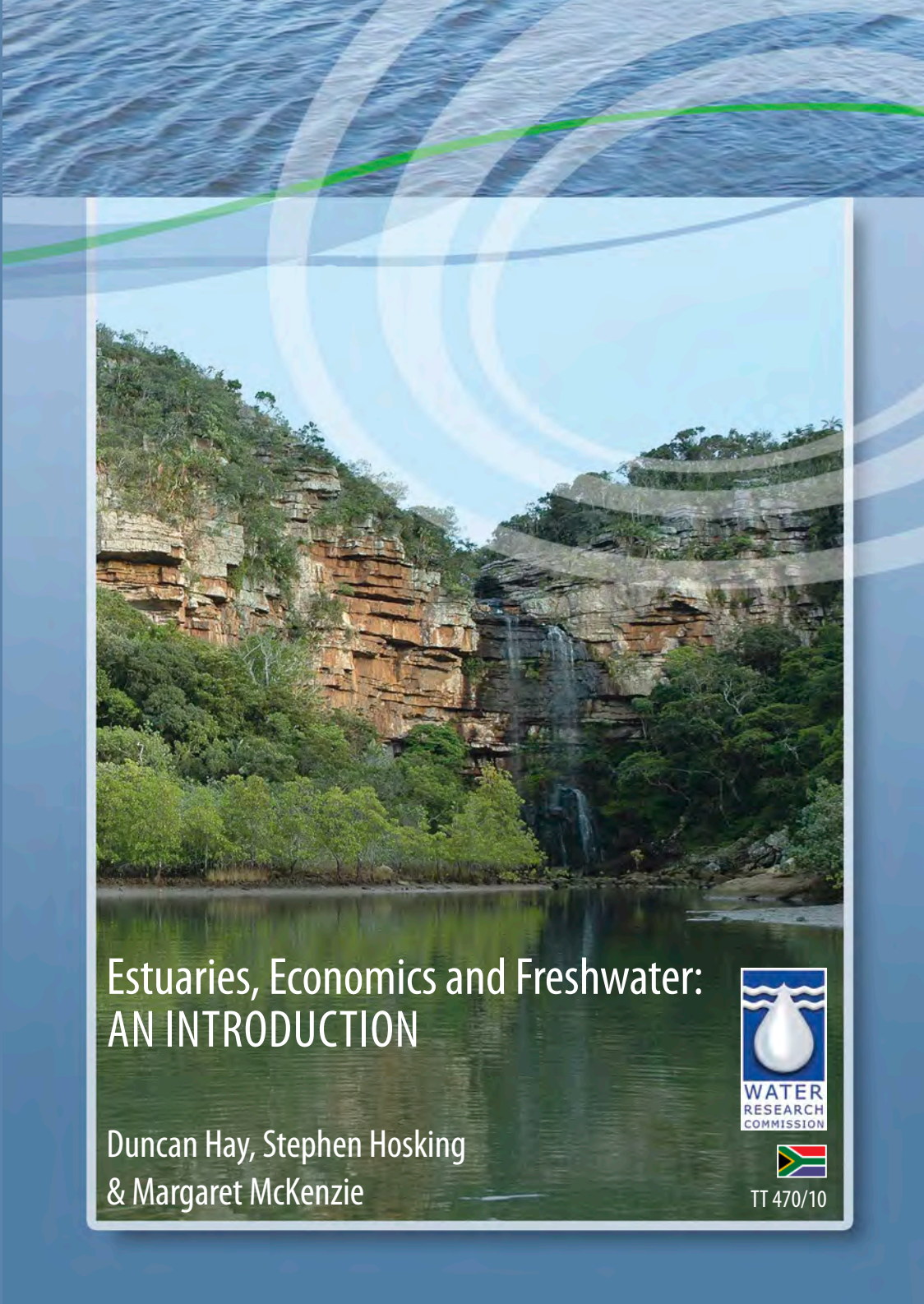

Estuaries, Economics and Freshwater: AN INTRODUCTION

Duncan Hay, Stephen Hosking
& Margaret McKenzie

WATER RESEARCH COMMISSION

TT 470/10

Estuaries, Economics and Freshwater: An Introduction

Report to the
Water Research Commission
by

Duncan Hay, Stephen Hosking and Margaret McKenzie

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University of KwaZulu-Natal

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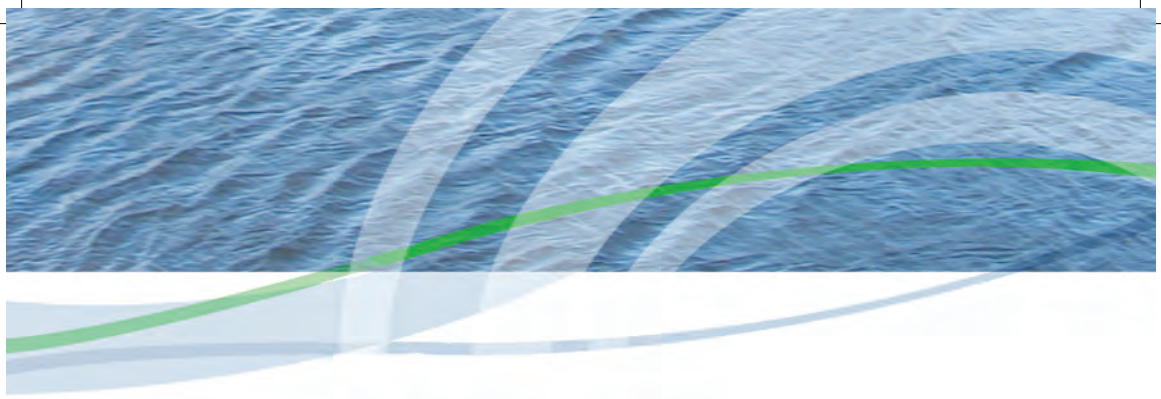


1. Introduction and purpose

As development in South Africa progresses, there is an increasing demand for fresh water. There is also increasing demand for energy but, unlike energy where if we run out we can make more, water is finite – we can't make more and there is only so much to allocate. Also, South Africa is a water-scarce country (Fig. 1) and many of our catchments are already under pressure from competing demands for the available water. Add to this our new water laws which recognise that the ecosystem (river, lake, wetland or estuary) has a legitimate right to some of that water. Also, there is a growing realization that we have abused, and continue to abuse, the available water. Not only do we have less to use but what we have is often of poor quality. Add to this the certainty that global climate change will alter rainfall patterns and the uncertainty of what this change will bring. The recognition dawns that, whatever the future holds, it will certainly include major water management challenges.

Compounding current and future water management challenges is the nature of the resource. Water, wetlands, rivers and estuaries are public or common property resources. They are not privately owned. They are 'owned' by society and managed on our behalf by the state. In order to effect management and arrive at decisions, extensive consultation is required. Managers of these resources and of people whose activities affect these resources already find themselves in the eye of a very complex storm. From the headwaters of the catchment to the sea, people are competing for what

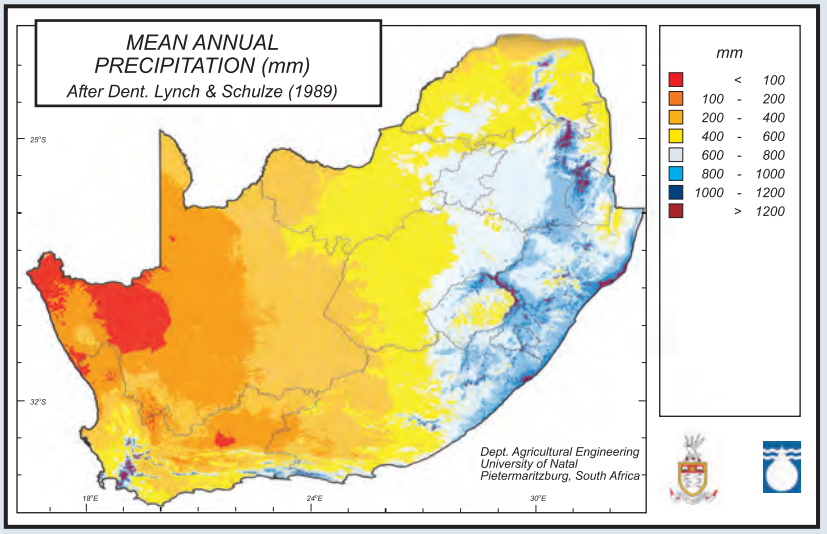


Fig. 1: South Africa is a water-scarce country.

is available – for water and the various ecosystem services associated with it. This issue is increasingly finding itself on a manager's desk – farmers, residents, industry and towns are removing water from river systems upstream while those downstream at estuaries are asserting their rights to the same water. Who gets the water, how much do they get, and what systems do we use to ensure fair and efficient allocation?

Compounding the difficulty of decision-making is the nature of water and its delivery, particularly in South Africa. One day it's drought and the next there are floods; one day crystal clear and the next heavily polluted or turbid.

Fair or equitable allocation is a complex challenge and, until recently, managers have not had the tools to support improved decision-making. However, things are changing. Scientists have developed systems to establish an estuary's freshwater requirements. Economists are allocating values to the various uses of water so that decisions can be made on what the most appropriate uses might be and what trade-offs might be made. Society is

becoming far more vocal about what it values and what is important. Specialists have developed structured yet adaptable management processes that provide frameworks for decision-making. In short, we are now able to capture the ecological, economic and social dimensions of a challenge, opportunity or problem in a structured and participative process and make well-informed decisions.

It is not the purpose of this handbook to turn managers into water specialists, estuary experts and/or economists. The purpose is to expose managers and stakeholders to what estuaries are, why freshwater is important to estuaries, what impacts on freshwater inflow into estuaries, and the role that economics might play in contributing to decision making on the various issues. The handbook is inspired by a Water Research Commission project which examined the economic value of freshwater inflows into estuaries.

2. Why are estuaries important?

People are attracted to and value estuaries. They are much more than important ecosystems. They are also important social and economic systems – they play an important part in the lives of thousands of people living along our coast and inland. If we fly along our coast, what do we see? Invariably, at each estuary there is development (Fig. 2) – homes, resorts, industry and

Fig. 2: Estuaries are a focal point of development

harbours. People congregate at them, the views are great, the water is generally calm, the fishing is good and the kids can swim. In addition, they are inexpensive places to get rid of waste water. It is no coincidence that most of the rivers in the eThekwini Municipality have waste-water treatment works discharging into them.

Their economic and social values are often dependent on the health of the ecosystem – you can't fish if pollutants have killed the fish, and the smell of rotting fish will certainly reduce the value of your nearby holiday home. The health of the ecosystem is often dependent on a supply of fresh water.

More specifically, estuaries offer a diverse and large range of ecosystem services that are a source of business, recreation, spiritual growth and human well-being. These ecosystem services are the source of a range of opportunities, such as:

- Fibre for thatching, craft production and onward sale;
- Wood for fuel and construction;
- Biochemical material from medicinal plant harvesting;

Fig. 3: Estuaries are a valuable source of food.

- Commercial and ornamental plant species;
- Food such as fish, bait, mariculture products, honey, sugar and bush-meat;
- Fodder for grazing; and
- Minerals such as sand, salt, diamonds and titanium.

Maintaining these ecosystem services provides a range of additional opportunities:

- Bioengineering, construction and maintenance fees to improve soil stability;
- Dredging fees and levies, beach user fees, mouth management fees and direct payment for sediment management and salinity control;
- Land reclamation fees and levies to fund soil formation and fertility;
- Pollution discharge (point and non-point source) license fees and levies, and solid waste collection fees for waste assimilation and dilution;
- Alien species eradication for pest control;
- Conservation management services and habitat restoration fees/levies for wind, fire and storm damage control;
- Insurance premiums for disaster management control;
- User and entrance fees and guiding services for places of natural, cultural and spiritual significance;
- Knowledge generation and learning sites;
- Land and infrastructure sales and leasing, user/access fees, licensing fees, rates, booking fees, safety and security fees/levies, and maintenance and restoration for settlements, mariculture, recreation and habitat conservation; and
- Ferry, cargo, pollution insurance, biodiversity offset and pollution cleanup fees from transport activities and infrastructure.

Who is benefiting from the opportunities arising out of the supply of these ecosystem services? Those who make use of estuary resources and obtain some kind of benefit are as varied as South African society itself. A rapid scan of South African estuaries indicates that:

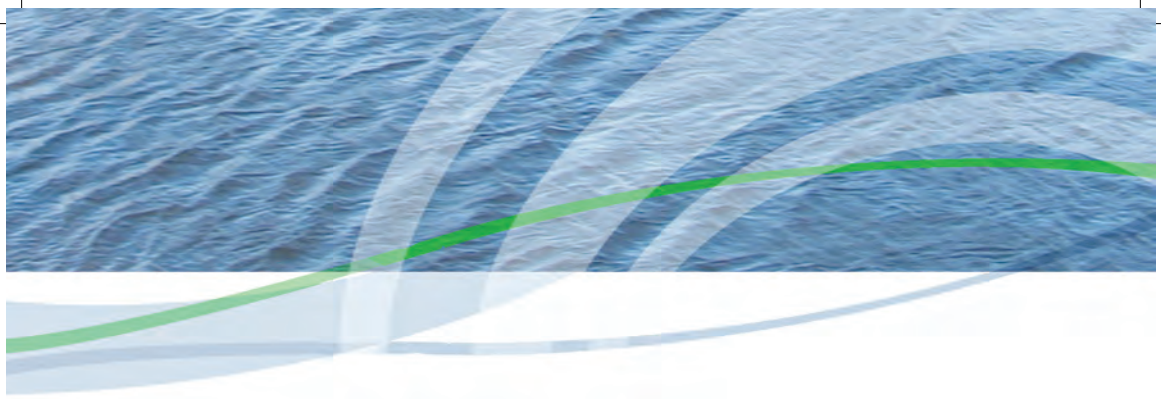
- Many estuaries are sources of fish, building material and grazing utilised by local rural people living at or near them. Good examples include Kosi, St Lucia and Amatikulu. These items might be sources of direct subsistence or enterprise to these people – you can eat the fish or sell the fish.

Fig. 4: Estuaries are a source of recreation and tourism.

- Many estuaries are sources of recreation and tourism. These operations provide jobs to local disadvantaged residents and have a significant economic multiplier (Fig. 4). The several resort hotels on estuaries of the Wild Coast are good examples. Umngazi River Bungalows supplies 200 direct jobs and then spins-off further jobs in fishing, walking, canoeing (Fig. 5) and horse-trail guiding, cultural activities, and bait and shellfish collection.

- Many estuaries are sources of residential development. Good examples include Nahoon, Gonubie and Bushmans. Here there are job opportunities for local residents. The rates earned by municipalities from these residential properties are a major source of income, allowing municipalities to hire employees, to invest in capacity building in these employees, to undertake preferential procurement for suppliers and to provide cash for local economic development initiatives.
- Potentially, estuaries are focal areas of major conservation management action. In future, sea level rise is likely to act as a catalyst for major investment in coastal infrastructure to ensure adequate protection. The focus of this investment will be in areas of greatest human concentration, often at estuaries. This has the potential to create numerous public and private sector job opportunities.

Fig. 5: Guests from Umngazi River Bungalows on a canoe trail.



3. Why is freshwater flow into an estuary important?

So, we have established that estuaries are important but, specifically, how important is the flow of freshwater into an estuary? To understand the importance of freshwater inflow we need to understand how an estuary functions.

Estuaries are distinctive geographic features on our coast. They are that part of a river system that interacts with the sea. Tidal currents of saltwater from the sea interacting with freshwater inflow from land, and the topography of the surrounding land, combine to create a unique, highly productive and highly dynamic ecosystem. The estuary acts as a nutrient trap. The flow of both fresh and seawater slows as it enters the system, depositing nutrients on the bottom. This is regularly aided by the plant life in and around the estuaries – mangroves, reeds and sea grasses slow the water flow further and trap nutrients. This is the foundation for the rich and varied life that we encounter in and around the system – microscopic diatoms, plankton, prawns, fish, birds, hippos, crocodiles and people. Of particular importance is the fact that estuaries regularly act as protected nursery areas for coastal prawn and fish species.

As we have mentioned, estuaries are places where salt and freshwater meet. The influence of the sea is dynamic but relatively constant. The tide flows

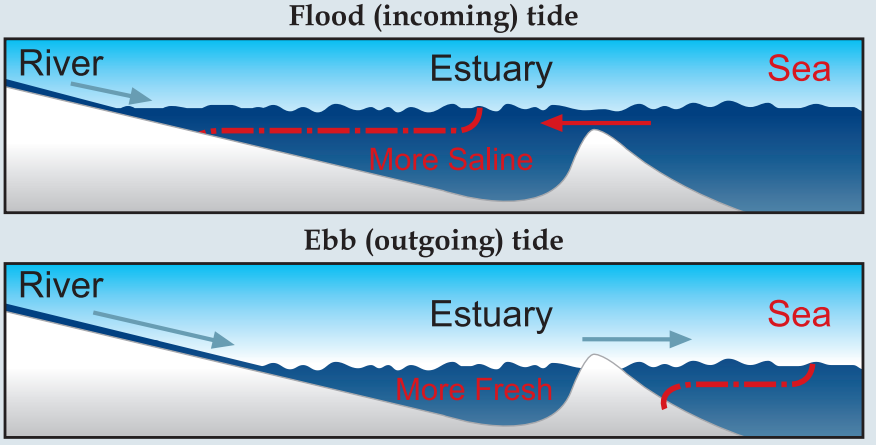


Fig. 6: The tidal movement into and out of an estuary (CSIR)

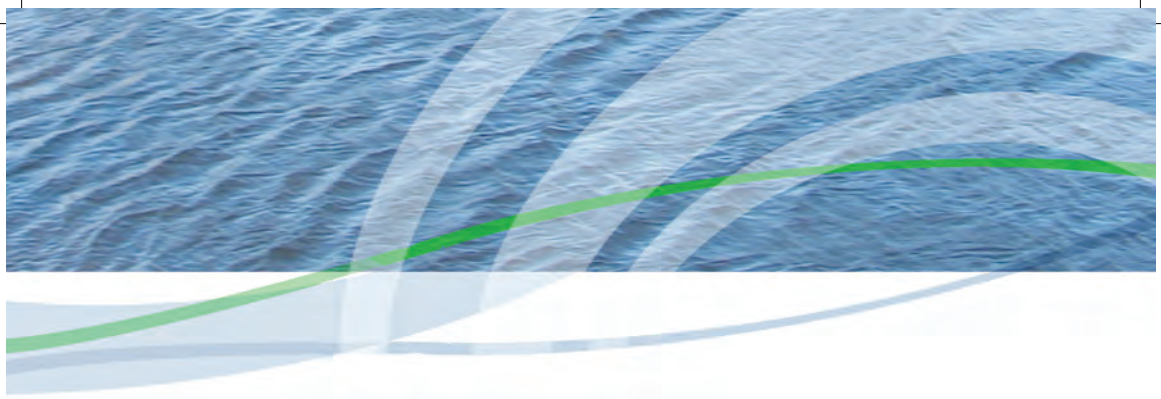
in and out twice a day (Fig. 6), and moves between spring and neap tides on a two-weekly cycle. Occasionally, storms at sea may disrupt this pattern, but it doesn't last long. What is highly variable, and often dictates the character of an estuary, is the freshwater inflow into the system.

In many instances we classify estuaries according to the pattern of freshwater inflow and its effect (Fig. 7). As examples, we categorise Durban Harbour and Knysna Lagoon as marine bays because of the limited freshwater inflow – they are sheltered extensions of the sea. The Tugela and Orange River estuaries we categorise as river mouths, because freshwater flow is usually so powerful that it prevents seawater entering. Common on our coast are what we categorise as intermittently open estuaries – these are estuaries with small catchments which close off to the sea, particularly in winter, when freshwater inflows are insufficient to keep the mouth open.

Compounding this variability of freshwater inflow is the strongly seasonal nature of our rainfall – lots in summer and very little in winter in our summer rainfall area, and lots in winter and very little in summer in our winter rainfall area – together with year on year climate that is highly variable.

Fig. 7: 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 sanctuary.

What is important to understand and appreciate is that estuaries thrive on this variability. It is an inherent and critical part of their design and functioning. For example, in summer rainfall areas, when the first significant spring rain falls and water flow increases, the mouth of the estuary is breached. In the sea, at the mouth of the closed estuary, juvenile fish and prawns have already taken their cue from the freshwater seeping into the sea. As the mouth breaches they recruit into the estuary which is sheltered and full of food. Floods are an estuary's "bread and butter" – while Cyclone Demoina in 1984 was perceived to have had a negative impact on St Lucia Estuary the reality was that it stimulated a number of biological processes that had been dormant during a long period of stability and drought.



4. Freshwater inflow and the law

Freshwater conservation, allocation and use are governed by the National Water Act of 1998. Heralded internationally as an innovative legislative framework for the governance of water resources, the Act is based on 28 principles. Principles 9 and 10 are particularly important. Water use for basic human needs and long term environmental needs are prioritised above all other uses. Together, these uses are commonly referred to as the Reserve. Part of the intention of the Reserve allocation is to ensure that the ecosystem – wetlands, rivers, lakes and estuaries – receive freshwater of sufficient quantity and acceptable quality to allow them to retain their ecological health.

Briefly, what is this act governing? In 2000 South Africa received about 600 billion cubic meters of rainfall. Only about 100 billion cubic meters were retained on land. Of this about half entered our rivers systems and groundwater and 20 billion were allocated by the Act. Almost half of this discretionary allocation was to the Reserve (9.5 billion cubic meters). Much of this allocation is largely theoretical and the reality is that many catchments are stressed – the Reserve is being abstracted for use.

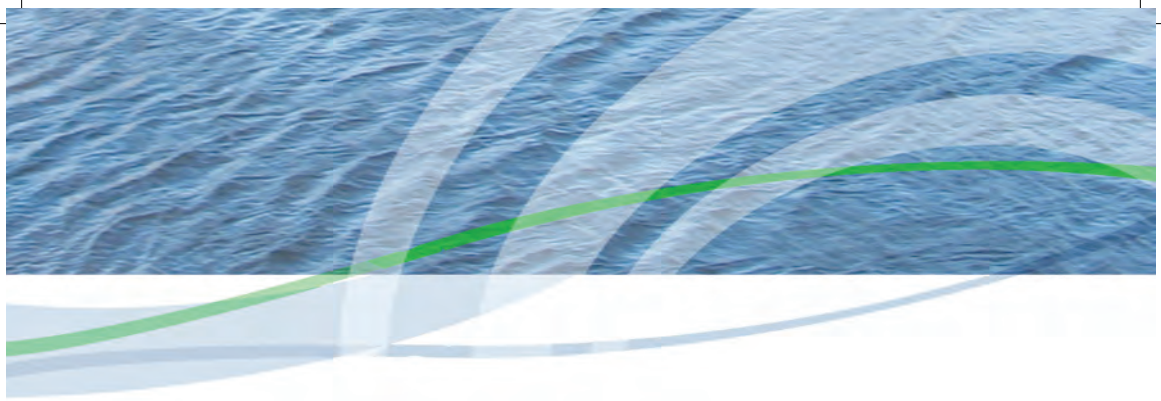
Within the context of the National Water Act, the Department of Water Affairs and scientists developed a method to determine the freshwater inflow requirements of estuaries. The method includes documenting the geographical boundaries of the estuary and determining estuarine health by comparing the present state of the estuary with a predicted reference

condition using an Estuarine Health Index. The importance of the estuary as an ecosystem is taken from a national rating system and, together with the present health, is used to set an 'Ecological Reserve Category' for the estuary. This category represents the level of protection afforded to an estuary. Freshwater is then reserved to maintain the estuary in that Ecological Reserve Category.

The Reserve is determined using an approach where realistic future river runoff scenarios, the present state and reference conditions are assessed. This allows us to evaluate the extent to which physical and biological conditions within an estuary are likely to vary with changes in river inflow. Results from these evaluations are used to select an acceptable river flow scenario that represents the highest reduction in freshwater inflow that will still protect the estuary ecosystem and keep it in the desired category.

Estuaries and their management are also governed by the recently gazetted Integrated Coastal Management Act of 2008. The Act makes provision for the establishment of management plans for each of South Africa's estuaries. A technical element of each of these plans is the establishment of the freshwater requirements of each estuary, as this would be an important contribution to management decision making.

Numerous other pieces of legislation will regulate activity that affects the quality and quantity of water entering an estuary. They include those governing conservation, agriculture, mining, industrial development – in fact, any legislation that governs the conservation or alteration of our landscape in any way will ultimately affect water quality and quantity. The important point here is that for effective management of our water resources, cooperative governance is essential – it is a shared resource with shared benefits and costs so it requires a shared responsibility. This joint responsibility is not just a government responsibility but a shared responsibility of all spheres of government and society.



5. What are the management challenges?

Beyond the natural variation which causes changes in freshwater inflow into estuaries there is the artificial variation that we cause. We might increase or decrease flows.

Increase

This is fairly unusual and the cause is usually quite specific. An increase in inflow is usually associated with a waste-water treatment works on the river upstream from the estuary. The water processed through the works normally originates in a different catchment and so it boosts the flow in the receiving catchment. A good example of this is the waste-water treatment works on the Ohlanga Estuary just north of Durban. The water being treated originates, for the most part, from Midmar Dam on the Mngeni River but is being treated and then disposed of in the Ohlanga River. What effect does this have? Assuming the water is of adequate quality, the primary effect is felt by intermittently open estuaries. The incidence of mouth breaching increases, nutrients are flushed out more regularly and those organisms that recruit into estuaries when the mouth opens battle to get the timing right. In the case of Ohlanga, as a solution, the eThekwini Municipality is proposing that it re-direct water from the treatment works to other catchments at a cost of about R 20 million.

Theoretically, water transfer schemes like that from the Mooi River to the Mngeni River could cause an increase in inflow into the Mngeni Estuary.

However, the reality is that most receiving rivers of the scheme are so highly regulated and the water demand so great, that the extra water never reaches the estuary.

Decrease

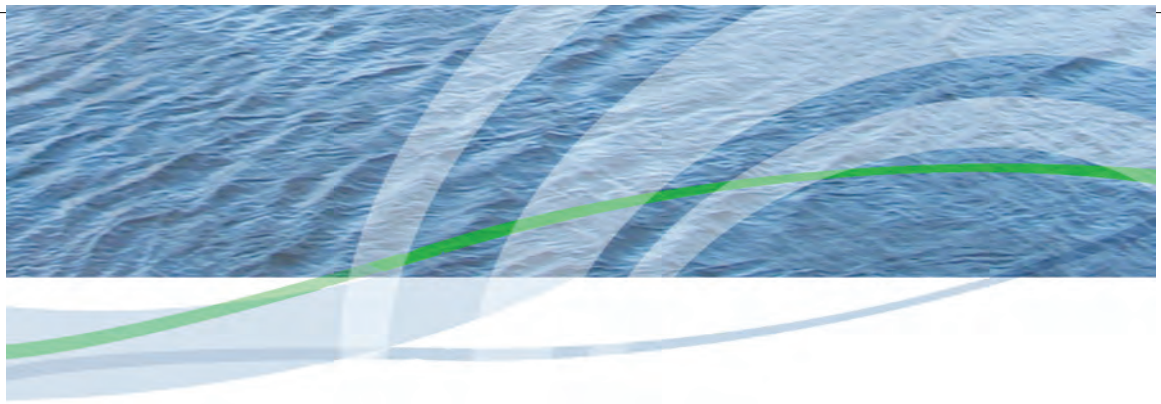
Our primary concern is the reduction in freshwater inflow into an estuary, one consequence of which is illustrated in Figure 8. This is caused for the most part by abstraction of water somewhere in the catchment. It might be plantation forests sucking up rainwater even before it gets to a water course, crop irrigation, domestic or industrial use, dam construction — any one of a myriad of human activities. What impact does it have?

- ***Loss and alteration of natural habitat:*** Certain habitats that were dependent on a specific pattern of freshwater inflow would either be lost or altered by reduced freshwater inflow. The result is a loss in biodiversity. For example, a freshwater dominated ecosystem might become a marine dominated ecosystem with changes in salinity levels.

Fig. 8: Mouth breaching is sometimes required when freshwater inflow is reduced and the mouth opens less frequently.

- ***Changes in mouth condition:*** Reduced freshwater inflow will cause the mouth to open less frequently. This, in turn, will affect the ability of organisms to enter the estuary from the sea and use it as a nursery ground. Prolonged mouth closures might result, at the least, in a movement towards a freshwater dominated system, and at worst, cause the build-up of organic material to the point where the system becomes deprived of oxygen. The result is the fish-kills we often read about in the press.
- ***Changes in nutrient status:*** Reduced freshwater inflow can have a variety of impacts on the nutrient status of an estuary. In general, the less the freshwater inflow, the less the nutrient inflow and productivity.
- ***Changes in sedimentation and turbidity:*** A decreased inflow of freshwater caused, for example, by a large dam in the catchment, will reduce the ability of the estuary to scour itself out periodically, and marine sand will enter and accumulate in the estuary. Catchment sediment will also be trapped and prevented from moving into the estuary. This will reduce turbidity. The Mngeni Estuary is a good example of this.
- ***Loss of system variability:*** As mentioned earlier, 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, particularly stabilizing freshwater inflow. 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 at a constant depth 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.

- ***Changes in salinity:*** Various activities can cause salinity levels to increase or decrease. If a catchment is extensively dammed, and freshwater inflow is reduced then 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 can cause salinity levels to increase, at times, to over three times that of sea water at times. 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 pollution levels:*** Estuaries are seen as systems into which pollutants can be disposed. Certainly, many of them have the ability to absorb this impact without undue harm. However, the moment one reduces the freshwater inflow one reduces the dilution rate and the ability of the estuary to absorb the pollution loading.



6. Principles guiding decisions on water allocations

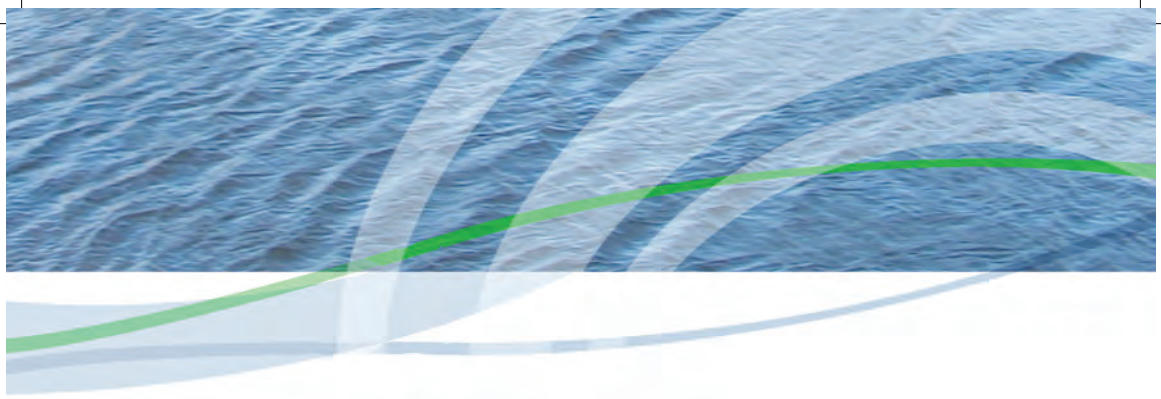
The models, systems and information that can contribute to management decision-making are many and varied. In this booklet we are not going to discuss estuary planning and management in detail. Information can be obtained from several publications listed in Chapter 8.

In terms of making decisions on freshwater allocations into estuaries, what should we be looking for? Here are some principles that might inform our decision-making?

- ***An estuary is a recognised user of water.*** Sufficient allocation of freshwater needs to be provided to an estuary, allowing it to function as such.
- ***Freshwater for basic human needs takes priority over other human uses.*** If a community is reliant on fishing at an estuary for basic subsistence and those fish require a certain level of freshwater inflow, then that allocation takes precedence over, for example, water for recreational use upstream.
- ***An estuary is a public asset.*** Any decisions on freshwater allocations to an estuary require public consultation and participation.
- ***We need to provide redress to those affected by the iniquitous allocation regimes of the past.*** It is often poor and marginalised people who have

been deprived of their rights to fresh water and the resources that go with it. This needs to be corrected.

- ***People make decisions, not systems or models or disciplines.*** Ecology, sociology, economics, strategic adaptive management and thresholds of possible concern can all assist in the decision-making process but they cannot make the decision.
- ***Decisions on freshwater allocation to an estuary cannot be based solely on economic considerations.*** Economic considerations are a single facet of a multi-dimensional decision-making process. Ultimately, a decision should reflect good science, good knowledge and society's value systems.
- ***Invest where there are major problems.*** Some catchments and estuaries are seriously stressed by freshwater abstraction. These are indicated by the high economic values of this fresh water. It is here that investment is required, rather than in systems that are less stressed.
- ***Try and avoid making decisions that are very difficult to undo if they are found to be wrong.*** As an example, don't make a law unless you absolutely have to, because laws are very difficult to repeal.



7. How economics can assist in decision-making

Turning to economics, what role can it play in contributing to decision-making on freshwater allocations to estuaries? But first, what is economics? Lionel Robbins describes it as, "The science which studies human behaviour as a relationship between ends and scarce means which have alternative uses." It is, in effect a study of choices and the incentives and disincentives to make various choices. So, within the context of this handbook, economics can help us analyse and guide the behaviour of people on making choices about the allocation of an often scarce resource – fresh water.

Ascribing an economic value to the various uses of water can be very useful. It is a way of providing information that contributes to management decision-making. 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". As an example, if a decision is required on whether or not to go ahead with a particular dam on a river, the authorities need to be able to compare the benefit of that retained water with the value of the water if it is allowed to continue downstream to the estuary.

Paraphrasing Dr Jane Turpie, a leading resource economist; valuing fresh water is also important because it:

- Highlights the contribution it is making or can make to our well-being;
- Shows that if we degrade water 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; and
- Creates incentive mechanisms and financing tools for management.

Economists have developed values for various attributes, goods and services of estuaries. As examples:

- In 1997 economists estimated that the global economic 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 more economically valuable than others, but we get the general idea – estuaries are economically important ecosystems.
- 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!
- 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 total value of one hectare is R12 000.

- 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.

However, it is apparent that not only are economic values useful, but the process of deriving those values is also useful. While conducting the research that inspired this handbook, local municipal officials were interviewed to gain their views. Some of the more technically-minded were a little skeptical of the various economic methodologies, but the overwhelming majority of those interviewed were supportive of this type of research:

- The research results allowed them to gauge how much residents value their estuary. Officials felt that the results gave a useful indication of the type of value that residents place on their estuaries. This could inform a range of management interventions from prioritisation of issues to environmental education and compliance.
- The results provided guidance to local municipalities on the allocation of budgets to estuary management. Officials felt that the results assisted managers in that they provide an indication of the portion of local rates that residents felt should be allocated to estuary management.
- The research improved the understanding of estuary residents. Officials felt that the research contributed to management by improving the understanding of estuary functioning by the residents surveyed.

What is also apparent is that the data collection for the research, which involved interviewing 7 768 people at 40 estuaries, got people thinking

about systems that many had previously taken for granted. The interview became, in effect, an educational conversation.

There are numerous methods used by economists to determine various values. One of these, the "Willingness to Pay" methodology has recently been tested to see what contribution it can make to assist in estuary management decision-making. The "Willingness to Pay" methodology involves interviewing stakeholders to determine if they would be willing to pay for services they are currently receiving for free. In the case of estuaries in South Africa, a wide range of stakeholders were interviewed about the services they currently receive as a result of freshwater inflows into their estuaries. Each person interviewed was asked what annual amount of money they would be prepared to pay to keep the services they currently receive for free. Stakeholders responded in a variety of ways. Some were not prepared to pay any money while others were prepared to pay because they value the services they receive. Using the responses received from all the people interviewed, it was possible to calculate an average amount of money that stakeholders in the area are willing to pay for the services. The average can then be multiplied by the total number of people that are affected to calculate a "Total Willingness to Pay". This method was used in the three examples below.

The allocation of river water to the Keurbooms Estuary: The annual inflow of freshwater into the Keurbooms Estuary (Fig. 9) is about 78.5 million cubic meters. The user population of Keurbooms is approximately 2 650 households averaging five people each. The value of this water per household was determined to be R 283.76. In the year 2000 it was calculated that the value of this water for recreation was about 1c per cubic meter. Farmers upstream, in the Klipdrif area, were prepared to pay about 10 c per cubic meter for water for irrigation. So, if one was comparing purely recreational versus irrigation use of the freshwater, there is a strong case for the irrigation option. However, it needs to be noted that water abstracted upstream for

Fig. 9: Mouth of the Keurbooms Estuary.

irrigation might only have an irrigation value. If that same water was left in the river and was allowed to enter the estuary, it would have much more than just a recreational value.

The allocation of river water to the Umngazi Estuary: In researching the Umngazi River (Fig. 10), it was found that there was no formal demand for water for irrigation upstream in the catchment. It was also found that people were unwilling to pay for water abstracted directly from the river. People were prepared to pay for treated water taken from the river but the amount they were prepared to pay was less than the cost of the transport and treatment of that water. Low levels of income and a government policy of freely distributing treated water to the population explain this result. In contrast, people were willing to pay for Umngazi River water supplied to its estuary – about 3 to 5c per cubic meter. The explanation for this difference is that the estuary is a luxury being used by people who have the ability to pay. However, given that residents can source water for basic needs from a number of sources, there is a compelling argument not to allocate further

water away from the estuary for upstream use. However, if an upstream use was found that people were prepared to pay for at a rate of over 3 to 5c a cubic meter, then one would consider re-allocating

Fig. 10: At Umngazi people are prepared to pay for freshwater for the estuary but not for upstream use.

Making decisions between estuaries: Table 1 details total willingness to pay per annum, changes in inflow, and economic value for eight estuaries from a sample of forty which have been researched recently. While there are numerous other factors to consider, these results assist in determining the importance of each catchment in terms of its water yield to the estuary. The results here can make a significant contribution to decision-making. Let's take a hypothetical example. A local municipality is considering various development opportunities in the adjacent Groot and Klein Brak catchments. Certainly one would not want to reduce the freshwater flow into the Groot Brak Estuary. All things being equal, one would abstract water from the adjacent Klein Brak River instead. This might fundamentally affect the location of development.

Table 1: Value of water per cubic meter – select estuaries in South Africa

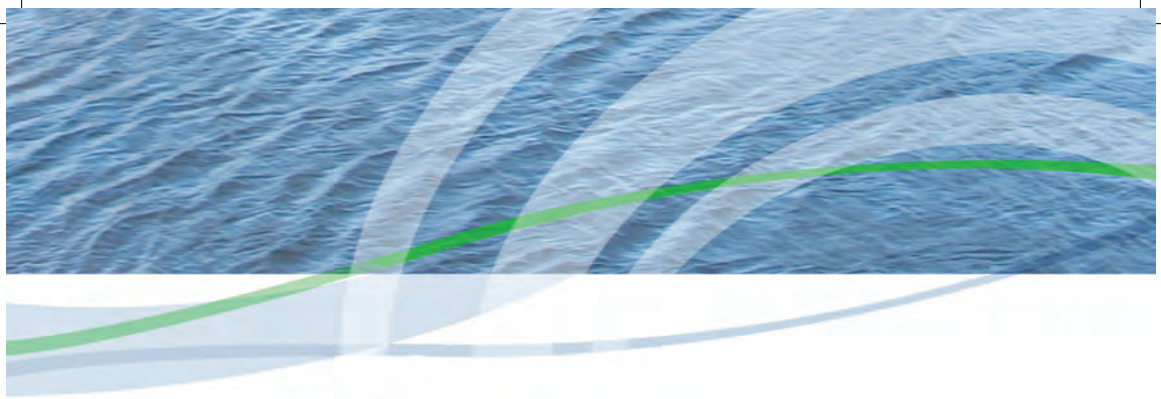
Estuary	TWTP p.a.	Change in inflow (millions of m^3 p.a.)	Value/m^3
Groot Brak: Low benefit scenario (-)	R 469 560	5	R0,094
Swartkops: High benefit scenario (-)	R1 220 170	13,5	R0,090
Kowie: High benefit scenario (+)	R 937 860	13	R0,072
Kariega: High benefit scenario (+)	R 421 308	7,4	R0,057
Swartkops: Low benefit scenario (-)	R 660 000	13,5	R0,049
Klein Brak: High benefit scenario (-)	R 141 360	11,2	R0,013
Knysna: High benefit scenario (-)	R 579 759	46	R0,013
Kromme: High benefit scenario (+)	R 918 400	75,5	R0,012
Knysna: Low benefit scenario (-)	R 513 612	46	R0,011
Klein Brak: Low benefit scenario (-)	R 118 941	11,2	R0,011
Keurbooms: High benefit scenario (-)	R 751 964	78,54	R0,010

Notes:
- TWTP – The willingness to pay
- Values relate to the period from November 2002 to June 2003, except for the Keurbooms, where the values relate to the year 2000 and to a pilot study.
- Signs after estuary names indicate increase (+) or decrease (-) in water inflow.

Note that the results from Table 1 are also a useful guide to indicate where management intervention is required first. The Groot Brak and Swartkops have the highest economic value of fresh water, and the Klein Brak and Keurbooms the lowest. Highest values indicate highest demand so it is advisable to invest there first.

A word of caution about the 'Willingness to Pay' methodology. Poor people's willingness to pay is driven by short-term survivalist needs. Policy responses, particularly those about natural resources, need to take a long term view. So, one needs to be cautious in using the willingness to pay response by poor people to direct and inform policy.

In conclusion one might ask – so, where to from here? We need to start comparing the costs and benefits of specific water allocation projects or options, particularly in situations where an estuary or river system is stressed by freshwater abstraction. Only then will we know where the water is going to come from, who it might be allocated to, who might be denied access and what all this is going to cost. Also, if threshold water reserves that are defined by scientists are endorsed by government and become a public good, there will be costs for maintaining them. How are these costs going to be covered? It might be in the form of a specific taxation set according to willingness to pay.



8. Efficiency and equity – some concluding thoughts

In the research project that inspired this handbook the researchers drew conclusions that are worth noting. The first was that if one is pursuing efficiency alone, it is both theoretically and practically sensible to allocate South Africa's river water with reference to its value at different points along the river. The researchers are correct but, in practical terms, it is a bit like saying that if you disregard your safety you can drive from Durban to Johannesburg in three hours. Bottom-line – one cannot separate equity and efficiency in the decision-making process.

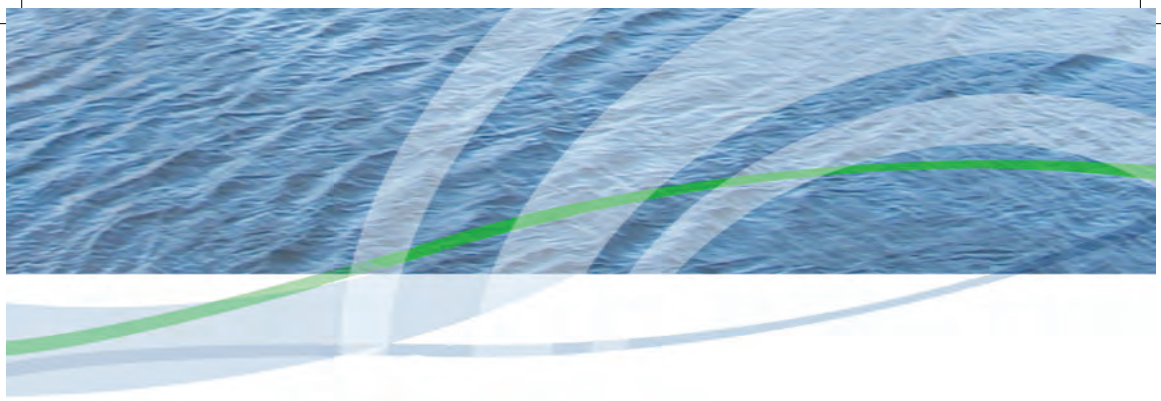
The second conclusion is that contingent valuation is a credible method of determining these values but there are some challenges. As mentioned in the previous chapter, if the methodology results in an educationally orientated conversation between researcher and stakeholder, this contributes further to its credibility – it goes beyond research.

The third conclusion is that, at estuaries in South Africa, there are regularly two primary user groups – mainly affluent white males engaged in various recreational activities and poor people engaged primarily in subsistence activities. This provides an additional caution on the use of efficiency without considering equity. Particularly in the context of South Africa's political past, it would not be prudent to allocate water to the affluent who demand it and can pay for it but

whose need is simply recreational, at the expense of the poor whose demands are muted, whose ability to pay is limited but whose basic needs are at stake.

The final conclusion is that, comparatively, the value of fresh water in a highly developed area is likely to be much higher than that of a less developed area. So the cost of allowing water to flow into an estuary in a highly developed area is likely to be much higher than in a less developed area. However, care needs to be taken when using this comparison as a basis for decision-making. Preventing fresh water from running into an estuary in a highly developed area might compromise basic livelihood options of people living at that estuary, and if fresh water is allowed to run through a less developed area into an estuary it might also compromise basic livelihood options of those living in the less developed area. Again, equity has to play a major role in the decision-making. Also, one should not confuse demand and need.

All this said, the research has brought efficiency, once peripheral to water allocation decision-making, to the centre of the conversation. And we all know that if we don't get efficient and clever in allocating fresh water we will end up with challenges that will dwarf those we already have.



9. Useful Reading

For those who wish to know more about estuaries and their management there are a number of books and handbooks that are available:

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 four user-friendly management 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)
- Hay D, Huizinga P and Mitchell S. 2005, ***Managing Sedimentary Processes in South African Estuaries: A Guide.*** (TT 241/05)
- Hay D (Editor), 2007. ***Estuaries and Integrated Development Planning: A Manager's Guide.*** (TT 294/07)

All four 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 last three are also 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)