


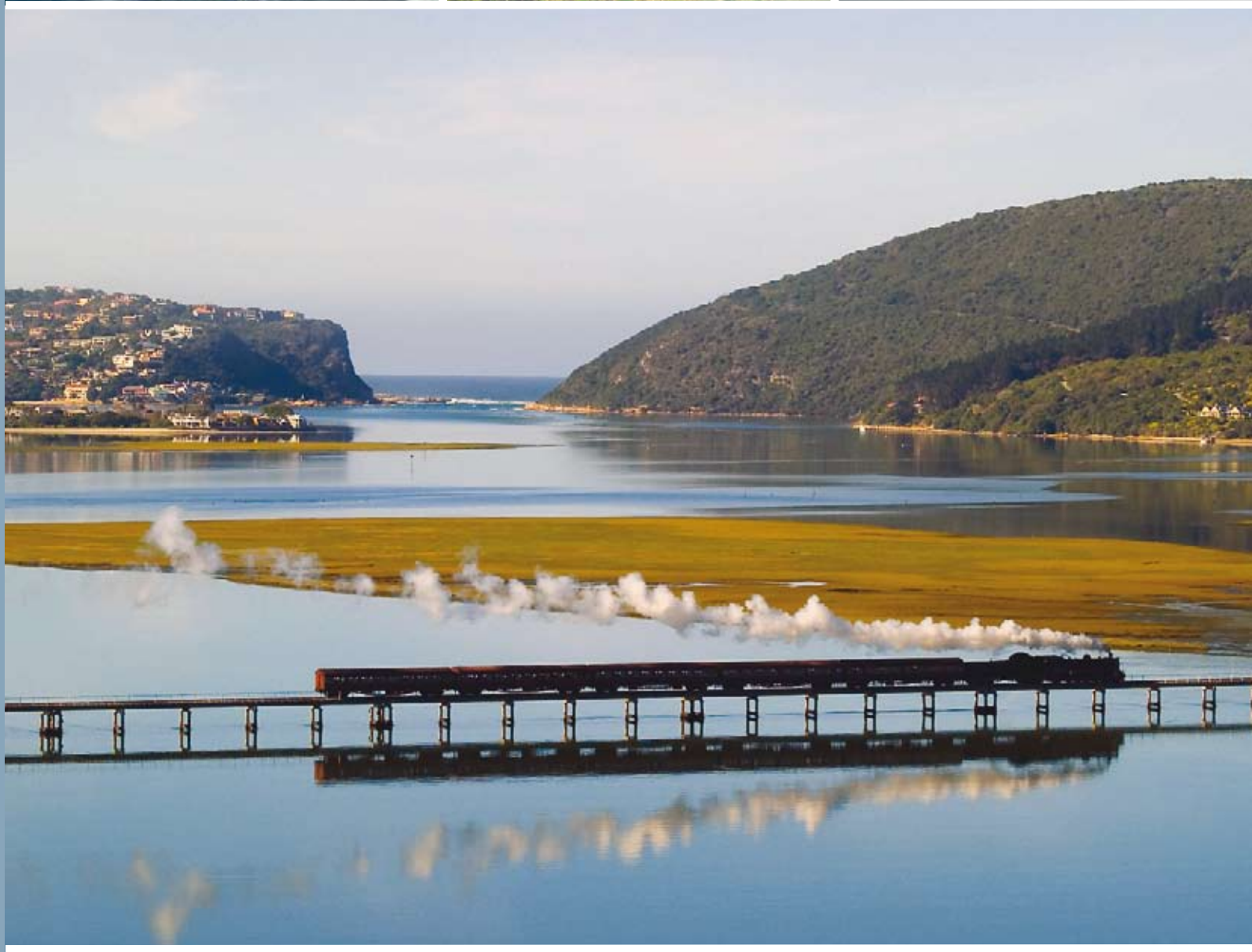

Estuaries and Integrated Development Planning: A Manager's Guide

Duncan Hay (Editor)

TT 294/07

Water Research Commission

ESTUARIES AND INTEGRATED DEVELOPMENT PLANNING:

A MANAGER'S GUIDE

Prepared for the Water Research Commission and
the Tony and Lisette Lewis Foundation by
the Centre for Environment, Agriculture and Development
at the University of KwaZulu-Natal

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Dedication

This handbook is dedicated to the memory of Ken Lynch who passed away in 2006. Ken, in both his personal capacity and as Chairman of the Tony and Lisette Lewis Foundation, was a long term supporter of the Eastern Cape Estuaries Management Programme. He provided guidance on direction and ensured a continual and steady flow of funds to the Programme. Most importantly he operated on the basis of complete trust and allowed us to get on with the job, rarely criticizing and always encouraging. Ken, we salute your contribution to conservation and environmental management in South Africa.

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The following individuals form the core of a dedicated team of researchers and practitioners involved in the programme:

- Professor Charles Breen – University of KwaZulu-Natal
- Ms Fonda Lewis – Institute of Natural Resources
- Dr Lesley McGwynne – Independent Consultant
- Ms Margaret McKenzie – Environdev
- Mr Andile Msimang – Institute of Natural Resources
- Mr Nhlanhla Sihlophe – University of KwaZulu-Natal
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Preface

As we enter 2007 we find ourselves in an unprecedented economic boom. There are more people with more money doing more things. Nowhere is this more apparent than in our coastal zone. More holiday and residential homes, more resorts, more boats, more businesses – the pressure to develop is huge. Two things find themselves in the eye of this development "storm" – estuaries and local municipalities. Estuaries are where things happen. They are focal development points because they provide a broad range of amenities for us – views, boating, fishing, relaxation and sources of food. Local municipalities have to manage what happens in the coastal zone and particularly at these estuaries. New legislation has imposed new and additional responsibilities on these municipalities and many are struggling to cope. They lack the cash, the human resources and the technical expertise.

Despite the economic boom many South Africans remain poor and lack the resources to make ends meet. Increasingly these people have to make direct use of "free" natural resources in order to get by. Estuaries are a source of these natural resources – fish for sale and to eat, bait for sale, and reeds and mangroves for construction. Both poverty and affluence place pressure on estuaries. It is a key responsibility of local municipalities, with support from other spheres of government and from society, to manage these pressures.

If we are to be successful in this management we need to be informed and to inform; we need to listen and learn about and contribute to management action. At the heart of this conversation is the Integrated Development Planning process of local municipalities, and how we ensure that the management, conservation and development of estuaries become an integral part of this process.

This handbook is designed to assist with this conversation – it is not a substitute for it. It is deliberately compiled for easy reading and it tries to avoid being too technically complex. It also does not assume to have all the answers. Every estuary and every municipality and every individual or group with an interest in the issues is unique. We hope that this handbook contributes to the collective conversation and from this the improved management of, arguably, our most important coastal assets.

Duncan Hay
Centre for Environment, Agriculture and Development
University of KwaZulu-Natal

Chapter 1
Why Estuaries and Integrated Development Plans (IDPs)?

What is the purpose of this handbook?

People are attracted to estuaries; they are beautiful. Estuaries are good places to collect food and building material. They are generally safe for swimming and boating and often make ideal harbours. Many estuaries are great places at which to live or to holiday. Some are convenient places to dispose of waste. Because of this, development in coastal areas, at and around estuaries, and in their catchments, has increased dramatically.

With this is an increased demand for the goods and services that estuaries supply. At estuaries we see more homes, more boats, more fishermen and more businesses and in the catchments we see more forestry and agriculture, more industry, and more homes. These different forms of development compete with each other for what an estuary can provide and, in some instances this competition compromises the value of the estuary system.

People are attracted to estuaries: The Kowie at Port Alfred (Duncan Hay)

The interactions between people and an estuary are often intense, and because the different interactions are often competing for the same things, decisions have to be made about who gets what. This requires active management. Estuaries are not privately owned; they are public resources. So, management is complex, and requires co-operation between residents, interest groups, government and the private sector.

A key question is who should be leading this management effort? Many of our estuaries in South Africa are small covering less than 100 ha. Many of their catchments are also small. So, all or part of an estuary and its catchment often lie entirely within a single local or district municipality. These municipalities, through their Integrated Development Planning (IDP) processes are responsible for managing developmental activities within their area of authority. It is these activities that allow people to obtain benefit from estuaries and it is also these

activities which impact on the ability of people to realise these benefits. So, it makes sense that these municipalities should take a leading role in estuary management and to do this within the context of their Integrated Development Plans.

An Integrated Development Plan (IDP) will be strengthened, by including estuary management in the IDP, because a key economic, social and environmental asset will have been identified, and considered. Decisions will be taken about its best use. And, the IDP process is good for estuary management. The IDP process encourages municipalities to look holistically at the governance, planning and management of the area under its authority – to look outside the traditional compartments of conservation and development, to cut across disciplines and integrate various issues. This is exactly what we have to do for successful estuary management. We have to consider, in a holistic rather than sectoral way what ecological, social and economic benefits it can bring to the municipality.

However, in many instances the ability of municipalities, to engage and lead in estuary management, is limited. Local authorities are trying to get to grips with immediate developmental needs, particularly the provision of housing and basic services such as roads, water and energy supply. A scan of IDPs in the Eastern Cape, where over half South Africa's estuaries are located, indicates that few have taken estuaries into account. Estuary management is not considered and not budgeted for. This is despite the fact that they are very valuable municipal assets. This handbook is prepared specifically for municipal authorities. It is designed to capacitate municipalities to engage in more effective estuary management. It describes:

- The value of estuaries, including examples (Chapter 2)
- How estuaries function (Chapter 3)
- What impacts on the functioning of an estuary and on its value (Chapter 4)
- How we might support the establishment of sustainable businesses at estuaries (Chapter 5)
- How we manage to optimise the benefits and reduce the impacts (Chapter 6)
- Where we can obtain more information (Chapter 7)

Who should read this handbook?

While this handbook is targeted at municipalities, it has a wider application. Municipalities do not operate in isolation. They are supported by provincial and national spheres of government, parastatals, the private sector, consultants, researchers and the public in general. This handbook is useful to all these organizations and people. It is particularly useful to local stakeholders as well, because they are the people who have the greatest interest in and passion for their own particular estuary. They are the eyes and ears of management.

Because estuary management is a part of environmental management, many argue that the primary target should be environmental managers linked to, or supporting, local authorities. This is correct. But, as we have already mentioned, estuary management is much more than environmental management. An estuary is an important economic resource so its management is important to economic development staff. An estuary is also a social and recreational resource, so it is valuable to amenities staff. An estuary is impacted on by the kind of development that happens around it, as well as the development in its catchment, so estuary management and IDP is equally important to planners, developers and infra-structure service providers. In short, anyone with a responsibility for or interest in an estuary should develop an understanding of how an estuary works and how it might be managed so that it continues working for the benefit of us all.

Chapter 2
What is the value of an estuary?

Why is economic value important?

Municipal authorities (and other spheres of government) make decisions based on political, social, economic and environmental considerations. In order to make these decisions authorities require a common currency so they can compare "apples with apples". So, as an example, if a decision is required, on whether or not to go ahead with a particular residential development, the authorities need to be able to compare the benefit of increased rates income for the municipality with the cost of loss of natural habitat that will happen as a result of the development. While it is easy to calculate increased rates revenue, it is more difficult to calculate the loss of natural habitat. This is where the economists, particularly resource economists can assist. Using a variety of methods, they can calculate these values in monetary terms, so that objective decision making can take place.

The valuation of estuaries is important, because valuation:

- Highlights the contribution that estuaries make to our well-being as well as to the economy;
- Shows that if we degrade an estuary this degradation carries a cost;
- Brings a more balanced approach to planning and management decision making because the economic costs and benefits of conserving a system can be weighed against the economic costs and benefits of development at that system;
- It creates incentive mechanisms and financing tools for management.

What is the value of an estuary?

In 1997 economists estimated that the global value of estuaries to society was US$4.1 trillion per annum. This translates into about US$23 000 per ha per annum or in Rand terms R161 000 per ha. Obviously not all estuaries are the same, and some are economically more valuable than others, but, you get the general idea – estuaries are economically important ecosystems. Although determining the economic value of estuaries is a recent and imperfect science, there are some local examples we can draw on.

The mangroves at Mngazana are worth R 3.4 million annually to the local community (Fonda Lewis)

At Mngazana local community members harvest mangroves for building material. These mangroves also form the nursery habitat for fish caught by subsistence and recreational fishermen, are the focal interest of commercial canoe trails and also contain a honey production business. The economic value of these mangroves, to local communities, was estimated to be R3.4 million per annum.

The subsistence fishery at Knysna Estuary is worth about R1 million per annum, but, this is insignificant, compared to the value of the view of the estuary. The portion of the value of property in Knysna that can be attributed to the view of the estuary is worth an estimated R1.4 – R2.0 billion!

The view of Knysna Estuary increases property values by R 1.4 - R 2.0 billion. (Knysna Tourism)

Many of our coastal fisheries are dependent on estuaries, as juvenile fish and prawns spend time in these systems. The value of these estuary dependent fisheries is estimated at R1 billion. This averages out at about R13 000 per ha per annum for all our estuaries. If we compare this to commercial sugar cane production the average gross return on a hectare is R6 000, less than half this value.

Kongweni Estuary at Margate is an interesting example, particularly for municipalities. The sewage system at Margate occasionally overflows, into the estuary, causing pollution. The estuary reaches the sea at Margate's prime swimming beach which recently lost its Blue Flag status because of the poor water quality. The overall loss to the Margate economy as a result of the degradation of the Kongweni Estuary is estimated to be between R58 million and R129 million per annum.

Another example, also of particular interest to municipalities, is that of the Ohlanga Estuary north of Durban. The waste water works at the estuary is artificially increasing the amount of freshwater entering the system. This causes the mouth of the estuary to breach (open) more often than it normally would. Although the economic impact of this is unknown the eThekwini Municipality is spending R20 million to direct the excess flow from the treatment works to another catchment.

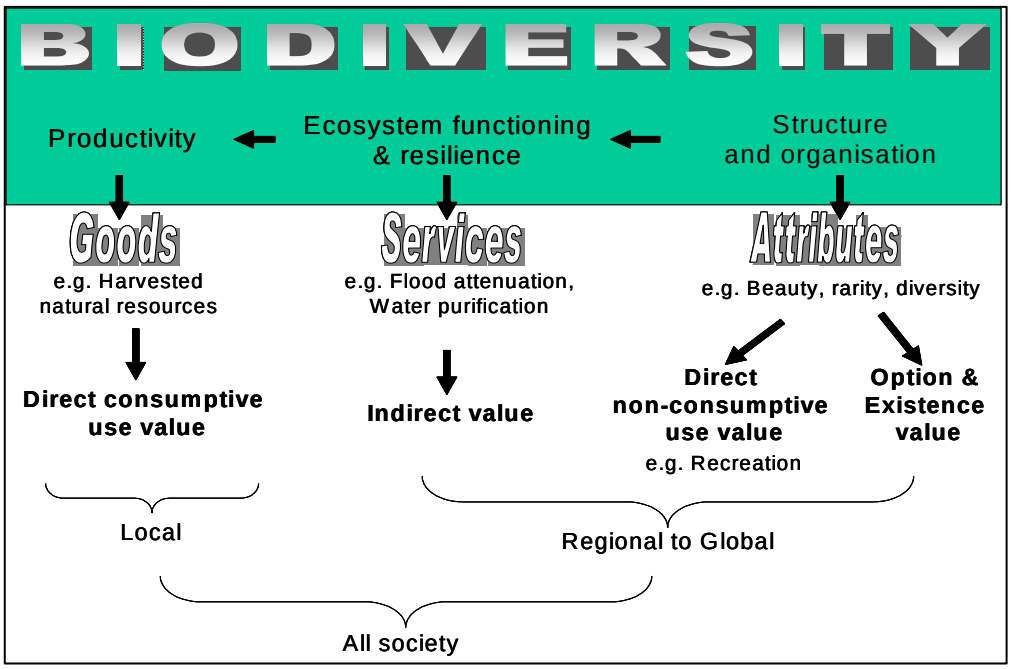
What types of values do estuaries generate?

Estuary values are generated as a result of the attributes they have, such as their beauty or rarity, the services they provide such as water purification and transport, as well as through the goods they provide, such as harvested fish, shell-fish, mangroves and reeds.

The first and most obvious form of value is generated by direct use of the estuary. This is the immediate use an estuarine resource, for example, subsistence-fishing which is consumptive resource use. Another example, which is non-consumptive, is boating – we use the resource but we don't consume it.

The second value is that generated by indirect use; where outputs from estuaries are the inputs to other sectors. An example of this would be purchasing tackle to fish at an estuary. The output from the estuary becomes an input into the retail and manufacturing trades. Another example would be the contribution estuaries make to coastal fisheries. For instance, juvenile prawns from Richards Bay form the input into the Tugela Bank Prawn Fishery.

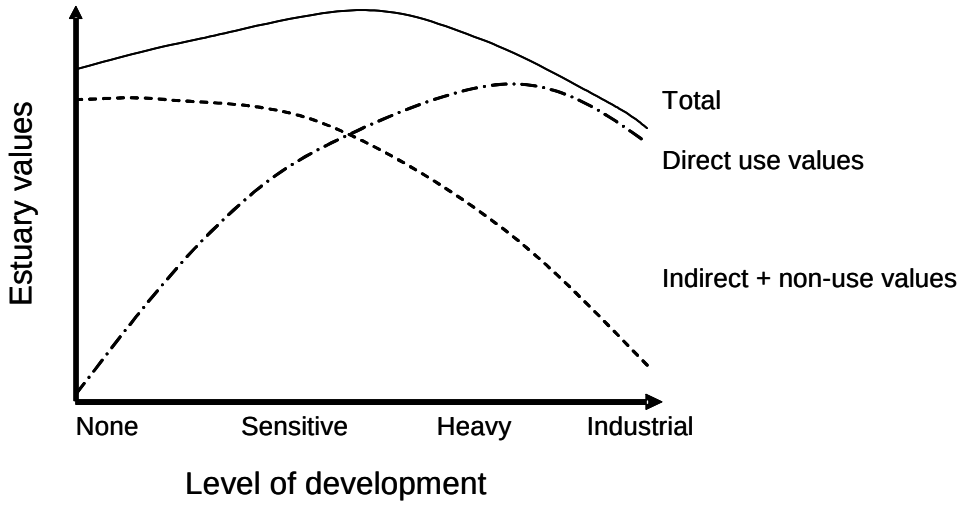
The third most subtle but often the highest value is that generated by passive-use or non-use (option and existence value). This would include the value of the genetic biodiversity and ecosystem functioning. Because we don't trade these things, they are difficult to measure. But most important though, they form the foundation for our direct and indirect use.



The relationship between biodiversity; goods services and attributes, and economic value (Jane Turpie)

The diagram above illustrates the relationships that exist between attributes, goods and services and various types of values. Note, the figure also illustrates that structure and organization, ecosystem functioning and resilience, and productivity - the key elements of estuary biodiversity – are the foundation for the rest. This illustrates the importance of conserving these elements, so that we can ensure the full value of the system is obtained.
How do we use valuation in management decision making?

Decision makers are unlikely to be economists. So, when important decisions are required, it is best to engage a specialist and get advice. However, this might be costly, because economic analysis is complex. In this section we will simply discuss the principles that inform decision making.



The relationship between levels of development and estuary values (Jane Turpie)

The graph, illustrated above, explores, in general terms, the relationships that exist between estuary values and the level of development at an estuary. With no development at an estuary obviously the direct use-value is zero. As we develop and use the system, the direct-use increases. Initially, the indirect and non-use values remain constant, as the natural resilience in the system absorbs the impact of the direct-use. However we reach a point where the intensity of direct-use exceeds the ability of the system to cope, and the indirect and non-use values decline.

Understanding this relationship between use and value is as critical for effective management, as understanding what you are managing for. Is the estuary a protected area? If so, the level and type of development is limited to optimise indirect and non-use values. Only direct use that is non-consumptive or low-level consumption is allowed. Is your estuary a commercial harbour? If so, recognise that while the direct-use values will be very high, the indirect and non-use values will suffer as a consequence. Here you would try to soften the impact of direct use, to maintain some level of functional integrity. Durban harbour is a classic example of a surprisingly vibrant ecosystem, despite very high levels of development.

Mtentu and Richards Bay: Two estuaries with very different management objectives and management approaches (Duncan Hay, DEAT)

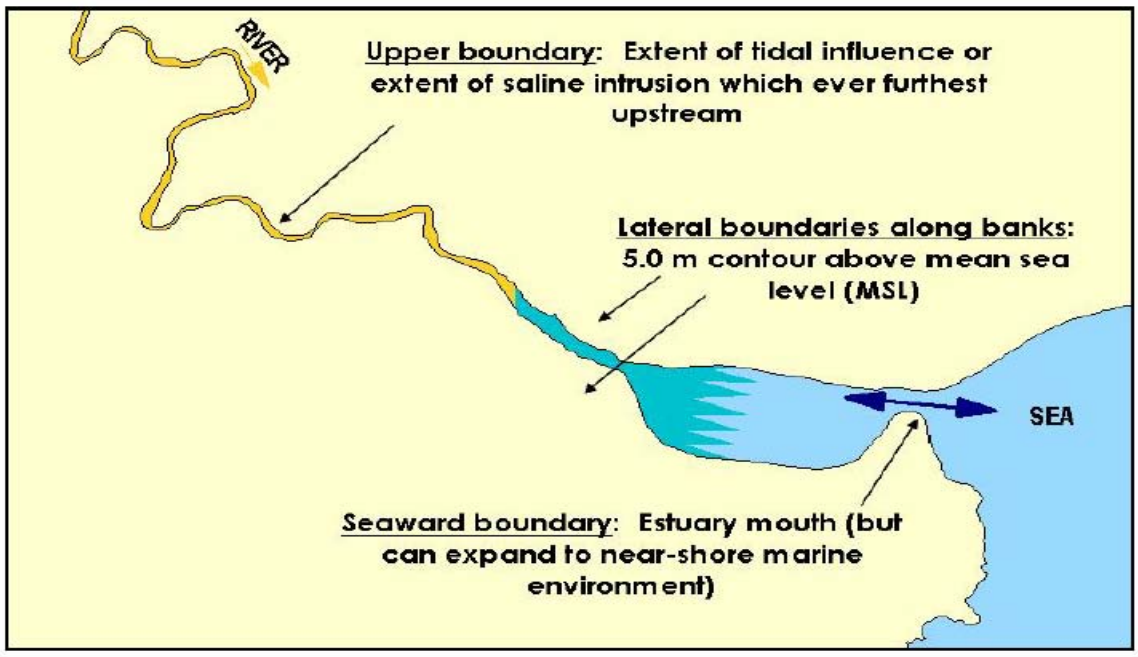
Chapter 3
How do estuaries function?

Why is it important to know how an estuary functions?

We saw in Chapter 2 that the value of an estuary is directly linked to its biodiversity – its structure and organization, ecosystem function and resilience, and its productivity. So, in order to optimise the value of an estuary to a local authority, we need to know how the system functions. Knowing the functions will also allow us to understand what impact various development options will have on an estuary (Chapter 4) and therefore on its value.

What is an estuary?

An estuary is that part of a river or lake that interacts directly with the sea. This creates a unique environment, where fresh and salt water mix, that is sheltered from the direct wave action of the sea, and where nutrients from both the catchment and from the sea are deposited. Usually areas of relative calm estuaries can also be subjected to flooding as well as to the action of storms at sea. The net result is an ecosystem that is highly productive, but that is also subjected to rapidly changing conditions.



The geographical boundaries of an estuary (CSIR)

We have approximately 260 estuaries in South Africa ranging in size from St Lucia covering 32 500 ha to Mkumbane which is not much larger than a tennis court. The majority are smaller than 50 ha. They have catchments that range in size from thousands of square kilometers such as the Orange to less than 10 km^2. All our estuaries have only been in their present positions for about five to ten thousand years, being formed after the last ice age when melting polar ice-caps drowned coastal river valleys.

What are the different types of estuaries?

Like people, every estuary is unique, with its own character and personality. However, we can group estuaries into various types. This is necessary because knowing the type of estuary we are managing, will tell us what kind of management action we should be taking:

Estuarine bays: Durban harbour and Knysna are estuarine bays. They are permanently open to the sea and freshwater inflow is usually fairly low. The result is that the salinity (saltiness) of the water is almost that of sea water.

Permanently open estuaries: Nahoon and Mngazana are permanently open estuaries. There is constant interaction between fresh and salt water through daily tidal changes and the level of freshwater inflow

River mouths: The Thukela and Orange are river mouths. In this instance the flow of freshwater in the river is so strong that it does not allow sea water to enter the river.

Estuarine lakes: Kosi and St Lucia are estuarine lakes. These are large bodies of water connected to the sea by a channel that is either permanently or temporarily open. The salinity of the water can be highly variable and is regulated by mouth condition, the inflow of freshwater and evaporation.

Temporarily open estuaries: Mngazi and Ohlanga are temporarily open estuaries. These are particularly common amongst our smaller estuaries. The combination of a reduced inflow of freshwater into the estuary and wave/tidal action in the sea causes a sand-bar to develop and close the mouth. This might be seasonal or the closed state might persist for years. Flooding usually causes the mouth to open and the time it takes to close again is variable.

Four different types of estuaries: Clockwise from top left. The Orange – a river mouth, Kosi – an estuarine lake, Sezela – a temporarily open estuary, and Mtentu – a permanently open estuary (DEAT, Drummond Densham)

What are the physical components of an estuary?

When considering the physical components of an estuary and the management of these components, we need to consider six interlinked factors:

- Where the estuary is located in South Africa
- Its physical size and the size of its catchment
- The topography of the land where it is located.
- The types of sediment it contains
- The flow of water in and out of it
- The quality of that water

Two highly contrasting estuaries on the left the deep, subtropical Msikaba located on the Wild Coast, and on the right the shallow, temperate Langebaan located on the West Coast (DEAT)

Water temperature is primarily influenced by where an estuary is located in South Africa. For example, the Oliphants, on the west coast, which is influenced by the cold Benguela Current, will be relatively cool, while Kosi, which is influenced by the much warmer Aghullas Current, will be relatively warm. Locality also influences river inflow. Those estuaries in winter rainfall areas will have high levels of inflow in winter, while those in summer rainfall areas will have high levels of freshwater inflow in summer.

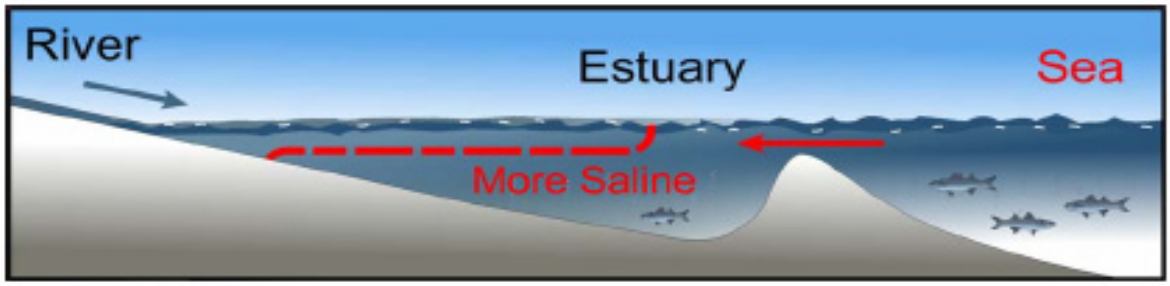
The physical size of an estuary and its catchment, and whether it is primarily shallow or deep will influence water flow patterns, the quality of the water and the sediment contained in the system. The topography of the land where an estuary is located, whether it be in a gorge, such as Mngazana and Msikaba, or on a floodplain such as Mngazana, will also effect water flow patterns, the water quality as well as the type of sediment. The sediment in an estuary is influenced primarily by water flow; how it is brought into an estuary, how it is moved around in the system and exported from the system. So, it is apparent that the two critical factors, we have to consider in some detail, are water flow/quantity and water quality.

The extreme of water flow is a flood. Floods fundamentally influence the erosion and deposition of sediment in estuaries. A classic example was Cyclone Demoina. Prior to the flood the Umfolozi Estuary was an average of 3 meters deep. The flood scoured the estuary to a depth of 21 meters in places. A smaller flood, later in the year, deposited sediment in the estuary and reduced its depth to a maximum of 8 meters. Normal seasonal inflows of freshwater into an estuary influence the state of the estuary mouth – whether it is open, or

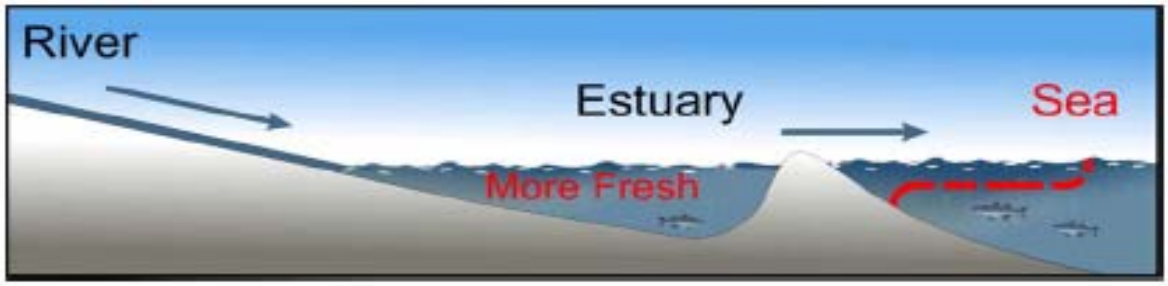
closed, and for how long it is opened or closed. Flows also influence the extent to which sea water can penetrate into an estuary – if the flow is high, it will only be a short distance and if the flow is low, seawater might penetrate several kilometers.

The general interaction between sea and freshwater in a tidal cycle, is illustrated below. As the tide floods (comes in) seawater pushes up the estuary, introducing more saline water and raising the water level. On the ebb tide (going out) the seawater recedes and is replaced by freshwater inflow. The salinity decreases and the water level drops. An important point to note in this cycle is that fresh water is heavier than sea water, and so a wedge forms with the freshwater flowing over the seawater.

Flood (incoming) tide



Ebb (outgoing) tide



The tidal movement into and out of an estuary (CSIR)

Under extreme conditions, when freshwater inflow is very low and evaporation is high, the salinity of the estuarine water can increase above seawater, of which. St Lucia is a good example. During floods, the estuary can become completely fresh. Water quality refers to what the water contains. This includes:

- Salinity (how much salt)
- Temperature
- pH
- Dissolved oxygen
- Solids suspended in the water which makes it muddy/turbid
- Inorganic nutrients such as phosphates and nitrates
- Organic nutrients such as carbon
- Toxic substances such as trace metals and hydrocarbons

The water quality in an estuary is dependent on:

- The source of the water in the estuary – if the catchment is eroding, the water sourced from that catchment will be high in suspended solids;
- How much time the water stays in the estuary – if the water spends a considerable time in an estuary, there will be a build up of inorganic and organic nutrients;
- Its shape and depth – a deep estuary will have very different temperature and flow characteristics from a shallow one;
- The plants and animals contained in the estuary – a large number of aquatic plants will boost dissolved oxygen, while a large number of animals will use up oxygen.

In summary, we can see that we are dealing with a highly variable system, subject to rapid and sometimes extreme change. An important point to note, linked closely to value, is that many estuaries are highly productive. This is because they act as a nutrient trap. Organic material, from both the catchment and the sea, is carried into the estuary by water. As current flow slows, these nutrients settle on the bottom and are available as food, to a wide variety, and large number, of plants and animals.

What are the biological components of an estuary?

High productivity supports a large number of plants and animals in estuaries. The plants range from microscopic algae to large mangroves while the animals range from microscopic plankton to hippopotami.

Estuary saltmarsh (DEAT)

Micro-algae: These are microscopic plants that occur in the water column as plankton and as bottom living (benthic) forms. They are an extremely important part of the ecosystem as they utilise many of the nutrients directly and are a major source of food for small animals.

Macrophytes: These are large plants including mangroves, salt marshes, submerged seaweed, reeds and sedges. They provide habitats for a number animal species. They are also a crucial part of the food chain taking up nutrients, being fed on directly and/or dying and decomposing and so returning nutrients to the system. Many also serve to slow water flow and so enhance deposition of nutrients and sediment. In this way they are habitat creators.

A bottom-living (benthic) mud-prawn (DEAT)

The Kingfish is a marine fish that uses estuaries (Ben Pretorius)

The Pied Kingfisher: an estuary resident (DEAT)

Hippopotami make extensive use of estuaries such as St Lucia (Lani Van Vuuren)

Zooplankton: These are microscopic animals that live in the water column and feed on the microscopic algae and detritus (course organic material).

Bottom-living (benthic) invertebrates:
These include small crabs, prawns, snails and mussels. Many of them feed on detritus, processing it for other smaller organisms to use. They are regularly the prey of larger animals.

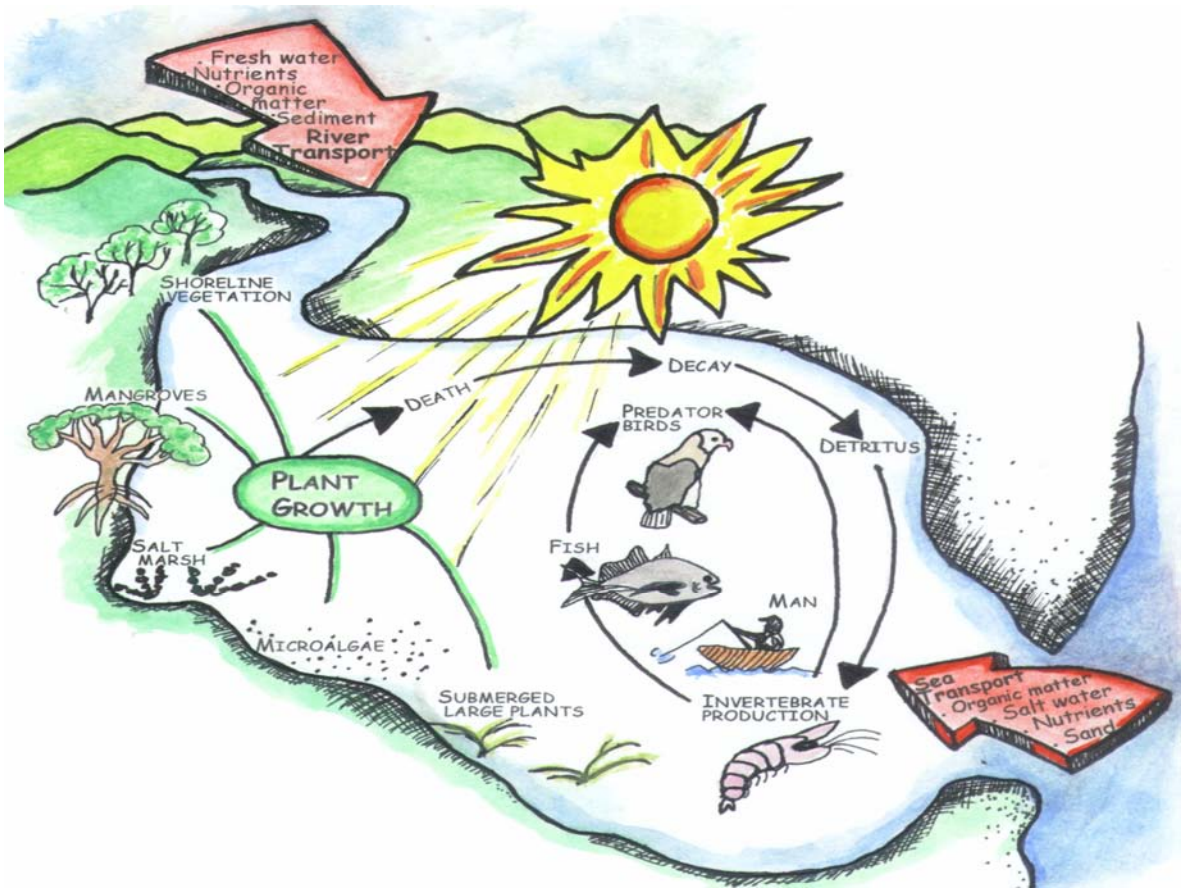
Fish: A large variety of fish occur in estuaries. Some, such as the estuarine round-herring, live entirely in the estuary, while others will use it seasonally, coming in from the sea as juveniles (for protection and food). For others, such as some eel species, it is simply part of their migration route, from freshwater to the sea and back again.

Birds: The concentration of prey items make estuaries an important habitat where numerous bird species feed, roost and breed. These include fish eagles and ospreys, herons, cormorants, gulls and terns, as well a variety of kingfishers.

Reptiles: In certain of our estuaries, particularly those in subtropical areas, crocodiles and water monitor lizards can be quite common. Attracted by the numerous prey items, they also use these areas to breed. Marine turtles also occur in some estuaries.

Mammals: Otters, water mongooses and hippopotami are examples of mammals that make extensive use of estuaries in which to feed or to rest. Dolphins also enter estuaries occasionally.

These biological components all form part of an intricate and complex food web, illustrated in the diagram below. For example: microscopic organisms will feed off detritus in the system and will, in turn, be fed on by larger benthic invertebrates. These benthic invertebrates will be preyed on by fish, which in turn, will be preyed on by other fish, birds, reptiles and mammals. These larger animals will excrete their waste into the estuary, where it becomes detritus and is once again fed by the micro-organisms. The system is ongoing and endless.



A simplified estuary food-web (Lauren Cohen)

Chapter 4
What affects the functioning of an estuary?

For officials with some form of responsibility for estuary management, it is important to know what affects or impacts on an estuary. Understanding this, together with the structure and function of a system, lets you predict what will affect the value of the system. Let's examine some of the more common impacts on estuaries and the activities associated with these impacts.

What are the impacts?

Stabilization of banks has significantly reduced the intertidal habitat at Keurbooms (Alan Whitfield)

Loss and alteration of natural habitat: The loss and or alteration of estuary habitat can be caused by a number of factors, but is most usually associated with the development of service infrastructure at or around an estuary for residential, commercial expansion. The Kowie at Port Alfred is a good example of a system highly modified by development. What was once salt marsh and intertidal mudflat, has now been built into a residential marina. The natural habitats have been lost, and with these the productivity they generate – nursery and feeding areas for fish have been reduced and so their contribution to coastal fisheries. However, the loss of these habitats and other impacts need to be weighed against the benefits of the Marina. It contributes a significant percentage of the rates base to the town of Port Alfred. Impor-tant to note is that loss or alteration of the habitat is usually permanent as the cost of rehabilitating to a natural condition is very high.

Opening an estuary mouth artificially can rapidly and radically change the system (Piet Huizinga)

Changes in mouth conditions: The manipulation of an estuary mouth, specifically breaching it artificially, is common practice in some regions. The reasons for this are usually twofold. When the mouth is closed, water levels rise and threaten to flood developments at the estuary or agricultural land on the estuary floodplain. During this closed period there is a build up of polluted water in the estuary, which needs to be

flushed out to sea. Opening the mouth rapidly, changes the salinity of the system rapidly. This flushes valuable nutrients out to sea and often takes place at a time when animals that move in and out of the estuary system do not expect it, and are not geared to take advantage of it.

Changes in water flow: Changes in water flow characteristics in an estuary are caused by a number of factors. Altering the mouth condition, as described, is one of these. Other changes include the construction of bridges and causeways across estuaries; the abstraction of water in the catchment; the creation of hard surfaces around an estuary or in its catchment; and the discharge of from wastewater treatment works. These all serve to change water flow characteristics and, with them, salinity levels, sedimentation and scouring rates, water temperature regimes and nutrient levels. All these changes impact on the ecology of the system.

Construction of this causeway fundamentally restricted the water flow in the estuary (DEAT)

Harvesting of bait can significantly impact on estuary habitats (Roy Taylor)

Natural resource use: This includes subsistence fishing; recreational and commercial fishing; bait collection, and the harvesting of reeds and mangroves. Fish that are caught are often juveniles that have not had a chance to breed. Collection of bait reduces these populations, but probably more important is that digging for bait impacts directly on habitats. Harvesting of mangroves reduces available habitats and the productivity of the system.

Sedimentation and turbidity: Sediment and silt originate either in the catchment or in the sea. Activities that alter sediment patterns include: land-use in a catchment and any activities that alter flow patterns in the estuary to increase or decrease flow of freshwater or seawater into an estuary. For example, a decreased flow of freshwater, caused by a large dam in the catchment, will cause marine sand to enter and accumulate in the estuary. Catchment sediment will also be trapped and prevented from moving into the estuary. Agriculture – both crop and stock production in a catchment - increases erosion and with it the amount of sediment entering the estuary. The Mzimvubu Estuary at Port St Johns is a classic example where overstocking of cattle in the

catchment and the resulting land degradation has caused large amounts of silt to enter the estuary. Piers, jetties and causeways in an estuary alter the flow of water and with it patterns of erosion and deposition in the system.

Loss of system variability: As mentioned in Chapter 3 estuaries are extremely dynamic and variable systems subject to rapid change. The organisms in these systems, both big and small, have adapted to this dynamic environment. They need the change. However, many estuaries have become highly regulated. Harbours such as Richards Bay and Durban have mouths that are kept permanently open to a certain depth. The depth in the harbour is maintained constant to allow ships to pass and freshwater inflow is diverted away from them. The water level at Zandvlei near Muizenburg is kept at a specific depth so as to accommodate the needs of recreational users and the residents of Marina da Gama. (If the water level drops too low the banks of properties start collapsing.) The overall affect impacts negatively on the biodiversity of the system.

Zandvlei is highly regulated to maintain recreational use and to protect properties (DEAT)

Recreational disturbance: The impact of people swimming, boating and fishing or just pottering around at the estuary edge can be significant especially during holiday periods. It is not unusual to see 400 motorised boats making use of the Bushmans Estuary over the Christmas period. A direct impact, borne out by recent research, is that fish simply leave the system when faced with this number of boats. When the fish disappear, the other animals that feed on the fish will disappear as well. Boats also cause significant wave action that erodes the banks of the estuary. We must emphasize that the use of motorized boats and jet-skis on small estuarine systems has a severe negative impact and this activity should be discouraged.

Motorised boating has a significant impact, particularly on small estuaries (CSIR)

Changes in salinity: Various activities can cause salinity levels to increase or decline. If a catchment is extensively dammed, and freshwater inflow is reduced the salinity in the estuary

will increase. An extreme example of this is St Lucia where reduced freshwater inflow, combined with a regulated open mouth condition, and high evaporation, caused salinity levels to increase, at times, to over three times that of seawater. If a wastewater works is discharging freshwater into a system, it will cause average salinity levels to decrease. While much of the plant and animal life can accommodate these changes, if the change from freshwater-dominated to saltwater-dominated (or visa versa) is sustained, a permanent change, in the composition and abundance of the resident plants and animals, will result.

Changes in nutrient status: Nutrient levels in an estuary can be increased or decreased by various actions. If the mouth of an estuary is breached regularly, nutrients are flushed out to sea. Or, if the catchment is dammed, the amount of freshwater entering the system decreases. The nutrients decrease as a result. Alternatively, if a wastewater treatment works discharges raw sewage into the system, or if there is agricultural run-off containing fertilizers, nutrient levels will increase. A decrease in nutrients means there is less for the biota to feed on and populations will decrease. An increase in nutrients will cause oxygen demand to increase. Oxygen depletion often results in what we commonly call "fish-kills".

Litter, often carried down from the catchment, impacts on estuaries (CSIR)

Pollution: Numerous sources can cause pollution of an estuary. In urban estuaries it might be solid waste, such as litter dumped directly into the system or washed off the streets, inorganic or organic pollutants from industry, air pollution that is picked up by rain and deposited directly into the system and/or sewerage discharges. At rural estuaries it might be pesticides and fertilizer in run-off from agricultural land. The specific impacts will depend on the volume and toxicity of the substances entering the system and the rate at which they can be diluted. Important to note is that some of the more dangerous pollutants can find their way into humans. In 1981, while researching the Mdloti Estuary north of Durban, high levels of cancer-causing dieldrin were found in the mullet in the system. These mullet were being caught and fed on by local subsistence fishermen. So, the dieldrin could have accumulated in these fishermen and their families.

How do we prevent or reduce these impacts?

There are numerous general and specific guidelines that, if considered by managers and planners, will significantly reduce the impact of activities on an estuary. Following is a list of ten of the more common guidelines one can follow:

- Ensure that the estuaries in a municipality and their management are catered for in the Integrated Development Plan. This plan would include the recognition of the economic, social and ecological value of the estuary; as well as consideration of the type of land-use around the estuaries and in their catchments so that impacts are limited. The plan should include rehabilitation actions. Have a clear statement on what would constitute undesirable and desirable activities at a particular estuary.
- Ensure that management systems are in place and that other government role-players and civil society are engaged in the management process (more about this in Chapter 6). In

each management plan, ensure that there is an emphasis on the education of local stakeholders and on active compliance monitoring and law enforcement.

- Consult the National Biodiversity Assessment Action Plan (NBSAP) which has rated all estuaries in South Africa in terms of their biodiversity conservation importance. This also provides guidance on each estuary's importance as a nursery area, its size and what its conservation status should be.
- In allowing activities at an estuary, try and minimize any impact that reduces the natural habitat, changes water flow, increases or decreases natural sedimentation an scouring, increases or reduces the nutrient levels and remove excessive plants and animals from the system. In short try and maintain an estuary in as natural a state as possible.
- Ensure that Environmental Impact Assessments (EIAs) are conducted for any development activities at an estuary and that these EIAs are particularly rigorous in their approach.
- Especially on small estuaries, strictly limit or ban entirely the use of motorized craft such as jet-skis and ski-boats. Also discourage or ban activities such as fishing competitions which can impact severely on the fish resource.
- The health of an estuary is dependent on the quality and quantity of freshwater it receives from the catchment. If there is significant abstraction of freshwater, or, if this is planned, commission an ecological reserve determination study, so as to ensure that the estuary gets its fare share of water. In some instances, particularly where there is a wastewater treatment works on an estuary or in the catchment, the flow of water into the system might be increased. Examine how water from the treatment works can be directed elsewhere.
- Accidents happen. Estuaries regularly intersect with infrastructure systems such as roads, railways and sewage pipelines or, in the case of harbours, are an integral part of the transport system. Spillage of toxic substances into estuaries is a common occurrence, so it is necessary to have systems in place which can cope with these disasters.
- Encourage the local stake-holders and civic organizations to act as your "eyes and ears" on the ground, in order to report transgressions; to monitor the health of the system informally and to educate users. Through capacity building exercises empower these local stake-holder groupings to take an active role in management.

Education can significantly reduce the pressure on estuaries (Margaret McKenzie)

- Encourage research which will result in an improved understanding of how an estuary functions. Ensure that the research findings are fed into management decision-making.

Chapter 5
How do we support estuary based economic opportunities?

Municipalities in South Africa are development orientated. We are trying to correct the disparities of the past, trying to increase income-earning opportunities for residents and to increase the income for the municipalities, so that there will be sustained delivery of infra-structure and services.

Estuaries provide numerous opportunities to do this and development should be encouraged. If we are unable to obtain tangible economic benefits from a system, what is the incentive for its management? However, we need to go about obtaining these economic benefits carefully. Firstly, we don't compromise the resource base; and secondly, so we don't take one resource at the expense of another which might result in a greater or more equitable benefit.

What is the role of the municipality in business and enterprise development?

The possibilities to develop enterprise opportunities at and around estuaries are many and varied, both in type and scale. Enterprises range from a single bait collector selling prawns, to local fisher folk, to multi-billion rand port-based cargo handling operations. It is not the intention here to describe each opportunity, as each will be unique. Instead we will detail the **key questions** that a municipality needs to ask and answer, as both the supporter of and regulator of economic development.

The canoe trail businesses at Mngazana add value to the estuary and assist in its conservation (Fonda Lewis)

Does the enterprise add value to the municipal economy?

- Is the enterprise aligned to the goals and objectives of the municipal IDP?
- Does it conform to the zonation set out in the Spatial Development Framework or other zoning plans?
- Will the enterprise facilitate the establishment of other enterprises and so indirectly add additional value?
- How many direct and indirect jobs will the enterprise create?

Are the necessary institutional arrangements in place to support and regulate the enterprise?

- Are the rights to the resources that the enterprise will use formally secured?
- Are the laws and regulations that govern the business operation in place and functional?
- Is the proposed business organization (partnership, co-operative, private company, private sector/community/state partnership etc) appropriate for the type of enterprise operation?

What environmental and social impacts will the enterprise have?

- Will the enterprise support or compromise the biodiversity conservation objectives?
- Will the enterprise improve or reduce livelihood opportunities of residents?
- What will the environmental impact of the enterprise be and what scale and detail of environmental impact assess-ment is required?

Guided fly-fishing on the Mtentu – providing jobs and income to Mbizana Municipality residents (Ben Pretorius)

Is the enterprise feasible?

- Does there appear to be a realistic market for the goods and/or services produced by the enterprise and will the enterprise be able to access these markets?
- Is the necessary infrastructure in place to support the enterprise?
- Do the capital infrastructure costs and the costs of operation relate to the return on investment (i.e. does the business plan make economic sense?)
- What are the risks?

In answering all these questions, the municipality should not be seen to be interfering directly in the proposed enterprise development. All we are trying to do, is to minimize the chance of failure of the enterprise and ultimately of the municipality. Assist where you can, to increase the resilience, sustainability and profitability of the enterprise in question.

A new opportunity – paying for management services

A new area of economic opportunity worth exploring is payment for management services. It is based on the premise that management cannot and should not be carried out free of charge. Someone needs to pay for it to happen. Also, it is unrealistic to expect enterprises operating at an estuary to carry the cost of management. They are already paying their rates and taxes to the State so it can carry out governance and management. Also, the benefit of good governance and good management does not only accrue to these enterprises. It also accrues to society broadly.

The idea is that local stakeholders are capacitated to, retained and paid to manage the estuary, in consultation with the relevant authority. This provides these stakeholders with a source of income for a service that is rendered. It is not social welfare. The first obvious question is where will the money come from? We all know that most coastal municipalities are cash-

strapped and estuary management is not a priority. A possibility, in the short term, is the Extended Public Works Programme. In the long term, Catchment Management Agencies might be a source of management service funding.

The bottom-line is that the concept is sound. The detail of what services are rendered, where funding is sourced, and how payment is made will differ depending on a particular context.

What opportunities exist for the municipality?

We mentioned in Chapter 1 that people build residential and holiday homes at and around estuaries. The land and the infrastructure have a greater value here than elsewhere, because of the views, the proximity to the asset and the lifestyle this allows. Increased land and infrastructure value, increases rates revenues. The opportunity exists in municipalities, to zone land more specifically to incorporate the benefits of living at or near an estuary. This applies not only to residential development. Businesses establish themselves at or near estuaries because, either they are directly reliant on some goods or services supplied by that estuary, or because that is where their market is. These businesses too, can attract increased rates revenues. Importantly, increased income to the municipality can be used to fund the management of the estuarine asset.

Residential development at Bushmans has contributed significantly to the rates base of the Ndlambe Municipality

The second key opportunity is the economic saving that estuaries allow municipalities to achieve in the provision of services, particularly wastewater treatment. It is no coincidence that there is a wastewater treatment works on almost every river in the Durban and Cape Town areas. Treated water can be disposed of back into the river and estuary system at little or no cost to the municipality, instead of the costly process of transferring it out to sea or another location.

While this needs to be conducted with care and requires monitoring, in some instances, this can benefit an estuary. Inflows of treated water can compensate for reduced freshwater inflow into an estuary as a result of activities in the catchment.

Chapter 6
How do we make decisions about estuaries?

Imagine, you are a municipal official and you encounter an issue or opportunity at an estuary in your municipality. It might be any one of the issues or opportunities mentioned in Chapters 4 or 5. How do you deal with it? The first thing to understand is that you are very rarely making decisions about the estuary itself. In most instances, you are making decisions about people, and their activities and behaviour that affect estuaries. Are people fishing illegally? Is there an area that requires special protection or rehabilitation? Where should we route a sewage pipeline so that there is limited impact? The second thing to understand is that when you make a decision about a certain activity or behaviour, you invariably affect another activity or behaviour. If we specially protect a certain area, where are we going to put the sewage pipeline? Just about everything is linked. So, you have to think holistically about the issues. Decisions about these issues are made in a structured process of governance and management and should be no different from the processes in the Integrated Development Planning process. Indeed, all decisions taken should be entirely within the context of, and consistent with the IDP process.

What is governance?

Governance is the process through which society manages its economic, social and political resources and institutions, to ensure the well-being of its people. This should include all sectors of society – government, the public, the private sector, Non-government Organisations (NGOs) and Community-based Organisations (CBOs), and researchers. Four governance principles will inform your approach:

Accountability: Whatever decisions you take in dealing with the issue, you are accountable firstly to the municipality and its residents, and secondly to the broad stakeholder base with an interest in the issue or opportunity.

Participation: Estuaries are public resources, and, unless it's an emergency, you need to consult with stakeholders to arrive at a decision. Even in an emergency, participation is required, to arrive at a decision.

Consistency: Decisions taken need to be consistent with various laws and with various protocols and procedures of the municipality

Transparency: All decisions taken need to be taken in a transparent and honest fashion.

What is management?

Management is simply a process of planning and acting with a specific purpose in mind. Because estuaries are public resources you cannot plan and act alone. This demands a co-management approach – involving various spheres of government and civil society in the decision making process.

Who should be involved?

The first step is to gather together a group of people with a common interest or problem. The starting point is the municipality. As we have seen, estuaries are not simply environmental resources. They also make important economic and social contributions. So, it is important to involve the appropriate departments in the municipality. This would include those responsible for environmental management, economic development, infra-structure development, planning, amenities management and finance. Local municipalities are supported by other spheres of government. In the context of estuaries it would be critical to involve the district municipality, the provincial environ-mental department and the national departments of Environment Affairs and Tourism (DEAT) and Water Affairs and Forestry (DWAF). Depending on the issues, other provincial and national government departments and parastatals might become involved on a needs basis. You also need to involve, civil society, including residents and rate-payers, tourism operators, developers, fisher folk and harvesters, boat operators, environmental organizations, and community-based organizations.

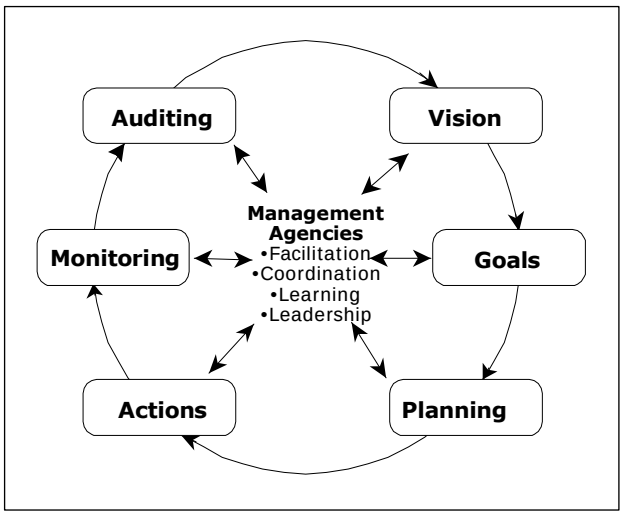
It is critical to involve local stakeholders in estuary management activities (Margaret McKenzie)

How do we organize into a decision making structure?

There are a variety of options to form a structure, depending on the number of stakeholders and the issues that need addressing. Ideally the group should be organized into a formal forum, with a constitution that contains its vision and goals to guide its behaviour. Often these groups are quite large and unwieldy so it is useful to elect an executive committee, who would meet regularly. The full forum might meet once or twice a year. The need to organize is often the result of conflict around a particular issue. This conflict makes organization difficult, as groups are polarised. Ideally, you need an independent party, with strong credibility, to assist with the organizing process.

What process should we follow?

The adjacent 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 an adaptive process which allows for adjustments as we move forward. In many ways it is identical to the IDP process of the municipality.



A typical Estuary Management Process (Charles Breen)

As a starting point, those getting together need to establish a broad and shared vision for the state of the estuary or section of interest. Adjacent is a typical **vision** – that for the Tyolomnqa Estuary Management Forum.

This vision should be a broad statement of intent that looks into the future. This vision also serves the purpose of resolving conflict.

Present and future generations are able to appreciate and share the unique natural, historical and cultural heritage of the Tyolomnqa Estuary whilst enjoying in peace the benefits of development founded on the protection and sustainable use of its resources.

The vision of the Tyolomnqa Estuary Management Forum

Conflict is usually about the here-and-now. The vision forces people to think long term and work back to the current issues. With a long-term view it is usually easier to resolve differences and gain consensus.

In order to realise the vision, a management forum needs to set itself some practical **goals**. These goals should be objective and measurable. As examples, adjacent are three of the seven goals of the Tyolomnqa Estuary Management Forum. It is critical that sufficient time and effort be given to this process. Not only does it build collective direction and purpose but it is at this stage where relationships and trust begins to build between group members.

1. ***To establish the desired state for the Tyolomnqa Estuary and its surrounds and develop a practical management plan that is able to achieve this desired state.***
2. ***To link the management plan to other planning and management processes, particularly the Integrated Development Plan of the Buffalo City Municipality.***
3. ***To identify and establish economic opportunities that benefit local communities and, at the same time, maintain or improve the ecological, historical and cultural integrity of the estuary and its surrounds.***

Three goals of the Tyolomnqa Estuary Management Forum

Once a management structure is established and functioning, and the vision and goals have been defined, it is necessary to develop a management plan as a basis for action.

An estuary management plan will usually include:

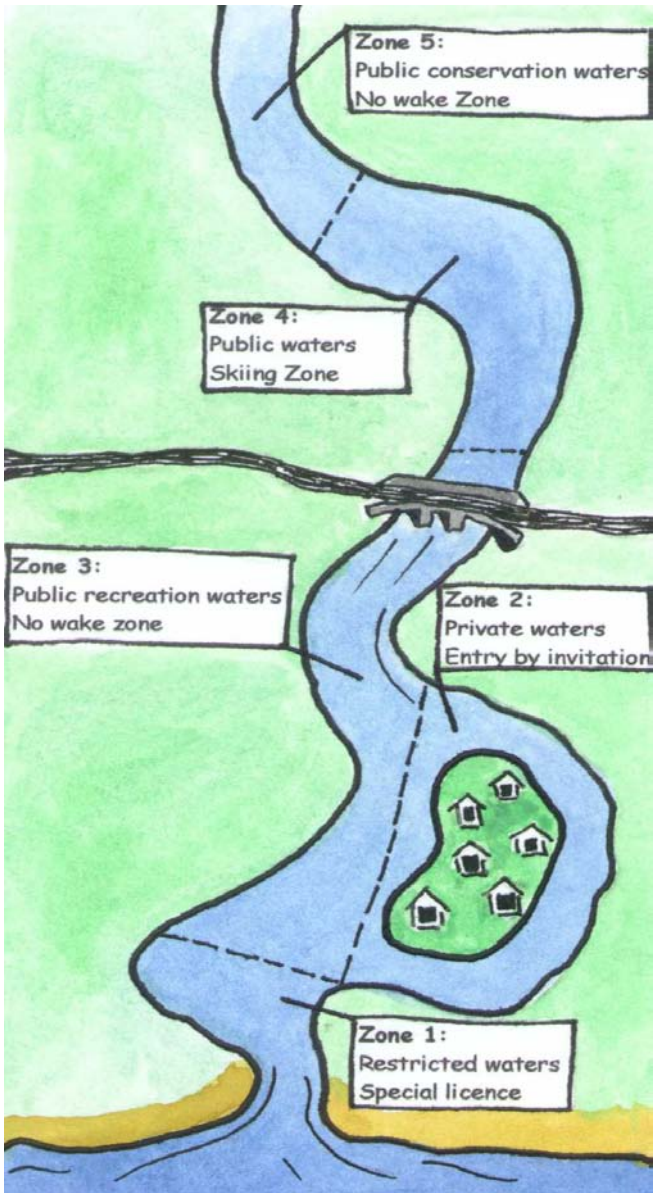
- The policy, legal and institutional context
- A general description of the estuary and its surrounds, focusing on its ecological, economic and social assets
- A strategic plan, which includes the visions and goals, and governance principles informing management
- A spatial plan, which will include any zonation that is required
- Various sector plans, which will deal with specific issues such as fishing, infrastructure development and so on.
- An implementation plan, which sets out the various action required to realise the goals: what is going to be done (in specific terms); who is going to do it and how it is going to be done; when it is going to be done and how long it will take; what it will cost; and how do we determine whether we are succeeding or not (indicators of success).

It is useful to get all stakeholders to sign off, in agreement with the management plan. There is provision within legislation for this to happen.

However, it is important to realise that 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.

While the specific responses of a forum and its constituents will vary from estuary to estuary, experience has also shown that there are certain actions that are common to most:



Zoning an estuary would be a typical planning and management activity (Lauren Cohen)

- Zone the estuary and its surroundings into different activity areas and determine the range of activities that may take place in each area. This would include recreational boating areas, recreational and subsistence fishing and bait collecting areas, conservation zones, and land-use planning around the estuary.
- Regulate commercial, recreational and subsistence fishing, and the harvesting of other natural resources such as mangroves and reeds.
- Ensure compliance with existing legislation and/or assist authorities in drafting regulations that improve sustainable use.
- Ensure the safety of people active 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 IDPs of local municipalities, coastal management plans, and catchment management plans.
- Establish a mouth management system for those estuaries that are intermittently open.
- Co-ordinate research to increase understanding of the system and/or to help answer specific questions for improved management.
- Monitoring that determines progress in achieving the forum's goals.

The success of carrying out these actions and others will depend largely on:

- The comprehensive nature and detail of the planning that precedes the action. If we know precisely what we have to do and how to do it, we are more likely to do it.
- The enthusiasm and commitment of forum members to engage in the doing.
- The capacity to act, which includes the skills of people who are tasked with various activities, and the resources they have to work with.

In deciding on how to act, it is very important to recognise the limits of our ability. While a forum might be able to plan and carry out certain actions itself, specialist assistance is often required. The critical issue is to recognise when specialist assistance is required.

Finally, monitoring progress, auditing and refinement is critical. We need to be able to measure progress, and, based on this, refine our planning and our actions.

What are the key management rules?

While management is simply the structured process of planning and acting, it is not a simple process. There are a number of factors that result in successful management of an estuary, which are worth bearing in mind:

Complexity: In most instances the purpose of planning and acting is to influence people's behaviour and attitude towards an estuary. People are complex and an estuary is a complex system. The interactions between people and estuaries are very complex and change rapidly with time. We need to recognise and expect this complexity and variability.

Estuary management requires cooperation between government, stakeholders and specialists (Margaret McKenzie)

Knowledge: The more we know about a problem or an issue, the better we are likely to be able to solve the problem or address the issue. However, we often encounter issues about which we know little or nothing but about which we still have to make decisions. When doing this, make sure a cautious approach is taken. Ask for help.

Learning and doing: Management is a process of learning and doing. Learning without doing gets you nowhere, and doing without learning results in costly mistakes.

Planning: Planning is a critical component of the management process. Invest in planning and take a systematic approach to dealing with the issue or problem.

Leadership: Providing good leadership in the management process is critical. Ultimately someone has to be accountable and take the decisions.

The Law: This is the axis around which society revolves. Know the law, follow it and make it work for you.

Cooperative management: You cannot manage alone, particularly with estuaries. Gather a team around you.

Relationships and trust: Good management happens when good relationships have been developed and trust established. Particularly in the early stages this needs to be the focus.

Communication: The key to successful management is effective communication.
Start small and be realistic: Good management comes with practice. It is best to start off dealing with small issues effectively and, once you have confidence and experience, engaging the bigger issues.
Empowerment: In capacitating and empowering others we capacitate and empower ourselves.
Prediction: A key to successful management decision making is to be able to predict the consequences of a decision and the resulting action. Prediction takes knowledge, skill and practice. Always think ahead and ask yourself "if we do this what will happen"?
Time: Everything takes longer than you think so incorporate this into your planning.

How does the law affect management decision making?

Everything we do takes place within the context of a policy and regulatory framework. The laws of our country regulate our behaviour. Activities and behaviour that affect estuaries are no different. It is not the intention here to provide a comprehensive review of all the policy, legislation and regulations that affect estuary management. One main reason for this is that the Department of Environmental Affairs and Tourism has just released the National Environmental Management: Integrated Coastal Management Bill for comment. This is a key legislative document that is likely to profoundly change the way estuaries and coastal resources are managed. Following is a short description of the most important current legislation.

Currently we can divide policy, legislation and regulations into three sections: water quality and quantity, land use and infrastructure development; and utilisation of living resources.

Legislation, while fragmented, covers all activities and behaviour that affect estuaries (DEAT)

Water quality and quantity: This is dealt with in the National Water Act. The key principle enshrined in the National Water Act is, that the natural environment is recognised as a water user. In practical terms, this means that water of sufficient quality and quantity needs to be allocated to the estuary so that it can function properly. The Act and its various pieces of legislation also cover water pollution, wastewater treatment works, and any actions that alter the banks or bed of rivers, streams, lakes or estuaries. This includes the construction of canals, dams and weirs.

Land-use & infrastructure development:
This is covered by a considerable body of national, provincial and local legislation. The most important of these are: Development Facilitation Act which requires that land-use objectives be established; the Municipal Systems Act which requires that municipalities establish Integrated Development Plans that contain land-use and infrastructure plans; and the National Environmental Management Act which lists which development activities require Environmental Impact Assessments (EIAs).

Utilisation of living resources: This is covered by three key pieces of legislation. The Marine Living Resources Act regulates the recreational, subsistence and commercial harvesting of any living organism that occurs in an estuary; the National Environmental Management: Biodiversity Act makes provision for the protection and conservation of ecosystems and species; and the Forest Act regulates the harvesting of mangroves.

Not fitting into these categories, but directly linked to them, are those pieces of legislation covering tenure. This is administered largely by the Department of Land Affairs. Security of tenure is critical to the wise and sustainable use of resources in and around estuaries.

Policy, legislation and regulations governing activities and behaviour at and around estuaries have been severely criticized for their fragmentary and sometimes conflicting nature. Also criticized is the fact that there is no single piece of legislation that gives protection to estuaries. This criticism is probably deserved and it is hoped that a new Integrated Coastal Management Act will address this. However, with a bit of juggling, one can normally find a legal instrument to cover most activities. Currently, it is not the lack of these instruments but the political will to enforce them diligently that is lacking.

How do we integrate estuary management into IDPs?

The first and most important way of ensuring that we consider estuary management in the IDP process, is by building the awareness of the value of estuaries among politicians, officials and civil society stakeholders. If it is in the hearts and minds of decision makers and those contributing to decision making it will be in the plan. Assuming this awareness has been created, technically how do we accomplish it?

At the assessment stage of an IDP the coast and estuaries should be considered explicitly. The kind of key questions that should be asked in conducting this assessment might include:

- What information do we have on our municipal estuaries and where can we locate it?
- What are the protocols, policies, laws and by-laws dictating the governance and management of our estuaries?
- What is the economic contribution of estuaries to the municipality and more broadly?
- What conservation importance is attached to these estuaries locally, regionally, nationally (the National Biodiversity Strategy and Action Plan will inform this)?
- What is the ecological state of our estuaries and what are the key factors contributing to their state?
- How will these factors change in the future and so influence the state?
- What are the key activities taking place at estuaries and how do they compete with or compliment one another?

At the visioning and setting of objectives stage of the IDP process, coastal and estuary management should form part of an explicit objective. This will ensure that it is included in the package of plans to follow.

In developing the package of plans that form the operational elements of the IDP there are no hard and fast rules on where estuaries should be included. This will vary from municipality to municipality. Given the economic importance of our coast, municipalities are being encouraged to establish coastal management plans. Some have already done so, and these are supported by national and provincial policies and programmes. It is natural for estuaries to be

municipalities, Cape Town being an example, are organizing their planning and management on a catchment basis. Estuaries form part of the catchment and so will be considered here. Ideally estuaries should be included in both catchment and coastal planning and management.

Beyond this, estuaries should also be considered in economic development and financing plans, strategic environmental assessments and environmental management plans, spatial development plans (SDPs), land-use management systems (LUMs), precinct plans, infrastructure development and service development plans, conservation plans, and disaster management plans. In short, estuaries need to be everywhere.

Chapter 7
Where to find information

For those who wish to know more about estuaries and their management there are a number of books, booklets, technical papers and also educational materials.

Good starting points are three user-friendly guides:

- Breen, C. M., and McKenzie, M., 2001. ***Managing Estuaries in South Africa: An Introduction.*** This publication has also been adapted and translated into isiXhosa and isiZulu.
- Hay, D. and McKenzie M, 2005, ***Managing Estuaries in South Africa: A Step by Step Guide.*** (TT 243/04)
- Huizinga, P and Mitchell S. 2005, ***Managing Sedimentary Processes in South African Estuaries: A Guide***. (TT 241/05)

All three publications are available free of charge from the University of KwaZulu-Natal. E-mail hay@ukzn.ac.za with your postal details to secure a copy. The second two are available from the Water Research Commission in Pretoria. Post or email your request to Water Research Commission, Private Bag X03, Gezina, 0031 and quote the reference number indicated in brackets above. (orders@wrc.org.za)

The definitive technical book on Estuaries is:

- Allanson B R and Baird D, 1999. ***Estuaries of South Africa.*** Published by Cambridge University Press (ISBN 0 521 584108)

There are also a number of technical publications available from the WRC:

- Breen, C. M., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., Wood, A., Lamberth, S., Boyd, A and Morant P,. 2004. ***Eastern Cape Estuaries Management Research Programme, Volumes I and II.*** WRC Report No. 1246/1/04. Water Research Commission, Pretoria.
- Breen, C. M., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., and Wood, A., 2004. ***Towards the Conservation and Sustainable Use of Eastern Cape Estuaries.*** WRC Report No. TT 237/04. Water Research Commission, Pretoria.
- Hay D (Editor) 2007. ***Profiling Estuary Management in Integrated Development Planning.*** WRC Report No. 1485/1/07, Water Research Commission, Pretoria.

Finally there is a training course in estuary management that focuses on the needs of municipal officials but is equally appropriate for a broad audience. For more details on this contact Duncan Hay at the University of KwaZulu-Natal on hay@ukzn.ac.za or Lara van Niekerk at the CSIR in Stellenbosch on lvnieker@csir.co.za.