Airphoto interpretation offers a possible means. The Mfolozi inventory (Begg 1988) demonstrated the effectiveness of this technique for estimating wetland extent and loss. Since South Africa has a good airphoto coverage, with the scale of most photos ranging from 1: 20 000 to 1:50 000, this technique certainly has potential. However, it is labour intensive and, in addition, most airphotos are not georectified, making it inaccurate to directly transpose the boundaries of wetlands delineated on photos directly onto maps.

Orthophotos, which are at scale of 1: 10 000 and are georectified, offer an alternative. However, their use would also be labour-intensive and furthermore, orthophotos are not available for the whole country. More rapid, lower-resolution techniques that provide full coverage of the country at a lower cost (notably satellite imagery) will need to be evaluated for their usefulness. Satellite imagery data, while being of a relatively low resolution (e g Landsat TM data have a resolution of 30 m by 30 m) are also costly. However, they have the advantage of being well suited for regularly updating wetland inventories (i e monitoring). The disadvantage of satellite imagery is that because of its lower resolution, small wetlands (i e those smaller than 1 ha in extent, depending very much on wetland type) will not be accounted for. In addition, certain wetland types (e g seasonal or temporary wetlands that occur in high rainfall areas) are not effectively detected using remote sensing (Thompson & Tapson 1994). An investigation commissioned by the Department of Environmental Affairs and Tourism is currently under way examining the cost-effectiveness of various techniques with which to make an inventory of the wetlands of the Natal Drakensberg. While remote sensing techniques (i e airphotos and satellite imagery) may be useful for determining wetland loss over large areas, field verification is also required. In this regard, one of the most valuable tools for determining wetland loss in the field is by examining the soil. Even when drained, wetland soils retain distinct morphological indicators of previous wet conditions that can be readily observed without requiring laboratory analysis (Tiner & Veneman 1988).

A national wetland inventory (including information on wetland type and wetland loss) is one of the key elements of a conservation strategy for wetlands (World Wide Fund for Nature 1992). Before under-

taking a national wetland inventory it is important to emphasise that despite the fact that characterization of wetland type is important for the planning and management of wetlands, there is no agreed upon wetland classification system for South Africa. Thus, as stated before, the development of a classification system for the wetlands of South Africa should form part of a national wetland inventory.

A Department of Environmental Affairs and Tourism workshop, in March 1994, dealt with the use of remote sensing for wetland mapping and monitoring. It was agreed that regional wetland inventories at a scale of at least 1: 50 000 should be undertaken for the whole country. However, due to the length of time these high resolution inventories would take, the workshop agreed that, as an interim measure, a broad-sweep overall national inventory should be undertaken as a matter of urgency. This would be valuable in

(1) providing the basis for a national wetlands status and trends report;

(2) assisting in identifying priority areas for wetland conservation/reclamation and

(3) focusing attention on those areas that most urgently require local/regional inventories. In the USA the first wetlands status and trends report that was produced sufficiently alarmed the USA government to pass the Emergency Wetlands Resource Act of 1986 (Thompson & Tapson 1994).

The authors are of the opinion that this initial national inventory would best be undertaken by

(1) collating and synthesing existing information and

(2) stratifying the entire country and obtaining information about wetland types, the natural extent of wetlands and level of loss from the sample areas (at a regional/local resolution) within all strata. Basic scientific principles of sampling would be applied. The results would then be interpolated across the whole country, based on observed climatic, physiographic and cultural features of the sample areas. For demonstration purposes a map has been produced at a very low resolution using the obviously incomplete wetland loss data reported on in this paper (Figure 3). This map could be greatly improved in resolution and accuracy by undertaking the proposed national inventory. The added advantage of having sample areas would be that they would provide described areas on which to build regional or local inventories and could also form the basis for a future monitoring programme.

The alternative to this sample approach would be to cover the whole country at a very low resolution. The disadvantage of this approach would be that only large wetlands (those > ca 50 ha) would be sampled and less detail on the past histories of individual wetlands would be obtained, making it difficult to determine the extent of wetland loss that has occurred in the past. Only the current extent of large wetlands would be obtained, which could neverthe-

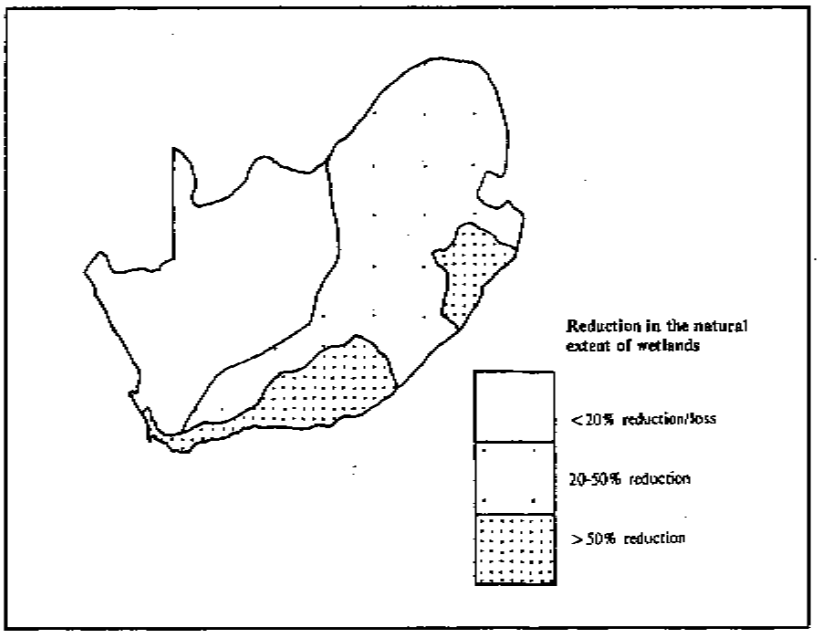

Figure 3: Hypothesised extent of wetland loss, based on the extrapolation of information from the isolated reports presented in this paper and using the climatic and physiographic information given in Figures 1 and 2

less serve as the baseline for future monitoring of changes in wetland extent. It would, however, not be of immediate value for estimating wetland loss.

5 Human factors contributing to wetland loss

While it is important that the physical causes of wetland loss are identified, the ultimate causes are, in fact, socio-economic. As such, some of the socio-economic factors considered to be important have been identified.

- There is a lack of appreciation by the private and public sectors of the functional values of wetlands (e g in a Department of Water Affairs [1986] publication on the management of the water resources of South Africa, no mention is made of the important role wetlands may play in improving water quality).
- There is no national policy for implementing a wetland protection and restoration strategy.
- The legislation affecting wetlands is weak and there has been an apparent reluctance on the part of administrators to apply it.
- In the past, certain government departments actively promoted wetland destruction through development. This was particularly prevalent in the years following the Second World War and was motivated by the drive to promote economic growth. Begg (1990) draws attention to the fact that wholesale drainage of wetlands for urban and industrial development on the outskirts of Durban, Pietermaritzburg and Richards Bay was condoned and subsidised and as recently as 1980, agricultural techniques deliberately designed to convert wetlands to alternative land-uses were being developed by the then Department of Agriculture and Fisheries (Hill *et al* 1981). However, in the last ten years, a marked change in the attitude of government departments dealing with wetland development has occurred. Nevertheless, although government departments no longer actively promote wetland development, there is still much to be done concerning the development and coordination of a wetland conservation strategy (see Section 6).
- Coordination within and between the various government departments, research bodies and NGOs concerned with wetland conservation is poor and resources allocated to wetland issues are inadequate.
- For certain types of wetlands (e g those with a low grazing and waterfowl value) the direct economic benefits that the wetland user may derive from the wetland in its undeveloped form is low compared with the direct economic benefits that could be derived if the wetland was developed.
- As wetlands often form the focal point of landscapes used for domestic stock production (including both the commercial and subsistence sectors) they often bear the brunt of any injudicious grazing practices.
- The demographic growth, a declining economy and rising poverty occurring in South Africa, have resulted in people making management decisions they know to be environmentally unsound in order to survive.

6 Development of a strategy for wetland conservation

The loss of wetlands is likely to continue unless a well-coordinated wetland conservation strategy is implemented in which resources and effort are optimally deployed by addressing the best targets with the most appropriate mechanisms. From the discussion so far, it is clear that human behaviour and perceptions will need to be changed if the current trend in wetland loss in South Africa is to be reversed. Dugan (1992) considers that in southern Africa the quantity and the quality of information on wetlands and their values need to be increased and communicated more effectively to ministerial-level decision-makers, government departments having an impact on wetland resources (e g nature conservation and agricultural extension workers), NGOs and local people using wetlands (e g commercial farmers and communal graziers).

Since human perceptions and behaviour vary between and among social groups, the effectiveness of different wetland conservation strategies is likely to vary depending on the target group involved. For example, a regulatory control strategy (i e disincentives) is likely to be more successful when applied to an affluent target group than when applied to a poor one. Thus, there is no simple recipe for developing a wetland conservation strategy as it will need to be both dynamic and targeted. The World Wide Fund For Nature (1992) has, however, identified six key elements that a strategy should contain (Table 2), which could be adapted and applied to the South African situation. They have also provided general guidelines for strategy development that are equally applicable. According to the World Wide Fund For Nature (1992) a strategy should

- reconcile environmental and economic needs and identify opportunities to reduce conflicts between development and conservation interests
- build on the strengths of existing programmes of relevance to wetlands (e g SHARENET or the conservancy programme) and existing wetland

Table 2: Elements of a conservation strategy for wetlands

1	An overall goal (e g no nett loss of wetlands)
2	Information about the country's wetlands (i e where they are located and what type) and the threats that put these wetlands at risk
3	An assessment of current wetland protection efforts
4	An action plan: * develop an appropriate management structure with recognized legal sanction * identify targets (sectors of the population) * match targets and mechanisms (incentives and disincentives)
5	Funding strategy
6	A monitoring and evaluation plan

conservation initiatives (e g policy proposals for the wetlands of Natal and KwaZulu [Begg 1990] would be very useful in the development of a national wetlands policy)

- include national, regional and local policies and programmes. (In the province of Natal, for example, policies for wetlands (Begg 1990) have not achieved their objectives due partly to the absence of both national and local policies and strategies) and
- promote landscape (catchment) approaches as a basis for wetland habitat conservation and management decisions.

7 Conclusions

From the discussion so far, it has been demonstrated that, with the exception of estuaries and a few isolated catchments, there is a lack of data about wetland losses in South Africa. Nevertheless, from what limited data are available, it is clear that the loss of some wetland types has been very high, particularly in certain geographical areas. It would appear that wetland loss has been greatest in the coastal belt and inland margin zone of South Africa. Although deliberate loss of wetlands due to drainage has decreased, partly because of a shift in government policy, loss due to flooding by dams continues largely unabated. Loss of wetlands due to poor management leading to erosion is also still prevalent, particularly in semi-arid regions.

Although many people are not aware of it, South Africa's exponentially growing population will become increasingly dependent on wetlands. It is, therefore, in their interests that wetland loss information be obtained. A national wetlands inventory should be undertaken as a matter of urgency. A stratified sampling approach described in this paper is considered to be the most effective means of providing the much needed national picture of wetland loss. If this information is to be used constructively it is also important that it forms part of a national wetland conservation strategy which identifies the key wetland-user target groups and matches these with appropriate mechanisms. Such a strategy should include measures to

(1) improve regulatory and non-regulatory protection

(2) promote awareness of wetland functional values and

(3) coordinate wetland research and inventory.

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