An evaluation of the potential for restoring degraded estuaries in South Africa

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Abstract

In this paper, the potential for restoring degraded estuaries is evaluated by applying a proposed restoration procedure to the severely degraded Eerste-Kuils Estuary in the Western Cape. Degradation has resulted from inappropriate development adjacent to the estuary and other effects of urban and rural activities in the river catchment. Despite the diffuse causes of degradation a number of restoration opportunities are seen to exist. These include the application of a "receiving water quality objectives" approach to waste-water effluent standards and the entrustment of regional functions to the Western Cape Regional Services Council.

Constraints to restoration are found to include its cost, the difficulty of relocating existing inappropriate land uses and the lack of a co-ordinating river authority. Although legal, administrative and economic restoration opportunities do exist, local authorities, communities and landowners must be convinced that tangible benefits can result from a restoration programme if it is to be successful. The existence of tangible benefits is a key prerequisite for the commitment and co-operation needed to implement possible restoration strategies.

Introduction

The degradation of South Africa's estuaries is already a cause for concern and accelerating population growth, concomitant development activities and an increasing demand for recreational facilities mean that the threat to estuarine ecosystems and resources is likely to increase. In his analysis of the state of the estuaries in the Cape and Natal Provinces, Heydorn (1986) found that almost a third were in a 'poor' condition.

A recognition of the value of estuarine systems has resulted in efforts to restore their beneficial functions and characteristics. Internationally, attempts to restore degraded estuaries have focused on reducing pollution loads by improving waste-water processing methods (Goldsmith and Hildyard, 1988), the re-establishment of estuarine wetlands (Allen and Hull, 1987), reducing nutrient loading and eutrophication by structural (e.g. settling basins) and functional (e.g. alternative fertiliser products) methods, and reducing industrial pollution by renegotiating effluent discharge permits (Collett and Leatherland, 1985).

In South Africa, restoration efforts have taken place in Natal, but none have yet been reported in the Cape. Rehabilitation of the Siyaya and Sipingo estuaries in Natal involved the re-establishment of riparian vegetation and the restoration of wetland systems (Begg, 1984; Natal Town and Regional Planning Commission, 1986). Restoration of the Sezela estuary included efforts to recycle industrial waste water, adopt improved effluent treatment methods and co-ordinate the use of herbicides and artificial breaching techniques to flush invasive plants and anoxic sediments to the sea (Begg, 1984; Ramm et al., 1987).

These efforts have necessarily addressed the symptoms and causes of degradation on a case-by-case basis, since few documented guidelines for estuarine restoration exist in South Africa. In particular, little is known of the social, economic or legal opportunities and constraints related to estuarine restoration.

In an attempt to improve this situation, a study was initiated in 1987 (Brownlie, 1988) to investigate estuarine restoration techniques adopted elsewhere, synthesise relevant knowledge and experience available in South Africa and develop a broad but practical approach for restoration projects. The report emanating from that study provides an implementable approach to estuarine restoration based on "leading questions", tables of restoration options and technical and legal notes relevant to each option.

This paper presents a hypothetical application of Brownlie's (1988) approach using the degraded Eerste-Kuils River estuary in the Western Cape as an example. The principles underlying the approach are explored in order to identify some of the social, economic, legal and administrative implications of possible restoration strategies. Opportunities for, and constraints to the restoration of degraded estuaries in South Africa are thus illustrated.

Estuarine restoration principles

Four principles underlie Brownlie's (1988) approach to estuarine restoration. They are:

- the symptoms of degradation must be identified;
- the probably causes of these symptoms must be determined;
- a desired "restored state" of the estuary must be chosen; and
- alternative strategies to achieve the restored state must be evaluated.

The characteristics that determine the natural resource status of an estuarine system include water flow (river hydrology and tidal exchange), sedimentation, water quality, estuarine ecology and aesthetic qualities. Detrimental changes to one or more of these characteristics can result in symptoms of degradation. These changes may be evident as reduced recreational opportunies, reduced biotic diversity, a reduction of habitats, impaired aesthetic quality or even as a health risk.

The Eerste-Kuils Estuary

The location of the Eerste-Kuils River and features of the

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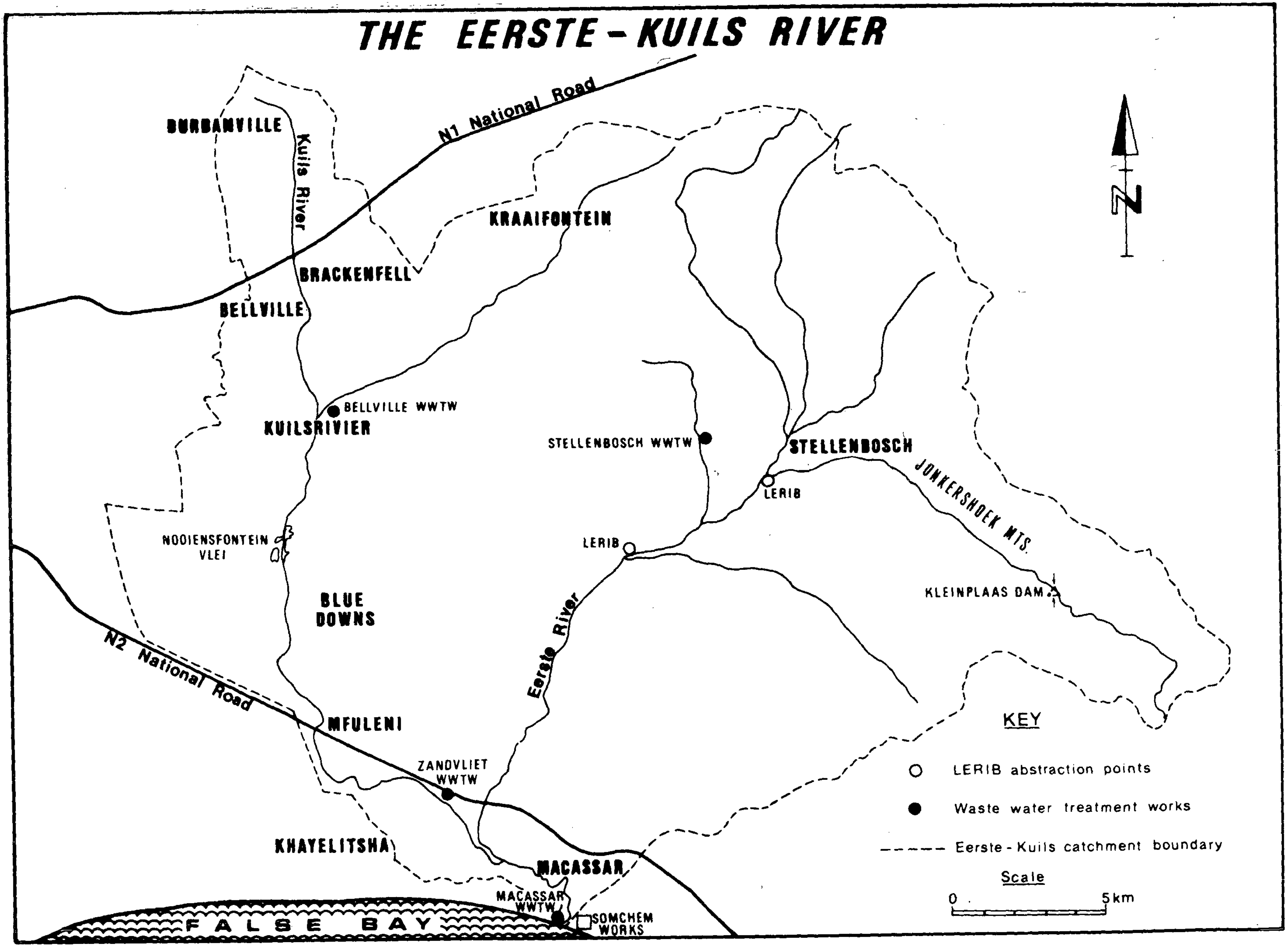

Figure 1
A map of the location

catchment are shown on the map (Fig. 1). The estuary is fed by the Eerste River, which rises in the Jonkershoek Mountains to the east, and the Kuils River, which rises in the northern part of the Cape Flats.

The estuary is situated in False Bay, about 36 km south-east of Cape Town. It is less than 2 km from the rapidly expanding Macassar residential area which has an expected population of 85 000 people when fully developed. Macassar Beach, a major regional recreation facility, is situated about 500 m west of the estuary. The east side of the estuary falls within the security area of a Somchem chemicals factory while the west bank is occupied by the Macassar waste-water treatment works. Access to the estuary is thus difficult and ultimately only possible from the west. Six municipalities as well as the Western Cape Regional Services Council and various Town Councils have authority within the Eerste-Kuils River catchment. Water is abstracted from the system by the Lower Eerste River Irrigation Board (LERIB in Fig. 1). Waste water is discharged to the system from 4 treatment works.

Application of the restoration principles

What are the symptoms of degradation?

The first stage of Brownlie's (1988) approach to restoration involves the identification of the symptoms of degradation. A review of available information relevant to the Eerste-Kuils River shows that these include altered river flow, increased flooding, poor water quality, reduced biotic diversity, impaired ecosystem functioning and reduced aesthetic and recreational values of the estuary (Heydorn and Grindley, 1982; Wiseman and Simpson, 1989). The estuary is thus degraded in terms of all of the estuarine characteristics described earlier.

What are the causes of degradation?

The symptoms of degradation exist as a result of activities in both the estuary and the river catchment. These activities are not described here, however, since they are addressed in detail below, when possible strategies for achieving the restoration objectives are examined.

What is a desirable restored state for the estuary?

Brownlie (1988) in her review of local and international estuarine restoration projects, found that appropriate and achievable restoration objectives can best be identified by the participation of the landowners, users, public interest groups, companies and local authorities that contribute to degradation or whose activities are affected by it. This means that the landowners, users, polluters and various authorities within the Eerste-Kuils River system should be involved in the identification of restoration objectives. Since these diverse interest groups are likely to have quite different agendas and objectives, negotiation and compromises are likely to be needed before an acceptable and achievable restored state of the estuary could be identified (Brownlie, 1988).

For the purposes of this study, it is necessary to identify a probable restoration objective for the Eerste-Kuils Estuary. In the light of the rapid urbanisation taking place adjacent to the estuary and the increasing pressure on nearby coastal recreational resources, a restoration objective that enhances the value of the estuary for recreational use and sustainable exploitation appears to be appropriate. This implies restoring ecological functions so that estuarine organisms can be sustainably exploited and undertaking action to restore aesthetic qualities and amenity values.

What are possible restoration strategies?

In order to develop a strategy to achieve the above restoration objectives, it is necessary to examine each of the symptoms caused by degradation. In the remainder of this paper, possible methods of achieving the restoration objectives are identified and the likely social, administrative, economic and legal implications of each method are described.

Restoring river flow characteristics

Summer river flow in the Eerste River ceases due to water abstraction for irrigation (Wiseman and Simpson, 1989). Compensation water is released from the Kleinplaas Dam, but this is entirely abstracted before it reaches the estuary (Petitjean, 1987). In contrast, the flow of the Kuils River has been substantially increased by the discharge of waste-water effluent to the system (ibid).

Restoring the river flow characteristics of the Eerste River can be addressed by either reducing the amount of water that is abstracted, or increasing the amount of "compensation water" released from the Kleinplaas Dam. No legislation remedies exist to implement these measures since the provision of riparian water rights for agriculture in the Water Act 54 of 1956 does not include conditions to maintain the in-stream flow needs of rivers. Hence, if additional water is released from the dam, downstream farmers may abstract the extra water before it reaches the estuary.

Two potential methods to allow river water to reach the estuary in summer can nevertheless be identified:

- Firstly, additional "compensation water" can be bought from the dam operators, the Department of Water Affairs and Forestry, for the benefit of the estuary.
- Secondly, additional water releases from the dam can be allocated for the environmental benefit of the river and estuary by the Minister of Water Affairs and Forestry in terms of either Section 56(3) or 62(21) of the Water Act.

These sections provide for the allocation of water to specific users in Government Water Control Areas such as the Eerste River.

To be successcul both of these methods require not only a financial commitment to the restoration project, but also the co-operation of agricultural water users. Thus some form of co-operative agreement between the Department of Water Affairs and Forestry and water users would be needed.

The discharge of waste-water effluents to the Kuils River has affected the estuary mainly in terms of water quality, rather than river flow. The restoration of water quality in the estuary is addressed later on in this paper.

Restoring flood characteristics

Winter spates in the Eerste River are largely unaffected by activities in the catchment, whereas the flood characteristics of the Kuils River have been altered by extensive urbanisation on the Cape Flats (Wiseman and Simpson, 1989). Although severe flooding problems occur in the Kuils River catchment, and will get worse unless remedial measures are taken (Ninham Shand,

1989) these affect the system during the wet winter months and do not appear to have contributed to the degradation of the estuary in terms of the restoration objectives. Techniques to restore the flood characteristics of the Kuils River are thus not considered further.

Improving water quality

Three major sources of pollution exist in the Eerste-Kuils River system, viz. waste-water effluent, runoff contaminated by agricultural residues, and storm-water runoff from urban areas (Wiseman and Simpson, 1989). Pollution in the estuary should be addressed in terms of Lusher's (1984) criteria for beneficial uses of coastal waters. Beneficial uses in terms of the restoration objectives include direct contact recreation, the collection of aquatic life for food and the maintenance of ecosystems.

The restoration strategy should therefore begin with a survey to identify pollutants that are present in concentrations exceeding Lusher's (1984) criteria for those uses. Since no such survey has been undertaken, an analysis is presented of potential strategies for reducing the input of nutrients to the estuary. Nutrients contribute to the occurrence of aquatic weeds, algae and scum which are key determinants of the acceptability of water bodies for recreational activities (Thornton and McMillan, 1989).

Waste-water effluents

All waste-water effluents that are discharged to rivers or the sea are required to meet standards prescribed by the Department of Water Affairs and Forestry in terms of the Water Act of 1956. Until recently uniform "General Standards" were applied to discharges to all rivers, although stricter "Special Standards" (including limits for nitrogen and phosphorus) are prescribed for certain "sensitive" rivers (Department of Water Affairs, 1986). The Eerste River has been declared a "sensitive" river, although permits and exemptions issued by the Department of Water Affairs and Forestry allow "General Standard" effluent to be discharged to both the Eerste and Kuils Rivers (Wiseman and Sowman, 1991).

The Department of Water Affairs and Forestry has, however, announced a new policy for effluent standards, called the "Receiving Water Quality Objectives" (RWQO) approach (Van der Merwe and Grobler, 1990). The new approach involves prescribing site-specific effluent standards according to the pollution load from non-point sources and the water quality needs of other water users. Applying the RWQO approach could thus result in the enforcement of the "Special Standards", or even stricter standards, should they be necessary for recreation or the "environmental conservation" of the estuary (Van der Merwe and Grobler, 1990).

Prescribing stricter effluent standards will, however, result in increased waste-water treatment costs. Since the benefits associated which stricter standards many not accrue to the community bearing the costs, for example in the case of the Bellville waste-water treatment works, the importance of involving all groups and communities in the restoration process is highlighted.

Furthermore, an opportunity to subsidise increased waste-water treatment costs is provided by the Water Act of 1956 (Section 162). Subsidies can be approved where environmental conservation or "hygiene" considerations require such improvements (Department of Water Affairs, 1986).

An additional opportunity to reduce the nutrient load of effluent discharges exists, since the Minister of Water Affairs and Forestry is empowered by the Water Act of 1956 to require that manufacturers remove substances thought to cause pollution from their products. Synthetic laundry detergents account for between 35 and 50% of the phosphorus load of waste-water treatment works (Wiechers and Heynike, 1986) and hence removing phosphorus compounds from detergents could reduce the nutrient load of waste-water effluents. This strategy has been attempted elsewhere in Southern Africa (e.g. Thornton and Boddington, 1989). Constraints to its usefulness were found to include the higher cost of phosphorus substitutes, different by-products arising from the substitutes and consumer resistance to non-foaming detergents (ibid). Nevertheless, public awareness programmes and further research into phosphorous substitutes could allow this potential strategy to be utilised.

Opportunities for reducing the nutrient load of waste-water effluents thus exist in the form of the RWQO policy, and legislative provisions for subsidies and for the removal of phosphates from detergents. Each of these opportunities entails costs which, together with some social constraints, must be addressed if waste-water effluent quality is to be improved as part of a restoration strategy.

Agricultural runoff

Agricultural activities in the Eerste-Kuils River catchment may contribute pollutants to the river and estuary in the form of pesticides and fertilisers which contaminate runoff. A water quality survey should thus include chlorinated hydrocarbons and other compounds associated with agricultural remedies, since many of these have possible health effects (Goldsmith and Hildyard, 1988). Although such a comprehensive survey would be both technologically complex and costly it is necessary that the skills needed for these analyses are developed if restoration efforts are to address this issue.

Reducing contaminated agricultural runoff to the river must begin with the identification of critical areas that contribute unwanted pollutants. The involvement of farmers, agricultural officers, pesticide and fertiliser manufactures, hands-on users and scientists is required in order to identify critical areas and solutions.

Few legal provisions exist in South Africa to control the excessive or inappropriate use of agricultural chemicals. Both the Fertilizers, Farm Weeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 and the Conservation of Agricultural Resources Act 43 of 1983 contain relevant provisions, but to date these have not been exercised in ways which could aid restoration efforts (Fuggle and Rabie, 1983; Wiseman and Glazewski, 1991).

Authority to prevent water pollution occurring due to farming operations is granted to the Minister of Water Affairs and Forestry in terms of the Water Act of 1956 (S23a). Although the authority to enter upon land to undertake measures for this purpose has been delegated to the Regional Director, Water Pollution Control (Government Notice No 966 of 19/5/1989), authority to determine whether a farming practice or substance causes water pollution remains at ministerial level.

The Department of Water Affairs and Forestry's policy in this respect is one of coercion and co-operation rather than of confrontation (Department of Water Affairs, 1986) and hence techniques of persuasion could be the focus of this restoration strategy. Such co-operative restoration strategies have been successful in Australia, where a slow-release fertiliser was developed to replace the more soluble superphosphates (Hodgkin and Birch, 1986), but a similar effort in South Africa reportedly failed (Begg, 1984). In Natal, changes in land-ownership and government representation caused a loss of interest in and commitment to the restoration project. Hence, elements of continuity and commitment are needed in addition to participative restoration planning.

Urban stormwater runoff

Large areas of low-cost high density residential development occur in the lower reaches of the Kuils River catchment, including for example the rapidly growing Khayelitsha township. Parts of Khayelitsha are served by the "bucket system" of sewage collection, and large areas have surface stormwater canals and gravel roads. A recent study (Ashton and Grobler, 1988) found that of the total phosphorus that entered a similar high-density, low-income township in the Orange Free State, 68% found its way to the catchment surface in the form of waste products.

A number of methods exist to improve stormwater quality, including detention basins, microstrainers, dissolved air flotation and improved street cleaning and waste collection. In terms of phosphorus removal from stormwater, microstrainers or dissolved air flotation are reportedly successful, but involve high capital and running costs (Wanielista, 1978). Similarly, the extension of reticulated sewage to the whole township will reduce the sewage contamination of stormwater, but entails high capital expenditure and will result in a point rather than diffuse source of phosphorus. Possible in-stream stormwater management devices include swirl regulator/concentrators and diversion boxes, designed to divert the important 'first flush' pollution load of stormwater (Urban Transport Group, 1987). These will, however, also effectively result in an additional point source of phosphorus unless an acceptable alternative discharge point can be found. An important part of the restoration planning process must therefore be an assessment of the relative significance of point and diffuse source of pollution.

Ordinarily, responsibility for stormwater drainage systems in residential areas is a local authority function. In the case of the Kuils River, however, the problems associated with the divided responsibility for stormwater management have been recognised and the function of stormwater management in the Kuils River catchment has been entrusted by the Administrator of the Cape to the Western Cape Regional Services Council (WCRSC) in terms of the Regional Services Councils (RSCs) Act of 1985 (Provincial Notice 454 of 19 May 1989). The initial focus of the WCRSC in this respect has been the implementation of flood attenuation measures and the formulation of a river management policy (Wiseman, 1990; Ninham Shand, 1989). The regional functions of RSCs thus provide an important opportunity to coordinate stormwater management in river systems, although it is not yet clear to what extent RSCs will be able to influence the design of stormwater drainage systems for new urban areas or provide funds for existing systems to be upgraded. Another possible strategy to improve water quality may be to restore and protect wetland areas.

Two important wetlands exist on the Kuils River, viz. the Nooiensfontein Vlei in the middle reaches of the river and the Khayelitsha wetlands above the confluence with the Eerste River. The Nooiensfontein Vlei is dominated by the aquatic weed water hyacinth *(Eichhornia crassipes)* and both systems are under intense pressure to be developed.

The importance of the Nooiensfontein Vlei for flood attenuation and nutrient removal has been recognised and plans to limit encroaching development and control the water hyacinth are being addressed (Ninham Shand, 1989). The Khayelitsha wetlands, however, have already been incorporated to a large extent into the Khayelitsha project area. This contradicts the recommendations of the Cape Metropolitan Area Guide Plan (Department of Development Planning, 1988) that a substantial area of the wetlands should be retained as open space. The provisions of the Guide Plan must therefore be more rigidly enforced for the protection of wetlands as a restoration measure to be successful.

Improving biotic diversity and ecosystem functioning

The potential to reduce the spread of algae and invasive aquatic plants is largely dependent on the effectiveness of measures to improve water quality and to reduce the nutrient load of the river. Alternatively, invasive plants can be harvested as a control measure. Since both the invasive plants water hyacinth *(Eichhornia crassipes)* and parrots feather *(Myriophyllum aquaticum)* are "noxious aquatic growths" in terms of the Cape Nature Conservation Ordinance No. 19 of 1974, there should be few constraints to the implementation of an eradication programme for these weeds.

The eradication programme, however, must include the removal of invasive plants upstream if re-infestation of the estuary is to be avoided. Upstream local authorities must thus be encouraged to support a programme even though direct benefits to communities within their area or jurisdiction are not immediately apparent.

Pollution events that affect the macrofauna of the estuary (Bartlett and Hennig, 1982) may also be addressed as part of the restoration of estuarine ecological functions. Suitable provisions for the prosecution of pollution offenders exist in the Cape Nature Conservation Ordinance of 1974, but in practice the Water Act of 1956 is likely to be more appropriate for this function due to its wider powers and larger maximum fines. Although some legal difficulties of convicting pollution offenders have been noted (Wiseman and Sowman, 1991; Wiseman and Glazewski, 1991), the existence of trained lawyers for pollution control in the Department of Water Affairs and Forestry and recent increases to the fines possible under the Water Act of 1956 mean that the deterrent function of the Act will improve (Department of Water Affairs and Forestry 1991). The training of specialised prosecutors in the Department of Justice could further enhance the deterrent value of the Act (Wiseman and Glazewski, 1991; Breyer-Menke and Moffat, 1989).

The Department of Water Affairs and Forestry can also enlist the aid of local authorities to help control pollution since the Water Act of 1956 provides that polluted effluent or stormwater runoff from industrial areas within a local authority's jurisdiction is the responsibility of that local authority (S21(3)). This effectively links the restoration objectives for the estuary with local authorities and industrial activities in the river catchment, thus providing an important opportunity to reduce pollution events as part of an estuarine restoration strategy.

In addition to the problems of invasive aquatic plants and the occurrence of algae and scum, riparian vegetation in the Eerste-Kuils River estuary has been adversely affected by trampling, grazing, off-road vehicles and wood collection (Heydorn and

Grindley, 1982). These disturbances have encouraged the spread of the invasive Port Jackson *(Acacia saligna)* and rooikrans *(Acacia cyclops)*.

The identification of measures to restore the indigenous riparian vegetation in the estuary must address the needs of existing users in order to find acceptable ways to restrict or control access. It may also be necessary to find alternative fuelwood sources and cattle grazing areas. Efforts to restore the terrestrial vegetation in the estuary, however, are unlikely to receive a high priority unless the issue of inappropriate and aesthetically undesirable development existing in the estuary is satisfactorily addressed.

Restoring aesthetic and recreational values

The recreational and aesthetic restoration objectives for the estuary require that land use and development in the estuarine zone be addressed in addition to water quality and ecological issues. The existing Macassar Sewage Works reduces the aesthetic and recreational values of the estuary due to its unsightly appearance, the occurrence of odours and the discharge of effluent to the estuary. Both the sewage works and the Somchem factory also impede access to the estuary. Little potential for the restoration of land use exists since, as Brownlie (1988) points out, "it is highly unlikely, where changes in land use have resulted in degradation, that meaningful shifts in land-use patterns could be attempted retroactively as a restoration measure." Nevertheless, changing land use can be effected as a restoration strategy if relevant government agencies, local authorities and landowners perceive needs, benefits and opportunities for such changes. The restoration process could include the identification of an alternative, more desirable site for the Macassar Sewage Works. Alternatively, future expansions to the works could be curtailed and additional treatment capacity provided elsewhere.

Although existing development apparently represents a severe constraint to the restoration of the estuary, future development plans, changing economic conditions and enhanced social perceptions can ensure that aesthetic and recreational values of the estuary are improved and not further degraded.

Discussion of restoration strategies

The amenity and resource values of the Eerste-Kuils Estuary have been degraded by inappropriate development adjacent to the estuary and the effects of rural and urban activities in the river system. Some of the activities that have directly or indirectly contributed to degradation are remote from the estuary itself. This examination of the causes of degradation has nevertheless found that a number of opportunities exist to enhance and restore beneficial uses of the estuary.

Government control of water releases from the Kleinplaas Dam, for example, could allow water to be allocated for the environmental conservation of the river and estuary. Although other water users pay a tariff for compensation water, a water allocation for the estuary can be successful if a co-operative agreement between water users, the operators of the dam and those promoting restoration can be reached. Such an agreement can be facilitated if tangible benefits can be shown to result from it.

Attention must also be focused on the summer flow of treated waste water to the estuary from the Kuils River. The "Receiving Water Quality Objectives" approach to the management of effluent quality provides an important opportunity to address water quality in the estuary. Improving the quality of effluent discharges will necessarily entail increased capital and running costs for local authorities operating waste-water treatment works in the river catchment. Subsidies for part of these costs can be provided by the Department of Water Affairs and Forestry, but the remaining costs must be borne by the local authority and recovered from ratepayers.

Other possible strategies exist to improve stormwater management systems in the catchment. In particular the entrustment of the function of stormwater management in the catchment area of the Kuils River to the Western Cape Regional Services Council provides a significant opportunity for the co-ordination of future stormwater management activities. It is not yet clear whether funds for devices to improve the quality of runoff reaching the river could be made available.

The restoration of the aesthetic qualities of the estuary requires a commitment by nearby local authroties and landowners to changing land use in the estuary. Such a commitment will only occur if there is public pressure to restore the estuary, or the relevant local authorities or landowners perceive that tangible benefits could result from relocating existing development away from the estuary. This can be achieved through pro-active environmental awareness programmes.

It can be seen that the choice and success of restoration strategies for the estuary is dictated by the objectives and likely results of the restoration programme. Restoration objectives are needed which can result in visible benefits within a relatively short period of time. This is necessary in order to gain the commitment of local, regional or central government authorities as well as co-operation between relevant authorities.

A major constraint to the restoration of the Eerste-Kuils Estuary is thus that local communities and authorities have yet to perceive the degradation that has occurred, or to recognise the opportunities for recreation or for the sustainable exploitation of estuarine resources that have been lost. This may be associated with socio-political and historical factors that have tended in the past to exclude low-income communities from resource planning and decision-making processes (Khan, 1990).

Conclusions

The potential for the restoration of the degraded Eerste-Kuils Estuary has been examined here with respect to the approach reported by Brownlie (1988). In accordance with this approach the symptoms and causes of degradation have been identified, a desirable restoration objective has been chosen and possible strategies to achieve this objective have been examined.

The choice of the Eerste-Kuils Estuary for this analysis may represent a "worst-case" scenario for estuarine restoration. The causes of degradation are diffuse, existing throughout the river system and estuary, and a number of groups and authorities in the estuary and river catchment must participate in the various restoration strategies if they are to be successful. Divided administrative control and the lack of a single river authority is currently a major constraint to restoration of the estuary.

Despite these complexities, opportunities and legal mechanisms to implement possible restoration strategies do exist. Foremost amongst these appears to be the "Receiving Water Quality Objectives" approach to effluent quality requirements. This approach could allow the quality of effluent return flows in the river system to be improved for the beneficial uses of environmental conservation and recreation in the estuary.

In the Eerste-Kuils River system neither this new policy nor the "polluter pays" principle have yet been widely implemented. Instead the inter-catchment transfer of water to supply the greater Cape Town area has effectively disassociated the quality of the water source from the quality of waste-water effluents. This means that the cost of waste-water treatment for disposal is unrelated to the cost of water purification for supply. Current financial planning and investment programmes for waste-water treatment will thus have to be radically revised if the "Receiving Water Quality Objectives" approach is to be successfully implemented as an estuarine restoration strategy.

Estuarine restoration thus far in South Africa has resulted from the efforts of pressure groups or the weight of vested interest in an estuary, rather than the implementation of legislative or procedural opportunities that were otherwise unexploited. The amenity and resource values of the Eerste-Kuils Estuary will thus remain degraded unless an affected group or community perceives the degradation that has occurred, identifies a need for restoration and shows that tangible benefits could result from enhancing and restoring the status of the estuary. This issue must be addressed in the earliest stages of any effort to restore a degraded estuary if the necessary commitment and co-operation for the implementation of restoration strategies are to be found.

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