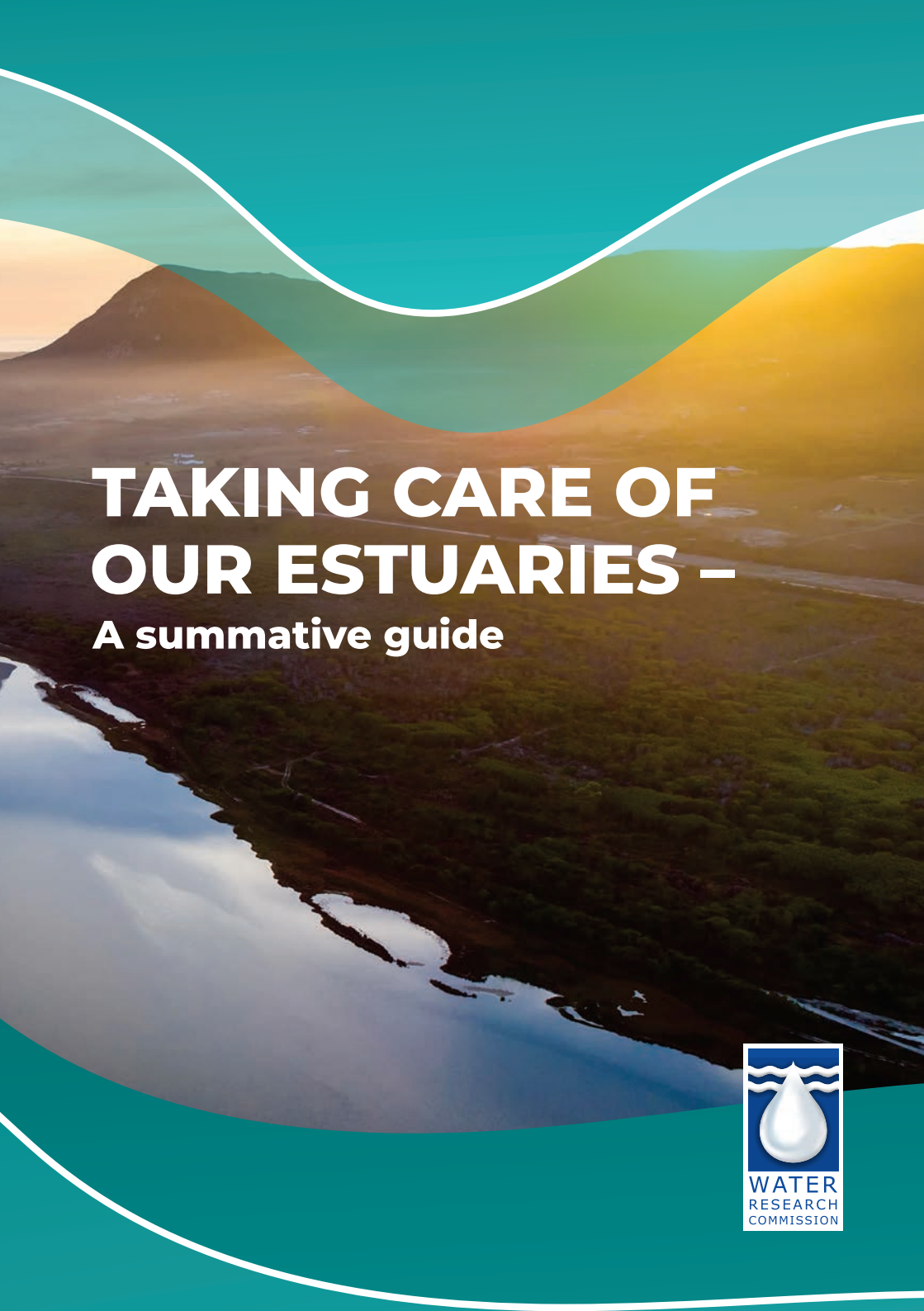

TAKING CARE OF OUR ESTUARIES –

A summative guide

WATER RESEARCH COMMISSION

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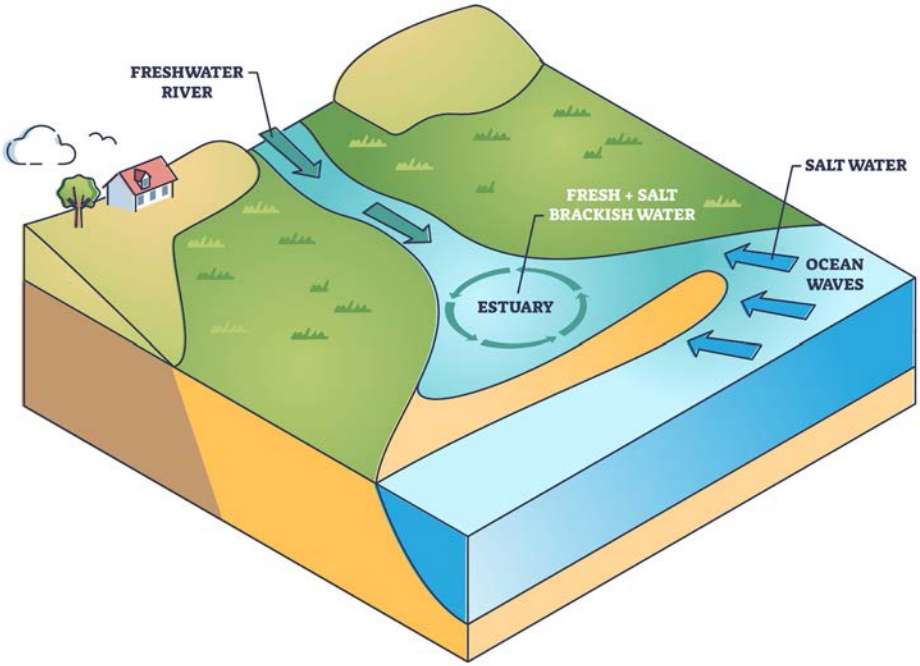

Estuaries form where a river meets the sea. They are the portion of a river system, which has, or can have, interaction with the sea. Unlike estuaries elsewhere, most South African estuaries are prone to closure by sand bars, which block off the mouth for varying lengths of time. During this closed phase, direct interaction with the sea stops.

DIFFERENT TYPES OF ESTUARIES

Permanently open estuaries

Permanently open estuaries are usually quite large systems with a perennial river and/or strong tidal exchange with the sea. Examples include the Breede, Swartkops and Mlalazi estuaries. Under low river flow conditions, tidal exchange is sufficient to keep the mouth open. The sea is the dominant influence on the estuary, but during floods, river influence is evident right down to the mouth. Permanently open estuaries have been known to close briefly during drought, but under normal conditions, they do not close.

Steve Crane/Flickr

The Kaaimans Estuary, located in the Western Cape at Wilderness, is a permanently open estuary.

Temporarily closed/open estuaries

About 70% of South African estuaries fall into this category. Examples include the Groen, van Stadens and Mhlanga estuaries. These estuaries are often closed for many months each year, and sometimes for more than a year at a time. Temporarily closed/open estuaries usually have small catchments and limited penetration by tidal waters when they are open. Mouth opening events usually occur after periods of high rainfall. River flow and tidal exchange are not sufficient to keep the mouth open. During very high seas, marine water sometimes washes over the sand bar at the mouth and 'tops up' the estuary on the other side.

River mouths

All rivers flowing into the sea have a river mouth. The categorisation 'river mouth estuary' reflects properties other than the presence of a mouth. These estuaries are usually permanently open to the sea. The river, and not the sea, dominates the physical processes within these estuaries. When high river flows occur, the mixing zones between freshwater and seawater can be pushed offshore, and marine water is unable to enter the estuary. Examples include the Orange, Mzimvubu and Thukela river mouths.

Estuarine lakes

Estuarine lakes occur where a coastal lake is connected to the sea by a channel of varying length and width. The mouth of an estuarine lake can be either permanently or temporarily open. Because they are usually large and shallow, water temperatures in these systems are more related to solar heating on their surfaces than to the influence of the temperature of either rivers or the sea. Examples include Swartvlei, St Lucia and Kosi.

St Lucia is an example of an estuarine lake.

Estuarine bays

Examples of estuarine bays in South Africa include Durban Bay, Knysna and Richards Bay. These estuaries have wide mouths with strong tidal exchange, resulting in a continuously open mouth and the regular replacement of marine water in the lower and middle reaches. Even under high flow conditions, seawater salinities persist in the bottom waters of the lower reaches as the dense freshwater flows over the more dense seawater. Water temperatures in an estuarine bay are more strongly influenced by the sea than the river.

HOW LARGE ARE OUR ESTUARIES?

South Africa's estuaries are small by world standards. We have around 260 functional estuaries and together they are smaller than the Chesapeake Bay system on the eastern seaboard of the United States.

South African estuaries range in size from the sizeable Lake St Lucia (32 500 hectares) to the tiny Mkumbane Estuary (0.3 hectares). Most South African estuaries have surface areas smaller than 50 hectares. Water depths are also highly variable and range from less than a metre in many small, temporarily closed/open estuaries to more than 10 metres in some of the larger estuarine lakes and bays.

THE PHYSICAL PROCESSES IN ESTUARIES

Tidal exchange
Incoming (flood) tides force seawater into estuaries, raising the water level. Water levels near the mouth decrease more quickly than higher up on the outflowing (ebb) tides. The difference in water level can result in strong outflowing currents. In large estuaries (e.g. Knysna), tidal exchange helps keep the mouth open.

Deposition and removal of sediments
Deposition and removal of sediments are very important processes. Erosion, when the sea level was lower than at present, created the physical form of the estuary and cycles of deposition and removal of sediments modified this. Rivers bring in sediment from the land and, during floods, they scour sediment out. In addition, wind and coastal currents transport marine sediment into and out of estuaries.

When river flow is low, the river and incoming tides may bring in more sediments than outflowing tides can remove. This causes the mouth of the estuary to shallow or close. Deposited sediments are stabilised by plant growth, which increases resistance to erosion.

The supply of sediments to estuaries is very variable from both the land and the sea. Most estuaries of KwaZulu-Natal receive high loads from land and sea, so they are greatly modified by sediment accumulation. By contrast, the estuaries along the Tsitsikamma coast are much less modified by sediment deposition. Estuaries change continuously as sediments accumulate and then are scoured out to sea.

CHEMICAL PROCESSES IN ESTUARIES

The ability of an estuary to support plants and animals depends largely on the physical and chemical characteristics of the water column and sediments. Typically, estuaries exhibit a mix of river and seawater and of material brought down by the river and transported in and out by the sea. This mix is modified by the growth, death and decay or organisms living in the estuary, and by alternating processes of sediment deposition and resuspension, which trap or release nutrients and toxic materials.

The result is a unique chemical environment, which is highly variable in time and space and which can change suddenly. There are usually marked salinity differences between the upper and lower parts of an estuary. This salinity gradient is an important determinant of biological processes. Rivers transporting large sediment loads can reduce the clarity of the water. This can also occur when dissolved organic matter in river water is mixed with seawater. The resulting particular material is an important food source for estuary animals.

Werner Bayer/Flickr

The salt pans near Velddrift are rich in birdlife due to the abundant food supply.

BIOLOGICAL PROCESSES IN ESTUARIES

Many organisms (e.g. prawns, crabs and some fish) have to spend time at sea to complete their lifecycles and movement in and out of estuaries promotes the exchange of genetic material. The seasons and cycles of the moon commonly determine when these movements occur. The chemical composition of water flowing out to sea provides cues that orient animals so they can enter or return to estuaries.

Organisms respond to changing conditions. Changes in salinity, nutrient content of the water and sediment deposition favour some species over others.

Estuaries act as nurseries for many marine animals.

HUMAN PROCESSES IN ESTUARIES

Estuary condition reflects human behaviour in the catchment, in the sea and in the estuary. Land and water use patterns result in less and less river water and more and more sediment and waste products reaching estuaries. Activities along the coast can change wind and sea currents, altering patterns of sand transport and deposition. Harvesting marine and estuarine organisms also decreases populations in estuaries.

The construction of causeways and jetties and activities, such as power boating, alter the patterns of deposition and erosion in estuaries. Together with other activities, such as trampling, digging for bait, and over-fishing, they reduce populations, disrupt behaviour patterns and destroy habitats.

The nature and character of estuaries are also greatly affected by development within the catchment and by activities occurring on the estuary. Managing how people use estuary goods and services lies at the heart of achieving sustainable, complementary use.

Swartkops estuary. Human development can have a severe impact on estuarine processes.

PLANTS IN ESTUARIES

Plants living in estuaries vary from large trees (e.g. mangroves) to tiny algae floating in the water. Each species has special requirements, which determine where it lives. Changing conditions also determine when they come and go.

The six plant community types found in South African estuaries:

- Small algae (microalgae) – On mud, sand and bigger plants, large populations of these organisms give surfaces a green or brow tinge.
- Large algae (macroalgae) – present in almost all estuaries and comprise two main groups, those with a threadlike (filamentous) form and those that are firmly attached and have a leafy (thalloid) form.
- Submerged large plants (macrophytes) – These rooted plants have stems and leaves, which may reach the water surface.
- Salt marshes – As the name suggests, salt marshes have saline soil and few species can tolerate these conditions. One or two species usually dominate, and may include grasses and fleshy plants. Salt marshes provide protection for certain invertebrates (e.g. crabs) and are a source of organic litter, which sustains many species.
- Mangroves – These are trees and shrubs that grow in tidal and saline coastal areas. They occur naturally in parts of our warm estuaries from the Kosi system to the Kei Estuary.

- Reeds and sedges – The presence of these species in estuaries usually indicates fresh or brak (slightly saline) water conditions. Reeds and sedges are particularly important sources of energy and nutrients during the freshwater phase of some estuaries. They also provide material for craftwork and construction.

Gerry Lynch/Flickr

Reeds at St Lucia.

Peter Prokosch/Flickr

A closeup of the salt marshes at Langebaan.

ANIMALS IN ESTUARIES

Large animals, such as crocodiles and hippos, were formerly widespread but nowadays their presence is largely restricted to estuaries in conserved areas. Animals differ from plants in that they can move, and many actively seek favourable conditions in estuaries. Salinity, type of substratum (rock, sand, mud) and presence of other species (e.g. submerged plants) influence the distribution and abundance of individual species.

Generally, the diversity of marine species declines up the estuary and the diversity of freshwater species declines towards the mouth. There are few truly estuarine species, and estuaries have lower species diversity, but higher abundance, than adjacent fresh- and marine systems.
The types of animals found in an estuary may include:

- Invertebrates – These are animals such as crabs and worms that don't have a backbone. Invertebrates are very important processors of living and dead plant material, making energy and nutrients available to other species.
- Fishes – Various groups of fish can be found in estuaries. The dominant group are marine species that breed at sea and use estuaries as nursery areas for their young. The second most important groups comprise truly estuarine species, which breed in estuaries and spend all or most of their lives within these systems.
- Birds – the variety of food resources and habitats provides opportunities for a diversity of bird species. Waders, waterfowl, kingfishers, cormorants, gulls, terns, egrets and herons may be found in and around estuaries. These birds may feed on vegetation, invertebrates or fish. There are more bird species found at East Coast estuaries than at West Coast estuaries.
- Other vertebrates – Historically, animals such as crocodiles and hippos were common in South African estuaries. Today, they are largely confined to protected estuarine lakes such as St Lucia and Kosi. Other predatory vertebrates that make use of estuaries include two species otter and the water mongoose.

Craig Adams/Flickr

A wide variety of bird species is found in estuaries.

Nowadays, large animals, such as hippos, are only found in sanctuaries such as iSimangaliso Wetland Park.

ESTUARY FOOD WEB

Food webs in estuaries are arranged around producers, decomposers and consumers. The producers are mostly plants. The large primary producers (mostly macrophytes) in estuaries are generally not directly consumed (eaten). Instead, they supply material which decays and is broken down by microorganisms (mostly bacteria and fungi). The result is fine particles or organic material (known as detritus), which is consumed by a wide variety of animals, including invertebrates (such as prawns) and fish.

Food webs in estuaries are complicated by their connections to freshwater systems, which are in turn strongly connected to land and marine systems. These sources augment (grow) detritus originating within the estuary. Much of the detritus accumulates on the surface of the mud where it is consumed by benthic organisms, which live in or on the substratum. These include above-surface filter feeders (such as mussels and clams), sub-surface filter feeders (such as mud prawns), crabs and worms.

Most of the animals that consume detritus are invertebrates. They then provide food for secondary consumers (e.g. predatory fish) and ultimately tertiary consumers (e.g. predatory birds and man). Detritus forms the main food base for almost all estuarine animal life, and the abundance of this resource is the main reason for the high productivity of these systems.

THE VALUE OF ESTUARIES

WHY DO WE NEED ESTUARIES?

Estuaries are focal points for community and business activities along the coast as they provide us with a wide range of opportunities and benefits. They are an important location for cultural and recreational activities for both coastal residents and visiting tourists.

Millions of households make use of estuaries every day. People live on properties close to estuaries to enjoy the attractive setting. They visit estuaries for fishing, water sports, and cultural outings. Many people rely on productive estuaries as a source of food, such as fish, for household subsistence.

Not only do estuaries enhance the quality of life for households, but they also provide numerous opportunities for jobs and income generation. Many businesses rely on estuaries to perform functions that have economic value, such as providing a nursery for marine fish and crustaceans, for transport, or for a place to provide facilities for tourists, which in turn helps to support businesses and jobs in the coastal region.

Local government benefits by generating substantial revenue from higher rates that result from elevated property values next to estuaries. More rate revenue means more services can be supplied to coastal communities.

Other benefits are supplied by estuaries that have little to no cost to users. For example, the abilities of estuaries to control or reduce flooding and to improve the quality of water provide major benefits to coastal communities. These benefits ensure that other economic activities, such as tourism, are maintained at a minimal cost to the local council.

As a consequence of these benefits, coastal communities, tourists and local governments on the coast depend on estuaries. For example, where would the Durban, Knysna, Velddrift, and Kosi communities be without estuaries at their back doors, or how would their economies look if the estuaries were only capable of providing half the current quantity of benefits? Because estuaries are natural features, the opportunities they offer are free. Free goods and services are seldom accorded their proper value and are thus commonly abused.

Rowan Pybus/Flickr

The traditional method of fishing used by the Tsonga community at Kosi Bay has been passed down through generations.

WHAT DO WE USE ESTUARIES FOR?

Estuaries provide a range of goods and services to communities. For example, local households and tourists can directly use estuary goods such as fish, plant fibres and bait. In turn, estuary processes provide services such as waste treatment, flood water control, erosion control and nutrient cycling (the process by which essential nutrients move between living organisms, the atmosphere, and the Earth, allowing them to be recycled and reused).

EXAMPLES OF ESTUARY GOODS AND SERVICES

- Nurseries for fish/ crustaceans
- Corridors for migratory birds
- Water supply and regulation
- Sediment supply and regulation
- Erosion control
- Waste treatment
- Food and bait production
- Nature appreciation
- Sport fishing
- Transport services
- Cultural values

WHY SHOULD WE MANAGE ESTUARIES?

Each of the goods and services provided by our estuaries has value. Apart from their financial value, healthy estuaries also benefit the economy. For example, in a fishing town such as St Lucia, several hundred jobs are created through meeting the variety of needs of local people and visitors using the estuary.

In other estuaries, such as those along the Pondoland and northern KwaZulu-Natal coasts, communities living around estuaries can harvest fish to feed their families.

When we make use of the goods and services from estuaries, it can have unintended consequences. For example, we can generate pollution, decrease biodiversity, increase sedimentation and decrease the size of the estuary. These unintended consequences all reduce the overall capability of the estuary to continue to supply the desired services.

In many cases, the people who bear the costs of a negative impact, such as water pollution, may not be the group that causes the impact. This implies that we influence the lives of other people through the way we use estuaries.

This means that to optimise the benefits of using an estuary, we don't need to manage the estuary as much as we need to manage people's use of the goods and services provided to the estuary and by the estuary. We need to try and limit conflicting uses, where one use reduces the opportunities of other users, and we need to try to increase the number of complementary uses. The concept of managing an estuary is no different from managing road use. We share a resource (the road surface and traffic lights) and using it requires very specific behaviour, which includes respect for the resource (the road) and respect for other users. Failure to do so results in costs to everyone, while respect promotes great benefits to all the users. Estuaries are no different.

Estuaries should be regarded as an asset and should be managed to maintain their value. The failure to do so can have major cost implications for local governments and communities.

INFLUENCE OF HUMAN ACTIVITIES

Slack12/Flickr

Many South African estuaries are considered great tourist attractions.

Estuaries are directly influenced by human activities occurring away from the estuary, on land and in the sea, and they are directly influenced by human activities occurring within the bounds of the estuary. All human activities that may impinge on estuaries are regulated and it is, therefore, possible to manage the influence they have on estuaries.

CONSEQUENCES OF ACTIVITIES IN THE CATCHMENT

Supply of freshwater decreases

Freshwater is an increasingly scarce resource in South Africa. Legislation makes provision for the allocation of water to sustain people and the structure and functioning of rivers and estuaries. Only after this requirement has been satisfied can the remaining water be allocated for other uses.

Storage (e.g., dams) and abstraction have two important consequences for estuaries: the amount of freshwater reaching estuaries is reduced, and the pattern of supply (volume and

flow) changes. Estuaries require a continuous supply of freshwater to maintain salinity gradients. Where base water flow ceases, estuaries may assume characteristics of the sea (e.g., Kromme Estuary) or exhibit reversed salinity gradients with the highest salinity in the upper reaches (e.g., St Lucia Estuary).

Periodically, elevated water flows are usually required to keep the mouth open and flood events scour estuaries after periods of gradual infilling with riverborne and marine sediment.

Dams are usually of such a size that they exert their greatest influences on small and intermediate flood events, and on base flow, both of which are critical for maintenance of estuary structure and functioning. Their effects can be particularly severe for estuaries in small catchments, with many small impoundments (e.g. farm dams). Large (infrequent) floods overtop dam walls and are not usually attenuated to any significant degree.

Releases of water from dams can be used to maintain ecosystem integrity and satisfy the legal requirements for the environmental reserve. This is achieved by establishing an estuary management system which incorporates monitoring the condition of the estuary and linking this into the operating rules for releases from the impoundment.

Flickr

Some of South Africa's estuaries have been so altered by human development that they are hardly recognisable.

Sediment load changes

The balance between the supply of sediment to estuaries and its removal from estuaries is an important determinant of the ability of an estuary to produce goods and services useful to people. If we change this balance, we can radically alter the value we place on an estuary. Because the gradient (slope) of rivers usually decreases near the sea, river flow rate slows down and sediment is deposited; the estuary is infilled and its attributes change, most usually reducing its value to users.

River flow transports sediments to the estuary and high flows (floods) remove it to the sea. The growing demand for freshwater has required the construction of dams. Since these capture flows, there are now fewer flows of sufficient size to remove the sediment from the estuaries. Only big floods pass down the river and scour out accumulated sediment, and nowadays these usually also bring lots of sediment with them.

Many estuaries require river flow to remove marine sediment washed through the mouth. As more water is stored and used in the catchment, there is less available to help the ebb tide remove marine sediment. Estuary mouths close more frequently and stay closed for longer.

Water quality deteriorates

Apart from being essential for life, water is a medium for transporting material in suspended (e.g., soil particles) and dissolved (e.g., nutrients) states. As a result, every human activity affects the quality of water, either directly or indirectly. Agricultural, industrial and urban activities increase the load of suspended and dissolved substances in water.

Water draining the landscape transports these suspended and dissolved substances to estuaries, where they may accumulate with undesirable consequences. Suspended particles increase turbidity that changes both eh quantity and quality of light entering the water column. This decreases the depth at which plants can grow and reduces productivity.

Turbidity also reduces visibility and predation. Where freshwater and seawater mix, the properties of particles change, causing them to precipitate, so that those parts of estuaries with high salinities tend to have clear water. Sediment particles carry with them adsorbed nutrients that support plant growth and toxic substances, such as pesticides and heavy metals. If sediments contain sufficient organic material, microbial activity may deplete oxygen and create conditions that cause toxic substances to be released into the water.

Although human disease-causing organisms do not normally survive for long in saline parts of estuaries, they can survive long enough to cause serious health problems. When wastes and untreated sewage enter estuaries, the risk of infection is elevated.

Under exceptional circumstances, seawater entering estuaries can impair water quality. The most likely causes are pollutants (e.g., oil) and 'blooms' of toxic microalgae.

NMMU/WRC archives

Macroalgal blooms in the Knysna estuary, the result of pollution.

WHY SHOULD WE MANAGE ESTUARIES?

Estuaries are recognised as being one of the most valuable habitats on Earth. In a healthy state, estuaries continuously provide a variety of goods and services. Mostly, these arise at little or no cost. However, in an unhealthy state (e.g., when polluted), estuaries become a costly burden as ongoing remedial action is required to achieve acceptable conditions. Maintaining a healthy state requires continuous intervention in order to regulate the consequences of human activities and to adapt use to changing needs and circumstances.

Because different users have different requirements, they do not always share a common view of what constitutes a healthy estuary, or how it should be managed. Differences can be resolved only where all user groups strive to appreciate and accommodate the reasonable needs of all. All interested parties need to collaborate to manage the use of estuaries for the greatest sustainable benefit of society. Who are these parties and how do they organise and operate to achieve their vision of a healthy estuary? The South African Constitution and supporting legislation promote public participation in the management of natural resources.

The legislation governing estuaries

There are enough laws to ensure the sustainable development and protection of estuaries and surrounds. The trick is what combination of laws to use and how to use them to realise a particular goal. These laws include:

- The Constitution (including the Environmental Bill of Rights)
- National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)
- Sea Shore Act (Act 21 of 1935)
- Environmental Conservation Act (Act 73 of 1989)
- National Environmental Management Act (Act 107 of 1998)
- Marine Living Resources Act (Act 18 of 1998)
- Conservation of Agricultural Resources Act (Act 43 of 1983)
- National Forest Act (Act 84 of 1998)
- Minerals Act (Act 50 of 1991)
- Municipal Systems Act (Act 32 of 2000)

GETTING ORGANISED

Cooperative management, or co-management, is when people with a common interest or problem get together to plan and act in order to achieve a common purpose or solve a problem. In an estuaries context, it is when people with an interest in an estuary or a group of estuaries get together to plan and act to achieve certain goals related to an estuary or group of estuaries. In South Africa, there are a number of examples of the establishment of co-management

The Boesmans-Kariega Estuary Care Forum

A good example of an estuary management forum is the Boesmans-Kariega Estuary Care Forum, which was established in 1998 as EstuaryCare to manage and conserve the Bushman's and Kariega estuaries in the Eastern Cape. The goal of this non-governmental organisation is to manage these unique assets for the benefit of our local community and to promote tourism based on the sustainable use of natural resources.

Among others, the forum works with the municipality to care for and manage the estuaries; engages the community in its work, keeps an eye on property developments and issues affecting the estuaries; measures and documents benchmark conditions; and assists with and advises on the formulation and implementation of Government Policy regarding coastal and estuarine environmental management.
Source: https://estuarycare.co.za/

structures. Who should be involved? As a starting point, it is important to have the right people and organisations contributing to management. Starting with the government, it is the custodian of the nation's natural resources, including estuaries, and it regulates development activities. Many government entities may be involved in the management of estuaries, from the Department of Water and Sanitation, and the Department of Forestry, Fisheries and the Environment, to parastatals such as the local water and harbour authority and provincial and local conservation authorities.

Civil society, such as residents and ratepayers, tourism operators, developers, fisherfolk and harvesters, boat operators, environmental organisations, and community-based organisations, should also be involved.

How do we organise this co-management group? There are a variety of options depending on the number of stakeholders and the issues that need addressing. Ideally, the group should be organised into a formal forum with a constitution that contains its vision and goals and that guides its behaviour. Often, these groups are quite large and unwieldy, so it is useful to elect an executive committee that would meet monthly or every two months. The full forum might meet once or twice a year.

The need to organise is often the result of conflict around a particular issue. This conflict makes organisation difficult as groups are polarised. Ideally, one needs an independent party with strong credibility to assist with the organising process.

THE MANAGEMENT PROCESS

The figure illustrates a typical management cycle – a process of establishing a vision and goals, planning, carrying out the necessary actions, monitoring and auditing to determine the result of the actions and then refining the system. It is a system that allows for continuous change and improvement.

The estuary management process.

Vision and goals

A broad and shared vision is needed for the state of the estuary or section of the estuary of interest. This vision should be a broad statement of intent that looks into the future. A vision also allows people to think long term, enabling them to resolve differences and gain consensus towards a shared future.

The forum also needs to set some practical goals. These goals can pertain to developing management plans, working towards the desired state of the estuary, or establishing economic opportunities that develop local communities, as practical examples.

Planning

All stakeholders should sign off on the management plan. The success of co-management and of the plan is determined largely by the extent to which trust, credibility, legitimacy and empathy are developed and nurtured among stakeholders during the management planning process. If formal agreements are to be negotiated, they should not precede the planning process but should be an outcome of the planning process.

Once the agreement has been finalised, the co-management arrangement can be launched.

Generic structure for a plan

Part A: Policy, legal and institutional context (overview of relevant policies and legislation and organisations impacting the area)
Part B: General description of the estuary and its surrounds
Part C: Strategic plan (Vision, goals, institutional arrangements for estuary management)
Part D: Spatial plan (Zonation of the estuary, including preferred activities, and land use allowed with consent)
Part E: Sector plans (Optional plans for sectors that require specific management, e.g., harvesting of mangroves, recreational fishing, subsistence fishing, etc.)
Part F: Implementation plan (For each goal, there should be a list of actions required, including what is going to be done, who is going to do it, when it is going to be done, what it will cost, and ways of determining success)

Action

While management issues vary from estuary to estuary, experience has shown that there are five major issues which usually require a management response:

1. Poverty among people living at and around an estuary.
2. The harvesting of marine living resources. This includes fishing, bait collection, mangrove and reed harvesting.
3. Recreational use of the water, such as boating, swimming and skiing.
4. Physical development in and around estuaries, such as residential developments, roads, railways, bridges etc.
5. Changes to freshwater inflow into an estuary caused by activities in the catchment, such as dam and weir construction, irrigation and plantations, and inter-basin transfers of water.

The following are the most common actions to be taken in response to the above:

- Zone the estuary and its surroundings into different activity areas and determine the range of activities that may take place in each area.
- Regulate commercial, recreational and subsistence fishing, and the harvesting of other natural resources.

- Ensure compliance with existing legislation and/or assist authorities in drafting regulations that improve sustainable use.
- Ensure the safety of people in the area.
- Build the capacity of the forum and those it represents to manage more effectively through education, training, raising awareness and the generation and sharing of knowledge.
- Support development opportunities which promote sustainable use of the estuary and surrounds and also provide economic opportunities for residents.
- Lobby upstream residents in the catchment to ensure that water reaching the estuary is of the required quality and quantity to sustain the system.
- Rehabilitate areas that have been degraded.
- Ensure that the management plan and its implementation link to other planning and management processes, particularly the integrated development plans of municipalities, coastal management plans and catchment management plans.
- Establish a mouth management system for those estuaries that are open intermittently.
- Coordinate research to increase understanding of the system and/or to help answer specific questions for improved management.
- Monitor to determine progress in achieving the forum's goals.

Monitoring and auditing

A management decision for an estuary and the resulting action are as good as the information on which it is based. This information is collected through monitoring key elements and processes within the management process. Key elements at the broadest level would cover ecological, socio-economic and organisational systems. Achieving a balance between these elements will result in sustainable use.

In most circumstances, it is not possible and too costly to monitor everything. We need to find key indicators that will help us tell a story. Long-term monitoring programmes help to highlight trends, document ecosystem variability, and measure compliance with legal limits, etc. Short-term monitoring programmes can be designed to monitor compliance to legislated limits, such as quotas for mud-prawn harvesting and fish catches, and for testing the effectiveness of particular management interventions.

Monitoring could include some or all of these issues:

- Hydrological and sedimentary processes
- Water quality
- Biodiversity
- Human population growth
- Control of human activities
- Planning and development
- Law enforcement
- Cooperative governance and co-management
- Effective management
- Satisfying basic human needs

Refinement

Any management plan needs to improve as it progresses and to be able to adapt to changing circumstances. The monitoring and auditing will indicate whether our actions are having the desired effect.

Refinement can take place at a number of levels. At the most profound level, monitoring and auditing might show that the vision for the estuary is unrealistic and requires modification. Or, it might simply be a refinement of a specific action that improves performance and allows us to achieve a desired goal.

Linking to other processes

Managing the activities in and around an estuary does not happen in isolation. Some laws and regulations provide a legal framework in which estuary management must take place. In addition, there are other planning and management activities going on at different scales which can affect our own activities, both positively and negatively.

The two most important of these are:

- Integrated development plans established by local and district municipalities
- Catchment management plans

Key rules of management

1. Ecosystems are complex and people are complex so the management that takes place at the interface between people and ecosystems is very complex.
2. There are no substitutes for good leadership and good planning.
3. The world is not perfect – be firm on the vision but flexible and adaptable in the mechanisms you use to achieve the vision.
4. The more you know and understand, the better your decisions will be.
5. Know the law, follow it, and make it work for you.
6. Management is a process of learning and doing. Learning without doing gets you nowhere, and doing without learning results in costly mistakes.
7. You cannot manage alone. Gather people around, establish trust, build relationships, obtain commitment and communicate, communicate, communicate.
8. Start small, practice the management process and be realistic in your expectations.
9. In empowering others, we empower ourselves.
10. Think ahead and try to predict the consequences of your actions.
11. Everything takes longer than you think.

TOOLS TO ADDRESS SPECIFIC ISSUES

For estuary co-management to succeed, it needs support in the form of additional tools and guidelines that address specific issues. This section outlines some specific tools and guidelines to address two specific issues:

- Sustainable use of living resources
- Biodiversity protection

SUSTAINABLE USE OF LIVING RESOURCES

Due to increasing demands on estuarine living resources (fish, invertebrates, and plants), the development of an environmentally and socially acceptable strategy to ensure long-term sustainability is probably the biggest challenge facing fisheries managers in South Africa. Ultimately, the sustainable use of estuaries and their resources depends on improved law enforcement, compliance with regulations, and dedicated research and monitoring efforts through the development and implementation of an effective management system.

Pippa Dini/Flickr

A recreational fisherman at Kosi Bay.

PROCESS TO ASSIST IN PROMOTING SUSTAINABLE USE OF MARINE LIVING RESOURCES

1. Classify the estuary. There are two main criteria used to classify an estuary. Firstly the mouth state (is the estuary open or closed). Secondly, the dominant user group (recreational, subsistence, mixed, unused, protected).
2. Formulate the required actions or guidelines to address specific issues to achieve the objectives and vision for the estuary.

The guidelines are grouped into four broad categories that incorporate the main issues, namely those applicable at the resource level, the ecosystem level and those pertaining to the socio-economic and institutional domain.

Resource

- Control access to bait-collecting areas.
- Rotate bait-collecting areas on an annual basis to allow for recovery.
- Restrict collection of mud prawn, sand prawn, bloodwork, pencil bait and tapeworm only during daylight hours and using only legal implements.
- Control tropical fish collection.
- Prohibit capture of fish during mouth breaching events in temporarily open/closed systems.
- Prohibit capture of linefish species (e.g. grunter) with cast nets, seine, gill nets and traps.
- Reduce the number of fishing competitions.
- Develop key indicators and implement effective monitoring programmes dedicated to individual species.
- Undertake directed research aimed at stock status and sustainable yields.
- Reduce bag limits on all threatened estuarine angling species.

Ecosystem

- Minimise impacts on associated sensitive habitats found adjacent to bait collection areas (e.g. salt marshes) by the construction of walkways.
- Restrict the number of boats and areas according to the carrying capacity of the estuary.
- Establish sanctuary areas where threatened invertebrate and floral species occur.
- Adopt an holistic approach to estuarine management (e.g. incorporate issues related to the catchment and all adjacent terrestrial and marine environments).
- Identify potential estuarine protected areas (EPA) for the conservation of over-exploited linefish species (e.g. dusky kob and white steenbras). The area must include the mouth and the adjacent marine environment.
- Ensure that artificial breaching of estuary mouths (how and when) is done in accordance with national legislation and guidelines.

- Protect sensitive and riparian habitats with reference to the use of vehicles, boat mooring sites and agricultural activities.
- Assess and monitor cumulative impacts using tools such as ecosystem-based methods and strategic environmental assessments.

Socio economic

- Establish exclusive subsistence bait fisheries on selected systems.
- Apply zonation, through consultation with all interested and affected parties, of estuaries for recreational and subsistence fishing activities and non-consumption activities to reduce user conflict.
- Prohibit power boating or impose engine size restrictions.
- Restrict recreational activities such as skiing and powerboating to certain times of the day to avoid user group conflict.
- Promote estuarine awareness and instil a feeling of social responsibility towards estuaries through advertising and marketing, and education of managers, user groups and the general public.
- Promote cooperative management through community involvement.
- Funds raised from estuary activities to be used for estuary management in the same region
- Identify and mitigate against impacts resulting from industrial and mining activities and urban development
- Promote alternatives to consumptive exploitation. For example, catch and release fisheries and ecotourism or alternative livelihood options, such as mariculture ventures and job creation for subsistence users.
- Reduce fishing effort by controlled access or increased access costs.
- Prioritise and increase funding for research and enforcement.
- Recognise and involve tribal authorities and indigenous social structures.
- Address the cause (e.g. poverty) and not the symptom (e.g. over-exploitation) in estuary management plans.

Institutional

- Identify and quantify (monitor) consumptive resources, their value, and the present levels of exploitation in all systems.
- Enforce, through compliance monitoring, existing legislation, such as permits, catch restrictions, use of cast nets, etc. Penalties need to be severe and convictions need to be secured, as well as municipal bylaws.
- Prevent illegal syndicates from using local communities to poach estuarine resources, in particular, linefish, swimming prawns and mud crabs.
- Eliminate illegal activities (e.g. gill netting, crab trapping and netting of swimming prawns).
- Promote communication and cooperation between local, provincial and national authorities.

- Generate a database on historic and current biophysical and socio-economic characteristics to facilitate the monitoring programme.
- Control pollution and waste emissions, including sewage, detergents, agricultural runoff, urban runoff, industrial waste, solid waste and fossil fuels.
- Control erosion and runoff associated with infrastructure development (roads, residential and industrial).
- Enforce legislation around water abstraction and catchment management.
- Control harvesting of mangroves.
- Return custodianship of estuaries to local authorities and forums to manage within a national framework.
- Incorporate findings and recommendations arising from research programmes into management plans.
- Police user groups equally and consistently between and within the different groups.
- Establish a lead agent to market estuaries and sell their value to the government and the general public.
- Improve capacity through employment of competent staff and the concentration of effort in priority areas or estuaries.

BIODIVERSITY PROTECTION

Each of South Africa's estuaries is unique in terms of its physical characteristics and biodiversity. Our estuaries support numerous species, which are uniquely adapted to estuaries, as well as a large number of species that also occur in other (e.g., freshwater or marine) habitats, but which are dependent on estuaries for part of their lifecycles.

Protection of biodiversity is necessary due to past damage and present and future threats, most of which are caused by the actions of people. Most major threats to estuaries have only arisen in the past few decades. At the local scale, immediate threats to biodiversity include the changing or destruction of habitats, overexploitation, recreational disturbance and pollution. Much of this can be attributed to the massive increase in coastal development and populations in recent years.

In addition, biodiversity is threatened by reductions in the quantity and quality of freshwater entering an estuary, which affects mouth dynamics, salinity regimes and sedimentation patterns. The latter is due to increased national demands on water supply and increased agricultural pressures on catchments. It is thus important that the problem of biodiversity protection is tackled at the catchment scale as well as at the local estuary management scale.

A biodiversity protection strategy needs a set of goals. These are ideally:

- To maintain the ecological integrity of estuaries, such that interactions among estuaries and

between estuaries and other ecosystems are maintained, and to

- Maintain the health of estuaries in a good to excellent condition, assuring that a representative set of estuaries is maintained in as close to their natural state as possible.

Five main components of a biodiversity protection strategy

Component one – Research and knowledge management
A biodiversity protection strategy and management action need to be informed by relevant research. Optimal management decisions rely on a good understanding of estuarine biodiversity and functioning, the value of goods and services supplied, and the demand for these.

Component two – Regulation and enforcement
Regulation should take place at both an estuary level and at a catchment or national level. At an estuary level, regulation mechanisms should be sufficiently variable to cater to the uniqueness of each estuary in terms of its combination of biodiversity, use value, threats, and socio-economic context.

Component three – Conditions and incentives
Creating conditions and incentives that support conservation is essential to remove or alleviate some of the threats, especially where regulatory mechanisms are weak due to a lack of enforcement.

Component four – Monitoring and adaptive management
Monitoring is an essential element of any conservation strategy. It contributes to basic understanding and research, as well as alerting managers to situations where conservation strategies have not been entirely successful. Coarse level monitoring using available local capacity, so that management authorities are alerted to major changes, should be seen as the minimum requirement for estuarine monitoring.

Component five – Rehabilitation
Rehabilitation is an option for degraded estuaries which require immediate attention, either because the value of the goods and services they can provide to society has been compromised or because they are of conservation importance at a national or provincial scale. In addition, rehabilitation is an important fallback option in the event of misguided management resulting in estuary degradation in future.

FURTHER READING

- C Breen and M McKenzie (Eds). *Managing estuaries in South Africa – An introduction* (**WRC report no. TT 183/02**), https://tinyurl.com/y6w7wv4p
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- DFFE (Department of Forestry, Fisheries and the Environment), *The National Estuarine Management Protocol*, https://tinyurl.com/2eyj7ajp
- DWS, *Rehabilitation management guidelines for water resources Volume 3: Estuaries*, https://tinyurl.com/ynfhr74c
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GLOSSARY

- **Biodiversity** – The richness, abundance and variability of plant and animal species and communities and the ecological processes that link them with one another and with soil, air and water.
- **Catchment** – The total land area from which a river is fed.
- **Deplete** – Reduce in numbers or quantity.
- **Ecosystem** – An interacting living system (physical, chemical and biological), e.g. estuary, pond, forest.
- **Estuary** – A partially enclosed, coastal body of water which is either permanently or periodically (from time to time) open to the sea and within which there is a measurable variation of salinity due to the mixture of seawater with freshwater derived from land drainage.
- **Goods** – things that have value.
- **Habitat** – The normal environment in which an organism lives.
- **Impoundment** – Dam.
- **Indicator** – Physical, chemical, biological or socio-economic measures of particular attributes used to indicate state or condition.
- **Invertebrate** – An animal that does not have a backbone.
- **Macroalgae** – Large plants not differentiated into stems, roots and leaves. Mostly seaweeds.
- **Macrophyte** – Large plants, usually aquatic, differentiated into stems, roots and leaves. Mostly flowering plants.
- **Mangrove** – Trees growing in regularly flooded parts of estuaries and along tropical coasts in other parts of the world.
- **Microalgae** – Small, usually microscopic, chlorophyll-containing organisms. Commonly aquatic.
- **Nursery areas** – areas where juvenile animals mature.
- **Nutrient** – Natural substances (elements) necessary for nourishment of life.
- **Organic** – substance comprised predominantly of carbon, hydrogen and oxygen, e.g. starch, sugar and protein.
- **Perennial** – lasting through the year.
- **Precipitate** – Deposit in solid form from a solution.
- **Predator** – An organism which preys upon another.
- **Service** – An ecosystem process (e.g. water purification) which is useful to society and which has value
- **Turbidity** – Lack of clarity, in this case, of water.


WATER
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