Mngazana Canoe Trails: Fonda Lewis

An Approach to Estuary-Based Economic Empowerment with a Particular Focus on the Eastern Cape Wild Coast

Report to the
Water Research Commission

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WRC Report No. 1705/1/11
ISBN 978-1-4312-0235-5

March 2012

Obtainable from

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Gezina, 0031

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The accompanying compact disc contains:
1. The final report in PDF-format
2. The Estuaries and Economic Empowerment "Social Learning and Ecosystem Services Toolkit"

Acknowledgements

The research team acknowledges the contributions of the following organisations and individuals to this research:

- The Water Research Commission (WRC) for funding the project;
- The University of KwaZulu-Natal (UKZN) for hosting the project;
- Members of the Reference Group including Dr Steven Mitchell (Chair), Ms Tandi Breetzke, Dr Mark Dent, Mr Pierre de Villiers, Mr David Lindley, Mr Ayanda Matoti, Mr Andrew Mather, Mr Ben Pretorius and Dr Alan Whitfield for their contributions;
- The people from Mbongolwana, Mngazana/Umngazi, East London, Eden District Municipality, CapeNature and the national Department of Water and Environment Affairs who participated in various working sessions we convened, and gave of their time and knowledge;
- Mrs Una Wium of the WRC, and Mrs Gail Knox-Davies and Mrs Kerry-Ann Jordaan of UKZN for administering the project.

Finally, on behalf of all the participants of the Eastern Cape Estuaries Management Programme, we would like to thank Dr Steve Mitchell for his consistent and enthusiastic support extending over twelve years. We wish you well in your retirement.

Preface

This project is the concluding chapter of a long-term research and outreach programme focusing on supporting the management of estuaries in the Eastern Cape. Commencing in 1998 the Eastern Cape Estuaries Management Programme (ECEMP) was informed, philosophically, by the identified need to develop local solutions to local problems and work upward and outward from there. Also, at a practical level, there was the recognition that estuaries are valuable ecological, social and economic assets and they required active management.

In its early stages the Programme was a partnership of the Water Research Commission and the Institute of Natural Resources. However it soon expanded to include, amongst others, the University of KwaZulu-Natal, University of Port Elizabeth (now the Nelson Mandela Metropolitan University), CSIR in Stellenbosch, Marine and Coastal Management at the Department of Environmental Affairs and Tourism (now the Department of Water and Environment Affairs), Anchor Environmental Consulting, and Environdev.

The first phase of the programme involved engaging managers of estuaries to determine what the management issues were. Following this a series of protocols were developed to address these issues – the research was demand driven. As a parallel process the Programme directly supported management efforts at Mtentu, Mzintlava, Mngazana, Tyolomnqa, Cowie and Bushmans/Kariega Estuaries, learning from these engagements. A key management issue was its institutional context. To address this, mechanisms were developed to link estuary-based planning and management to the newly established Integrated Development Planning (IDP) processes of local municipalities. This included an education and training course in estuary management aimed at local officials and stakeholders.

It was during this programme that our informal observation – disadvantaged people living at or near estuaries were continually marginalised in the economic development process – led to this research project.

The Eastern Cape Estuaries Management Programme has underpinned and acted as a foundation for a number of linked initiatives:

- UKZN and Environdev assisted the KwaZulu-Natal Coastal Committee in establishing the KZN Estuaries Programme.
- The CSIR assisted national government in establishing a national protocol for estuaries management. This was the foundation for the chapter on estuaries included in the recently enacted Integrated Coastal Management Act.
- CSIR, Anchor Environmental Consulting, and Marine and Coastal Management assisted CapeNature in establishing the CAPE Estuaries Programme, focusing on the management of estuaries in both the Western and Eastern Cape. Over fifteen management plans are being generated at estuaries in this region.
- Staff at Nelson Mandela Metropolitan University has rolled out the education and training programme to over one hundred people and it is also being rolled out by Estuary Research and Management in KwaZulu-Natal.
- UKZN researchers and partners are taking the lessons learnt into other areas of interest, amongst other, livelihoods and wetlands.

Executive summary

South Africa is challenged by the imperative of economic growth particularly for those who have been and are still being disadvantaged. Ecosystem services supply a range of benefits and so play a fundamental role toward sustainable social and economic development.

Whilst there is wide appreciation of the variability in demand for ecosystem goods and services, there is less appreciation for the variability in the potential of ecosystems to deliver services. Economic enterprises that are based on ecosystem services are thus continuously subject to uncertainty in both demand and supply. Business enterprises based on natural resource systems are vulnerable to failure when this complexity and uncertainty is not taken into account.

The aim of this research was to develop an approach and associated methodologies that would reduce the vulnerability of enterprises founded on one or more ecosystem services. Although the focus was on estuaries and the people living around them, the intention was to develop an approach that would have much wider relevance.

Specifically, informal observations made over ten years while conducting research on and supporting the management of Eastern Cape estuaries indicated that disadvantaged people living at or near estuaries were obtaining limited economic benefit from estuary resources. Given these observations this research engaged five questions:

- What frameworks and/or models might inform and improve individual and collective understanding of potential for estuaries to support economic empowerment?
- What are opportunities and present state of estuary based economic empowerment with a particular focus on the Eastern Cape Wild Coast?
- From the frameworks and/or models what methodologies might be developed to enable a more fundamental understanding of economic empowerment at estuaries?
- Are the methodologies that are developed applicable in other common pool social-ecological systems such as wetlands?
- What are the policy and management implications of the research?

The general scientific philosophy that informed the approach to this research is Post-Normal Science (PNS) (Funtowicz and Ravetz 2008). PNS engages the management of complex science-related issues. In doing so it explicitly engages uncertainty, value loading and multiple legitimate perspectives as integral parts of the scientific process. The approach is particularly suited to issue-driven science such as environmental management where the factual basis of the issue is often uncertain, where there are numerous contrasting value systems in the mix, where stakes are high and where decisions are urgent.

Informed by the principles and attributes of PNS the research team:

1. Developed, through ongoing interaction over the duration of the research process, a common understanding of and working definitions for the key concepts and terms used in the research.
2. Developed, through a review of formal literature and group discussions, an analytical framework for engaging economic empowerment issues at estuaries, and identified the data requirements.

3. Assessed, through a desk-top review and informal observations and discussions, the state of and opportunities for economic empowerment with a particular focus on Eastern Cape Wild Coast estuaries.
4. Developed, applied, refined and assessed the transferability of the methodology by applying it at two estuary-based case studies and a freshwater wetland based case-study.
5. Analysed, through engagement with government and formal and informal papers, the relevance of the research to and to coastal policy and management environmental impact assessment processes.

Commonly used concepts and terms including economic empowerment, benefit sharing, social-ecological systems, estuaries, ecosystem services, resilience, robustness, stability, complexity, uncertainty, adaptive management and property rights were provided with working definitions.

There is a large body of work that focuses on the analysis of social-ecological systems. In reviewing this literature four frameworks were selected for consideration.
- Walker et al. (2002) – Framework for analysing the resilience of SESs;
- Ostrom (2007) – Framework for identifying the social-ecological variables that affect the resilience of a SES;
- Ostrom (1990) – Principles for common-pool resource institutions; and
- Anderies et al. (2004) – Framework for the studying the robustness of SESs, and recommendations for the governance of robust SESs.

Of these, that of Anderies et al. (2004) was considered most appropriate. How it might be used to disaggregate an estuary social-ecological system was explained. In addition matrices which described the linkages between facets of the framework, and which listed questions related to these linkages were developed. These formed the foundation for a methodology of engaging estuary and wetland social-ecological system case-studies.

The research also assessed the state of and opportunities for economic empowerment at Eastern Cape Wild Coast estuaries. First, the overall provincial and local government context was assessed. A key finding was that, while there was evidence of economic empowerment in the public sector through state employment, this had not translated into infrastructure delivery that might benefit 'private' economic empowerment. At the estuary landscape level the main drivers of economic empowerment were resort hotels which provided employment and subsidiary business opportunities.

The methodology was applied and refined at two estuary-based case studies and one freshwater wetland based case-study. Key findings included the following:
- There are significant opportunities for the establishment of estuary or wetland based enterprises that can act as catalysts for economic empowerment, but there is a lack of support necessary to do this.
- Stakeholder response to the methodology was, without exception, overwhelmingly positive.
- Participants were able to engage the process effectively.
- The methodology was valid, and missing components were identified and included.
- The methodology could be applied in numerous pro-active and responsive planning and management contexts.
- It was transferable to other common property resource systems.

- It had several limitations none which significantly detracted from its overall value.

The findings of the research might make a significant contribution to both policy and practice. At a practical level:

- Key elements of this research might be included in the estuary management protocol as well as the planning guidelines that emanate from the protocol.
- The estuaries and economic empowerment methodology might be used to organise and focus information collected during the situation assessment phase of the estuary planning and management process.
- It might be useful to develop and include two educational modules: one on estuaries and ecosystem services and a second (linked to the first) on estuaries and economic empowerment/ economic development in the existing estuary management training course material.
- Department of Environment Affairs might consider commissioning further case-studies to apply and refine the methodology and provide exposure to local government.
- Department of Environment Affairs might consider investigating what public sector employment opportunities there might be which would result in increased investment and improved maintenance of estuary assets.
- The framework might contribute to improved objectivity in the environmental impact assessment (EIA) process.

Chapter 1: Introduction and research questions

South Africa is challenged by the imperative of economic growth particularly for those who have been and are still disadvantaged. As we have come to better understand the role of ecosystems as providers of services from which society benefits, we appreciate the fundamental role they play in progress toward sustainable social and economic development. Which ecosystem services we choose to use and how we use them to promote social and economic development impacts on the capacity of the ecosystem to deliver services. So, the decisions we make involve trade-offs among both the services we can use and the people who will benefit. Making choices among use options is challenging, particularly when the decision may further disadvantage the poor whose wellbeing is dependent on ecosystem services.

Whilst there is wide appreciation of the variability in demand for ecosystem goods and services (the seasonality of tourism for example) there is rather less appreciation for the variability in the potential of ecosystems to deliver services (plentiful fish at some times and hardly any at other times). Economic enterprises that are based on ecosystem services are thus continuously subject to uncertainty in both demand and supply. Business enterprises based on natural resource systems are vulnerable to failure when this complexity and uncertainty is not taken into account.

The aim of this research was to develop an approach and associated methodologies that would reduce the vulnerability of enterprises founded on one or more ecosystem services. The intention was to enable those who may be considering establishing an enterprise and those who may be required to authorise such an enterprise to consider the uncertainties and risks before making their decision. It was motivated particularly by the vulnerability of small scale, local enterprises that were intended to create economic opportunity for rural disadvantaged people. Although our focus was on estuaries and the people living around them, our intention was to develop an approach that would have much wider relevance.

Specifically, informal observations made over ten years while conducting research on and supporting the management of Eastern Cape estuaries indicated that disadvantaged people living at or near estuaries were obtaining limited economic benefit from estuary resources. Given these observations this research engaged four questions:

- What frameworks and/or models might inform and improve individual and collective understanding of potential for estuaries to support economic empowerment
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- From the frameworks and/or models what methodologies might be developed to enable a more fundamental understanding of economic empowerment at estuaries?
- Are the methodologies that are developed applicable in other common pool social-ecological systems, such as wetlands?
- What are the policy and management implications of the research?

Chapter 2: Science and methodology

The general scientific philosophy that informed the approach to this research is Post-Normal Science (PNS) (Funtowicz and Ravetz, 2008). To paraphrase their definition, PNS engages the management of complex science-related issues. In doing so it explicitly engages uncertainty, value loading and multiple legitimate perspectives as integral parts of the scientific process. The approach is particularly suited to issue-driven science such as environmental management where the factual basis of the issue is often uncertain, where there are numerous contrasting value systems in the mix, where stakes are high and where decisions are urgent.

To summarise the key attributes or characteristics of PNS identified by Funtowicz and Ravetz (2008) and other scholars:

1. Science is appreciated within the context of uncertain natural systems, uncertain social systems and uncertain social-ecological systems
2. Political and social contexts are included in economic analyses
3. Panacea or 'cure-all' based approaches are avoided (Ostrom, 2007)
4. Participation in decision making is extended
5. The value of local knowledge and ingenuity is acknowledged and included
6. Dialogue is inclusive and rigid demonstration is avoided.
7. Humility, modesty and accountability are essential requirements in engaging uncertainty and complexity (Sardar, 2009)

So, informed by the principles and attributes of PNS the research team:

1. Developed, through ongoing interaction over the duration of the research process, a common understanding of and working definitions for the key concepts and terms used in the research. (Chapter 3)
2. Developed, through a review of formal literature and group discussions, an analytical framework for engaging economic empowerment issues at estuaries, and identified the data requirements (Chapter 3)
3. Assessed, through a desk-top review and informal observations and discussions, the state of and opportunities for economic empowerment with a particular focus on Eastern Cape Wild Coast estuaries. (Chapter 4)
4. Developed, applied, refined and assessed the transferability of the methodology by applying it at two estuary-based case studies and a freshwater wetland based case-study. (Chapter 5)
5. Analysed, through engagement with government and formal and informal papers, the relevance of the research to coastal policy and management, and environmental impact assessment processes. (Chapter 6)

Chapter 3: Concepts, terms and frameworks

3.1 Introduction

Natural resource systems (ecosystems) produce services (Millennium Assessment, 2005). As a foundation these might include supporting services such as soil formation, nutrient cycling and primary production. Building on these are provisioning services such as food, freshwater, wood and fuel; regulating services such as climate regulation, water purification and disease regulation; and cultural services which might be aesthetic, educational, cultural and/or recreational. These services are potentially useful for humans and offer opportunity for establishing enterprises. But, because all estuaries are different, every one produces a unique mix of services. So, whilst a particular enterprise may be feasible for one estuary this may not be so for another. Because the services ecosystems generate are subject to the influences of natural and human-generated processes that are highly variable, the supply of services is never constant. Whilst some services such as a sense of place or the opportunity for recreation may seem to be constant over time, others such as food supply may show significant temporal and spatial variation. Every enterprise that is founded on using a service (or set of services) produced by a natural ecosystem such as an estuary must anticipate services that are variable in time and space as a consequence of both natural and human influence. Some of these drivers may be within our ability to control such as pollution or overfishing but others such as storms and floods that can completely reshape an estuary are largely beyond our control.

Demand for services also affects the viability of an estuary-based enterprise. For example, among the services in estuaries that are in greatest demand are aesthetics, recreation and food (subsistence harvesting). These demands may be very variable over time, as illustrated by fluctuating availability of fish and tourism that exhibits seasonality, and in space as not all demands are compatible and can be accommodated at the same time in the same place. And there may be little demand for services in some estuaries (or parts of estuaries) simply because inadequate infrastructure limits access.

The overall result is that successful estuary-based enterprises are those that are able to establish themselves and operate profitably under conditions of varying supply of and demand for services.

However, it is not simply supply and demand that influences an enterprise's ability to operate successfully. Enterprises are founded within systems that are complex and dynamic. Enterprises might be affected by, amongst others, external shocks such as floods, by the availability of supporting policies and legislation, by physical infrastructure, by security of tenure (or a lack there-of) and by political change.

These initial insights informed the post-normal science philosophical approach to this research in which we envisaged estuaries as being embedded in social-ecological systems characterised as complex systems with high levels of uncertainty, value loaded and with multiple legitimate perspectives.

The purpose of this chapter is to explore the conceptual basis for engagement. It covers two areas: first it provides working definitions for the main concepts and terminology used in the

report, and second, it explores a series of analytical frameworks that might guide the engagement of estuaries and economic empowerment.

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3.2 Concepts and terminology

At the outset we, the researchers, were faced with a plethora of concepts and terminology that were new to us. What is a social-ecological system? What is the difference between a resource, a service and a benefit? What is a public infrastructure provider? What is the difference between resilience, robustness and stability? We were dazed and a little confused.

We recognise that some terms, within the context of Post-Normal Science (PNS) and this research, will be unfamiliar to many readers or might mean different things to different readers. Some of these terms – complexity and uncertainty – have been used already but need to be defined. Another – an estuary – might be a social construct to one reader and bio-physical construct to another. What follows is a brief commentary on the key concepts and terminology used in this research report. The aim is to convey what we understand them to mean – fairly simple (if that is possible) working definitions.

Economic empowerment is embedded in policy and regulation in South Africa, most notably in the Broad-Based Black Economic Empowerment Act of 2003 (Government Gazette, 2004). The overall intention of the Act is to transform the economy of South Africa, through a number of statutory and incentive/disincentive based systems, so that it represents the demographics of the people of the country. It ranges from the provision of jobs to ownership of enterprises and control of the supply chain. In the context of this project broad-based black economic empowerment refers specifically to any economic activity (public or private) that aims to improve the socio-economic circumstance of disadvantaged people living at, near or in association with estuaries, and a more equitable sharing of the benefits supplied by estuary-based ecosystem services.

Economic empowerment can be a form of **benefit sharing** and the intention of Act is to promote greater equity in access to and the distribution of economic benefits. There appears to be little consensus on a precise definition of benefit sharing. A working definition might include a " ….commitment to channel some kind of returns – whether monetary or non-monetary – back to the range of designated participants: affected communities, source communities or source nations…." http://research.iftf.net/node/721. Benefit sharing arrangements in this report refer to the shared rules, norms, and organizational mechanisms that regulate the behaviour of collective actors in the governance of ecosystem services (Nkhata et al. in prep).

Economic empowerment founded on natural resourced base enterprises occurs within the context of a **social ecological system (SES). A** SES is a complex system that comprises two linked sub-systems; a social (human)and an ecological (biophysical) subsystem. Within an SES we may recognize a variety of nested subsystems defined by the users and the service(s) they choose to use. Both social and ecological systems contain parts that interact interdependently and each may contain interactive subsystems as well. We use the term "SES" to refer to the subset of social systems in which some of the interdependent relationships among humans are mediated through interactions with biophysical and non-human biological units. (Anderies et al. 2004). To use examples from this project a SES might be an estuary ecosystem linked to a variety of social sub-systems such as tourists, residents, subsistence users and commercial fishermen. Nested in this might be a smaller SES such as the fish population linked to both commercial and subsistence fishermen. What is important about this concept is that it requires that we consider the system as we may choose to bound it – socio-economic and biophysical components – as one system

Estuaries are traditionally conceptualised as ecosystems or landscape features with specific bio-geographic characteristics. They occur at the interface between freshwater systems and the sea and are generally regarded as highly productive systems. In the context of this research we consider estuaries more broadly as social-ecological systems comprising an ecosystem (the estuary and its surrounds) providing a range of ecosystem services and society that might benefit from this range of services. The supply of services is sometimes mediated by an estuary ecosystem's complex relationships with other ecosystems such as the sea, adjacent shorelines, feeding river systems, adjacent floodplains and such-like. For the purposes of this study we regarded an estuary-based SES as comprising both the aquatic system (the estuary) and the landscape within which it is located. So, the boundaries of an estuary social-ecological system vary with the dimensions of landscape rather than those of the estuary. As such, they are largely determined by who accesses the services of both the estuary and surrounds, and how such access is regulated. Whilst the dimensions of an estuary are slow to change and may remain largely constant, those of the landscape (the social sub-system) may change quickly, as would happen if new infrastructure changed accessibility to ecosystem services.

As stated above, estuaries are suppliers of **ecosystem services.** This refers to those aspects of ecosystems utilised (actively or passively) to produce human well-being (Fisher and Turner, 2008). The types of services are described in the introduction to this chapter. Fisher and Turner (2008) point out that services are not necessarily benefits; that ecosystem services are ecological in nature, and that ecosystem services do not have to be utilised directly.

Social ecological systems such as estuaries and their surrounds have attributes which either confer or compromise their **resilience**, **robustness** or **stability**. All three terms infer the ability to withstand or adapt to a shock or force. However, there are differences in their meanings that transcend semantics. Resilience is the ability of a strained (shocked, forced) entity to recover its original condition/state (Giampietro, 2004). Walker et al (2002) might consider a resilient system one which retains its structure and functions – it is still recognisable from its attributes. It is sometimes termed adaptive capacity. Robustness is the ability of an entity to show firmness, to resist stress to be not easily disturbed (Giampietro, 2004). A "robust" system will typically not perform as efficiently with respect to a chosen set of criteria as its non-robust counterpart. However, the robust system's performance will not drop off as rapidly as its non-robust counterpart when confronted with external disturbance or internal stress (Anderies et al. 2004). Stability is the property of an entity that causes it, when disturbed from a condition of equilibrium (or steady motion), to develop forces or movement that restore the original condition (Giampietro, 2004).

Social-ecological systems such as estuaries are **complex** systems. Complexity is used to characterise something which has many parts in an intricate arrangement. The arrangement between these parts might change rapidly in time and space (Wikipedia). Complex systems are dynamic varying over time and are influenced by what has happened in the past and because cause and effect are not linearly related it becomes difficult predict behaviour. Complicated systems, such as computers, by contrast consistently provide the same outcome to the same intervention making prediction possible.

Given this complexity there is significant **uncertainty** about what has happened, what is happening and what might happen in an estuary-based social-ecological system. The concept of uncertainty can be defined in three ways and all are applicable. It might refer to imperfect

knowledge about a system, or the inherent variability and unpredictability of a system, or the ambiguity caused by multiple perceptions about a phenomenon (Brugnach et al. 2008).

Given the high levels of complexity and uncertainty an **adaptive management** approach is required. Adaptive management is a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously maximizes one or more objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is often characterized as "learning by doing." (Wikipedia)

Particularly challenging for enterprise development at estuaries are **property rights**. Property rights are the norms and rules that govern access to property. Property does not refer to an object or a natural resource. It refers to the benefit stream arises from the use of that object or resource. In the context of natural resources five property rights regimes have been identified by Coelho et al. (2009):

- Private property – individuals have the right to undertake socially acceptable use of the resource and exclude other users
- State property – individuals have rules of access to a resource determined by a management agency
- Common property – a group of clearly defined co-owners has access to the resource and can exclude non-members. The co-owners have both the rights and responsibilities of management
- Open-access property – no defined group of users is set and the benefit stream from the resource is available to everyone.
- "Anti-Commons" property – a regime in which multiple owners hold effective rights of exclusion over a scarce resource.

3.3 Analytical frameworks

There is a large body of work that focuses on the analysis of social-ecological systems. In reviewing this literature four frameworks were selected for consideration.

- Walker et al (2002) – Framework for analysing the resilience of SESs;
- Ostrom (2007) – Framework for identifying the social-ecological variables that affect the resilience of a SES;
- Ostrom (1990) – Principles for common-pool resource institutions; and
- Anderies et al (2004) – Framework for the studying the robustness of SESs, and recommendations for the governance of robust SESs.

Walker et al. (2002) developed an analytical framework that was predominantly based on stakeholder engagement and focused on the resilience of the SES. Their framework borrowed some aspects of the adaptive management approach developed by Holling (1978) and Walters (1986) and others, as well as ideas of scenario planning from van der Heijden (1996). Walker et al. (2002) stressed the importance of involving all associated stakeholders at the onset of an assessment as "without their participation, achieving a collectively and socially desirable outcome is not possible, because key information resides in the knowledge and mental models of stakeholders, and because, without the inclusion that comes from participatory approaches, any proposed solution would face a legitimacy problem". To assist with the identification of relevant stakeholders, Walker et al. (2002) suggested that it is desirable to

have knowledge of the institutional arrangement that determines the rules for ecosystem services (as per The Millennium Assessment, 2005) with particular reference to property or user rights and the decision making processes. The approach of Walker et al. (2002) has four steps (Figure 3.1).

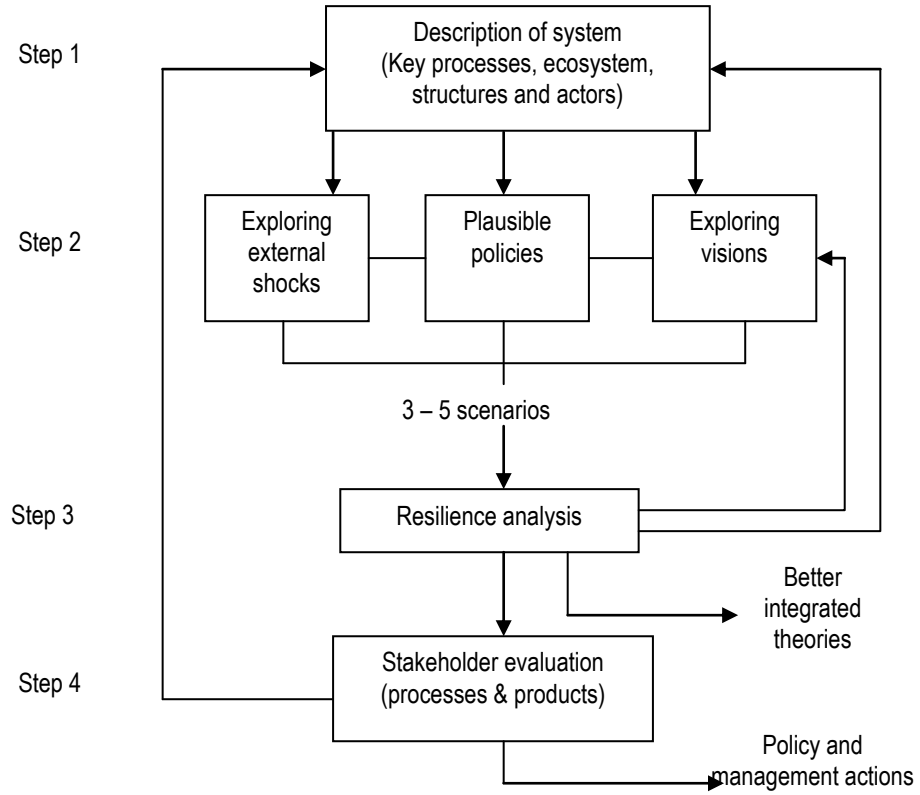

Figure 3.1: Walker et al. (2002) Framework for the analysis of social-ecological systems

- Step 1: Resilience of what? This is a comprehensive description of the system including key natural and social processes, structures and actors
- Step 2: Resilience to what? This involves exploring shocks, developing plausible policies to deal with external shocks and developing a vision for the future of the system.
- Step 3: Where does resilience reside? This is a detailed quantitative analysis to determine where the resilience in the system is. This might include modelling and non-modelling approaches
- Step 4: How do we manage for resilience? This step involves the evaluation of management and policy implications.

Ostrom (2007) developed a framework to identify which variables, within both ecological and social domains, affect human behaviour, and thus the resilience of a SES over time. Researchers have identified a variety of different variables which affect interactions within SESs (Agrawal 2001; Ostrom 2007). She proposed organizing these variables into a nested multi-tier framework (Figure 3.2). Ostrom's (2007) framework allows analyses of how the attributes of (i) a resource system (e.g. grazing land); (ii) the resource units generated by that system (i.e. fodder) (iii) the users of that system (i.e. herders), and (iv) the governance system which, combined, affect interactions (both directly and indirectly) and outcomes at a

particular time and place. The framework also allows identification of how these attributes can affect and be affected by both small and large scale socio, economic, political and ecological impacts.

Ostrom's (2007) framework built on Agrawal's (2001) research which examined the factors that affect self-organisation and robustness of common-property regimes. Agrawal (2001) identified thirty variables in major theoretical work that had affected incentives, actions, and outcomes that related to sustainable resource governance.

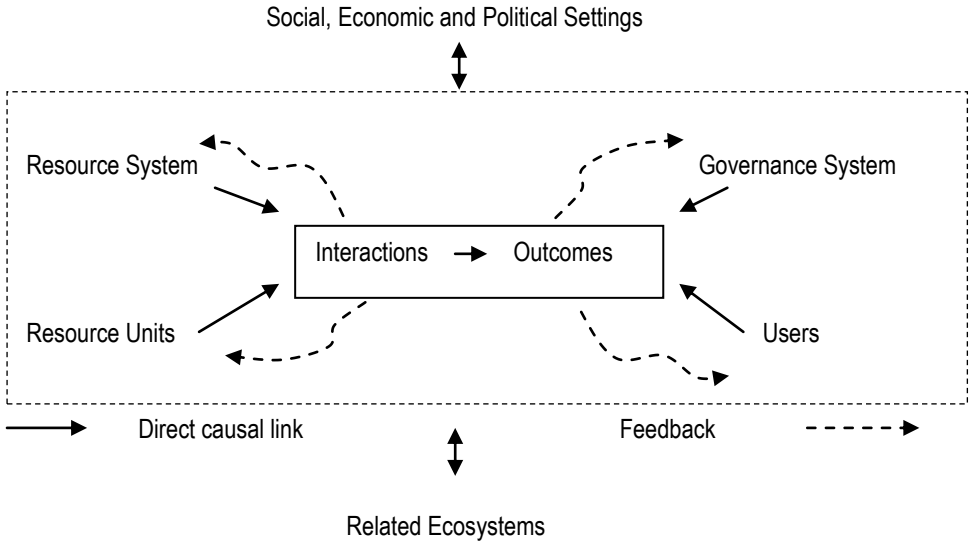

Figure 3.2: Ostrom's (2007) Multitier framework for analysing a SES

Anderies et al. (2004) developed a framework to study the robustness of SESs (Figure 3.3 and Tables 3.1 and 3.2). They stated that robustness is a more appropriate concept when trying to understand how SESs can deal with disruptions, and that the concept of resilience was more appropriate when trying to understand the self-organizing components of a SES and how they interact. Their framework addresses three issues:

1. Cooperation and potential for collective action must be maintained within the social system (the resource);
2. Ecological systems are dynamic, as are the rules of the games that agents play amongst themselves (governance system); and
3. Ecological systems can occupy multiple stable states and move rapidly between them (associated infrastructure).

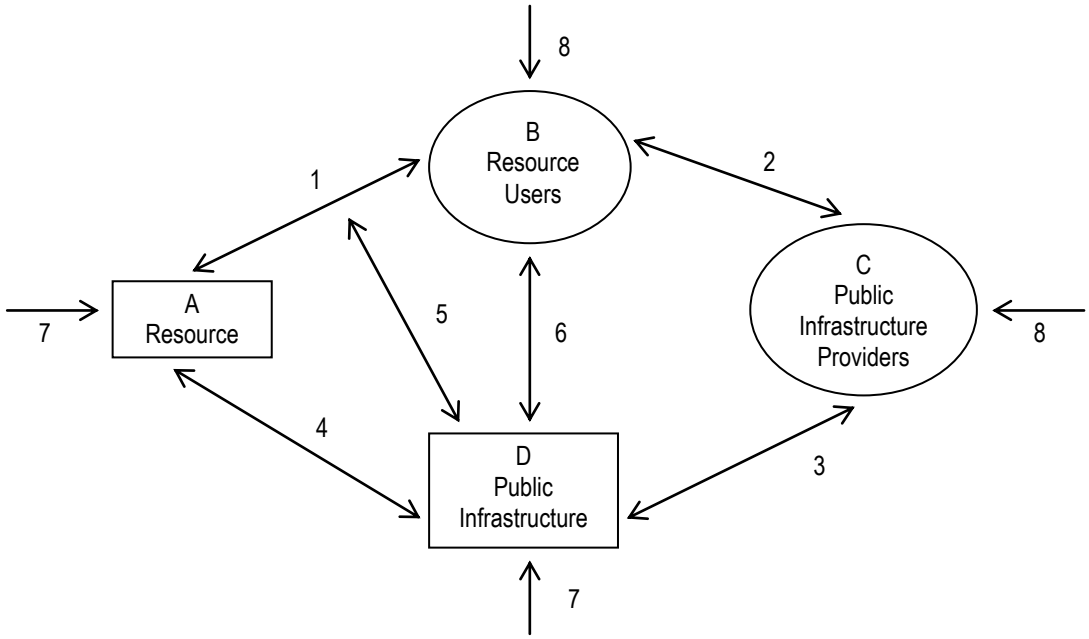

Figure 3.3: Anderies et al. (2004). Conceptual framework of a Social-Ecological System (SES)

Table 3.1: Entities involved in a SES, identified by Anderies et al. (2004)

ENTITIES	EXAMPLES	POTENTIAL PROBLEMS
A Resource	Water source, Fishery	Uncertainty, Complexity / Uncertainty
B Resource Users	Farmers using irrigation	Stealing water, getting a free ride on maintenance
	Fishers harvesting from inshore fishery	Over harvesting
C Public infrastructure providers	Executive and council of local users' association	Internal conflict or indecision about which polices to adopt
	Government bureau	Information loss
D Public infrastructure	Engineering works	Wear out over time
Institutional rules	Memory loss over time, deliberate cheating	
External Environment	Weather, economy, political system	Sudden changes as well as slow changes that are not noticed.

Table 3.2: Links involved in a SES, identified by Anderies et al. (2004)

LINK	EXAMPLES	POTENTIAL PROBLEMS
(1) Between resource and resource users	Availability of water at time of need / availability of fish	Too much or too little water / too many uneconomic fish – too many valued fish
(2) Between users and public infrastructure providers	Voting for providers Contributing resources Recommending policies Monitoring performance of providers	Indeterminacy / lack of participation Free riding Rent seeking Lack of information / free riding
(3) Between public infrastructure providers and public infrastructure	Building initial structure Regular maintenance	Overcapitalization or undercapitalization Shirking disrupting temporal and spatial patters of resource use
	Monitoring and enforcing rules	Cost / corruption
(4) Between public infrastructure and resource	Impact of infrastructure on the resource level	Ineffective
(5) Between public infrastructure and resource dynamics	Impact of infrastructure on the feedback structure of resource-harvest dynamics	Ineffective, unintended consequences
(6) Between resource users and public infrastructure	Co production of infrastructure itself, maintenance of works, monitoring and sanctioning	No incentives / free riding
(7) External forces on resource and infrastructure	Severe weather, earthquake, landslide, new roads	Destroys resource and infrastructure
(8) External forces on social actors	Major changes in political system, migration, commodity prices, and regulation	Conflict, uncertainty, migration, greatly increased demand

The Anderies et al. (2004) framework addresses two types of disturbances:

- External disturbance: Impacts that affect the resource and the public infrastructure (Arrow 7); Impacts that affect the resource users and the public infrastructure providers (Arrow 8);
- Internal disturbances: The reorganisation of the ecological or social system caused by the impacts on the subsystems of the ecological or social system.

Ostrom (1990) identified design principles for common-pool resource institutions (see below). Anderies et al. (2004) recommended that a robust system could be characterized as incorporating a large number of these principles:

1. **Clearly Defined Boundaries**: The boundaries of the resource system (e.g. irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.
2. **Proportional Equivalence between Benefits and Costs**: Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labour, materials, and / or money inputs.
3. **Collective-Choice Arrangements:** Most individuals affected by harvesting and protection rules are included in the group who can modify these rules.
4. **Monitoring:** Monitoring, who actively audits biophysical conditions and user behaviours, are at least partially accountable to the users or the users themselves.
5. **Graduated Sanctions:** Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offence) from other users, from officials accountable to these users, or from both.
6. **Conflict-Resolution Mechanisms:** Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.

7. **Minimal Recognition of Rights to Organise:** The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.
8. **Nested Enterprises**: Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities are organised in multiple layers of nested enterprises.

In reviewing the four frameworks it was apparent that they had much in common. This was not surprising as many the researchers involved in their development were (and are) collaborators. The frameworks also required similar data inputs:

1. Identification of the spatial boundaries of the SES;
2. Stakeholders / resource users;
   - Identification of the main drivers and passengers;
   - Identification of scenarios / visions and desirable states;
   - Identification of uncertainties – which can be controlled / quantified;
   - Identification of disturbances – internal / external, controllable / non-controllable;
   - Identification of relationship between stakeholders / resource users and public infrastructure providers;
3. Key ecosystem goods and services;
   - What variables act as drivers of key ecological goods and services?
   - Which of these variables are of concern to stakeholders?
   - Which of these driving variables are controllable / non-controllable?
4. Current governance systems;
   - Property rights, decision-making processes, access to information;
   - Penalties, monitoring, conflict resolution, enforcement;
   - Management and policy implementation;
   - To what extent can rules be modified / adapted?
   - Identify institutional framework for rules that govern ecological usage;
   - Identification of policies that govern the working of the variables stakeholders consider important;

The Anderies et al. (2004) analytical framework was chosen as the primary guide as it provides a simple structured mechanism for disaggregating the components of a SES, and promotes the identification of the relationships between the different components. The framework also accommodates the potential for external biophysical drivers, such as floods and droughts, and external social and economic drivers, such as interest rate changes or road crime, to impact on the system. The Anderies et al. (2004) framework comprises four key components; the resource, the resource users, the public infrastructure associated with the resource and/or users, and the public infrastructure providers.

Applying the framework to estuary-based SESs

The resource

The estuary ecosystem (a biophysical resource) comprises a number of habitats (subsystems) that singly or in combination can supply the set of ecosystem services. They include the river-estuary interface, mangroves, reed-beds, salt marshes, water surface area, water column, intertidal flats, sub-tidal flats, deep water sediments, rocky shores and estuary mouth. Each of these habitats is a potential asset and in combination they describe the estuary asset. However, for society to realise the value of these assets it has to access them from the

adjoining land or sea and so this land/sea and its varied habitats (such as grasslands, forests, dunes and near-shore sea) must be viewed as part of the total biophysical resource (the total asset) that may support an estuary-based economic enterprise.

Resource users

The resource users (the people that use the ecosystem services) can originate from a wide range of locations. There are two main categories of users:

- Those who make direct use of estuary services. This includes:
    - people living within the basin landscape of the estuary who benefit from one or more of the ecosystem services – such as local residents recreate on the estuary or who use the discharge waste water into the estuary
    - people who travel from outside of the landscape basin to use the estuary the services – such as tourists or anglers
- Those who use of estuary services indirectly. This group includes
    - people who live outside of the estuary landscape basin that benefit tangibly from an estuary service without travelling to the estuary e.g. people living upstream who benefit from discharging waste water that into a river that flows into an estuary, or coastal and marine anglers who catch fish that use estuaries as nursery habitats.
    - people (usually living far away from the estuary) who benefit intangibly from the existence of the estuary, e.g. people who benefit from biodiversity associated with estuaries often without being aware of the nature of the service the estuary provides.

Because of the complex nature of ecosystems every use of an ecosystem service influences the potential to realise benefits from other services. In designing an instrument to evaluate opportunity for an enterprise these relationships should be taken into account.

Public infrastructure

Public infrastructure enables society to regulate access to and use of ecosystem services. It consists of all social, institutional and economic capital associated with the estuary system. This capital may include the following:

- Built structures – such as hotels, causeways and roads,
- Laws and regulations – such as those governing the use of the estuary and feeder river,
- Organisations – such as business management structures, local community committees, local chamber of commerce, tourism marketing associations, national conservation agencies, road transport departments, etc.
- Indigenous knowledge – such as local understanding of fish and bird populations,
- Scientific knowledge – such as the understanding of spawning behaviour of marine fish and crustaceans,
- Business relationships – such as hotels and their suppliers and marketing agents,
- Available skills – such as those servicing the hospitality industry, organizing the community action, etc.
- Available transport – such as vehicles for provincial conservation agencies to travel to or on the estuary.

The public infrastructure associated with the estuary may have strong positive or negative influence on prospects for a successful enterprise. For example, good road infrastructure may enable access to an opportunity for recreation yet this may be counteracted by policies that permit discharge of effluent into the estuary. Analysis of the implications of public infrastructure can determine the course of action when considering an estuary-based enterprise.

Public infrastructure providers

The public infrastructure providers are those people who supply the social (e.g. policies and research) and built capital (e.g. roads and hotels) that influence access to and use of the ecosystem services. There are two main groups:

- *Public sector*
  Public sector influences may arise across a range of scales from local to national and in some cases international. For example, the public sector infrastructure providers for the Isamangaliso Wetland Park that incorporates the St Lucia system, include those who provide the infrastructure that enables designation as a World Heritage Site, national and provincial government who provide the infrastructure for management and local government that provides the enabling municipal infrastructure.

- *Private sector*
  These providers include financiers, formal and informal traders, local residents who service the hospitality industry, non-government organizations with varied missions and business

Opportunities for economic empowerment

The opportunities for economic empowerment include:
- Use of the ecosystem services – such as harvesting of resources for sale (bait), fishing ghillies, etc.
- Providing access to activities such as bird guiding, canoe guiding, trail guides, guided horse trails, etc. – all activities around providing access to use of services.
- Providing access to the estuary – such entrance control – taking a gate fee for access to the area – much like a protected area does.
- Built asset development and management – such as construction services for building and roads, management services for buildings and roads. These can range for labour supply through to sub-contracting (such as thatching) through to building contractors.
- Monitoring of the natural assets and use – such measuring bait harvesting, fish catches, wood harvesting, quality of the guiding services supplied, etc.
- Training of resource users and public infrastructure providers as a business activity – such as training guides, training in sustainable harvesting technologies, training in organisational development, training in road maintenance, etc.
- Management of natural assets – such as controlled harvesting, quantification of sustainable off-takes, policing of local regulations, solid waste clean-ups, fire management, alien plant management, etc.

– Restoration of natural assets – restoration of mangrove forests, estuary bank stabilisation, alien plant removal, forest restoration, etc.

The estuary social-ecological system is a complex system where the four components of the system need to 'mesh' in order to support enterprise development. When the one of the elements, such as an upstream municipality, abstracts too much freshwater and discharges too much waste water, then the entire system gets influenced, such as the local and visiting angler who now have a lower population of fish to catch, with less protein going to poor homes, and fewer visitors coming to the estuary to fish and resulting in a shrinking local economy, with more harvesting pressure on resources.

In order to formalise an approach to analysing and understanding of the dynamic linkages between the four organising components of the social ecological system, we prepared the matrix shown in Table 3.3. The four elements (the resource, users, infrastructure and the providers) are set out on both axes and each cell reflects the interactions between two elements. This helps to focus attention on the relationships that may be operating within and between the four elements of the system. Also included in this matrix are the external biophysical, social and economic forces that may generate perturbations in the local system.

Examples are provided in the matrix to illustrate the types of relationships that may exist or develop between the various system components. Each cell is designated according to its position in the matrix (A1 through E4) and allowing pertinent questions to be posed as illustrated in Table 3.4. These questions direct the search for information required to assess a perceived economic opportunity.

Table 3.3: Matrix showing the linkages between the four main components of an SES

		RESOURCE 1	**RESOURCE USER 2**	**PUBLIC INFRASTRUCTURE 3**	**PUBLIC INFRASTRUCTURE PROVIDER 4**
Internal relationships	**Resource user A**	The estuary asset supplies ecosystem goods and services in variable quantities and qualities to resource users. These services may include fish, recreation amenity, timber, fish nursery, etc. A1	Resource users can have neutral, or positive and negative relationships between each other in the use of resources. For example recreation fisherman could compete with subsistence fishermen for fish resources. A2	Public infrastructure can be developed by resource users, such as a developer could build a hotel on the banks of an estuary. A3	A resource user such as a fishing concession/charter could contribute financial resources towards the management agency responsible for management of the estuary. A4
	Public infrastructure B	Public infrastructure, such as a tarred road could facilitate large scale access to an estuary, resulting in intense fishing pressure that would reduce the fish stocks to a low level. B1	Public infrastructure such as land ownership policies in communal land in the eastern Cape could provide preferential access to BEE beneficiaries. B2	Public infrastructure can be developed which does not add value to each other, such as developing a public parking lot adjacent to an exclusive lodge on the estuary. B3	A public infrastructure provider, such as the Provincial roads department can upgrade road access, through investing in road maintenance. B4

		RESOURCE 1	RESOURCE USER 2	PUBLIC INFRASTRUCTURE 3	PUBLIC INFRASTRUCTURE PROVIDER 4
	Public infrastructure provider C	Local municipalities, or private sector agents, such as hotels owners could influence the state of water quality in estuaries. C1	Co-management of built or natural assets can occur – such as fishermen and hotel owners cooperating to manage fish stocks by promoting tag-and-release. C2	The capacity and competency of public infrastructure providers to implement policy may be good or poor, generating different outcomes. One municipality may manage solid waste well while another municipality may disregard their solid waste policy entirely. C3	Inter-government communication is an example of public infrastructure providers interacting. The effectiveness of this interaction will impact significantly on a context conducive to BEE. For example – lending money to a community to build a tourist camp, without including training on management will not generate a resilient system. C4
External relationships	**Biophysical forces D**	External biophysical forces such as droughts, floods and unexpected natural events can change the quantity of services supplied by an estuary. A flood may reduce fishing quality. D1	Resource users may develop enterprises based on natural resource harvesting that disregards fluctuations in the supply of ecosystem services, causing an enterprise to fail. D2	Biophysical forces can influence public infrastructure. For example natural disasters can cause washaways and destroyed communications, limiting access to the enterprise and causing financial losses. D3	Public infrastructure providers can be prepared or ill-prepared for unexpected biophysical forces. For example, those un-prepared for disasters may not be able to have public infrastructure (like roads) repaired timeously and consequently enterprises dependent on the road will not be resilient. D4
	Social and economic forces E	External forces can alter the resource base. For example, poverty and affluence can result in over-use and exclusion of access to resource. Poor people may over use fish stocks, or affluent people may displace poor users, such a fishing concession which excludes local fishermen from previously used sites. E1	External forces can influence resource users, such as conflict, crime and uncertainty – which can influence changes in the demand for local services. For example, dangerous driving on access routes may discourage tourists from visiting eastern cape estuaries. E2	Changes to distant public infrastructure can increase use pressures on eastern cape estuaries. For example, the development of the proposed toll road in northern Pondoland will result in greater use of many estuaries on the northern wild coast. E3	The effectiveness of public infrastructure providers, such as governance at a national level – has potential to impact on resilience of local systems. For example, sound fiscal management can attract foreign investors who could invest on eastern cape estuaries. E4

Following the selection of the framework and the compilation of a matrix a list of questions data required to help assess the relationships within and between the different components was produced (Table 3.4). Where relevant, questioning on opportunities and threats were included as recommended by Walker et al (2002). The numbering of the questions below corresponds to the numbering used in the previous matrix (Table 3.3).

Table 3.4: List of questions required to help assess the resilience of the relationships within and between the different components of an SES

A2	**COMPETITION BETWEEN RESOURCES USERS**
1	Who are the users, how do they use the resource and how dependent are the resource users on the resource?
2	Are there conflicts between and / or within the different user groups?
3	What opportunities exist between and / or within the different types of user groups for enterprise development?
A3	**DEVELOPMENT OF INFRASTRUCTURE (PUBLIC INFRASTRUCTURE BUILT BY PRIVATE SECTOR)**
	Economic Capital
1	What built infrastructure is available within the system to the resource users?
2	Who is responsible and to what extent is the built infrastructure developed and maintained?
3	Considering current infrastructure, to what extent i) are the resource services secure; ii) is there personal security?
4	What built infrastructure is available to access the system?
5	Does the built infrastructure meet current demand (quality, quantity)?
6	If not, what opportunities exist to improve or add additional built infrastructure?
7	Are there any constraints with improving or adding built infrastructure?
	Social Capital
8	What is the i) level of education amongst the resource users; and ii) social capital of the govt. officials?
9	What skills (i.e. knowledge, communication, hospitality) exist amongst resource users?
10	How adaptable are the resource users to i) changes in the availability of the resource; ii) changes in demand; iii) pursuing other activities to sustain livelihoods, etc.?
11	Do opportunities exist to improve the social capital (i.e. training) of the resource users, and what constrains the improvement of this social capital?
	Governing Capital
12	What rules of law (local, provincial, national, international) are applicable to the resource users?
13	To what extent are these rules of law enforced?
14	If rules of law are not enforced, why?
	Technological Capital
15	To what degree is cell, telephone, email, fax available to the resource users; and to what degree are these facilities necessary?
16	If availability is limited, what are the constraints, and how could these constraints be overcome?
A4	**CONTRIBUTING RESOURCES FOR MANAGEMENT**
1	To what degree is government contributing to the management of resource users with regards to: i) the resource; ii) research; iii) built capital; iv) skills / knowledge; v) security; vi) communication?
2	Could government contribute more to the above and, if so i) how; and ii) what are the constraints for government contributing to the above?
B1	**IMPACT OF INFRASTRUCTURE ON RESOURCE LEVELS**
1	What are the impacts of i) knowledge / skills; ii) built capital; iii) security / governance; and vi) communication on the resource?
B2	**POLICY IMPLICATIONS – EQUITY AND BEE –PREFERENTIAL ACCESS**
1	What policies are applicable to the resource users and what implications do these policies have on the resource users?
2	To what extent do these policies give i) adequate protection to the resource; ii) give adequate security (i.e. access, availability) of the resource for the resource users?
3	How could policies be improved and what prohibits improved policy implementation?
4	What opportunities would improved policy implementation create?
B3	**INTEGRATED IMPLEMENTATION OF DEVELOPMENTS**
1	Are there conflicts between government actions and / or government infrastructure?
B4	**BUILT INFRASTRUCTURE**
1	Is the current built infrastructure supplied by government sufficient?
2	Do opportunities exist for government to improve the built infrastructure, and what constrains the implementation of improved built infrastructure?
C1	**MONITORING THE STATE OF THE ASSET**
1	To what extent is the state of the resource monitored and who is responsible for this monitoring?

2	Is their evidence, and if so to what extent, are the findings of any monitoring efforts used to evaluate management, and thus influence future actions (adaptive management)?
3	How would it be possible to improve this monitoring?
C2	**CO-MANAGEMENT OF BUILT OR NATURAL ASSETS**
1	How adequate is the cooperation between the resource users and government to manage the i) built environment; ii) social / cultural environment; iii) natural environment?
2	How would it be possible to improve cooperation between the resource user and government to improve the above three environments?
3	What prohibits improving the cooperation between the resource user and government to improve the above three environments?
C3	**CAPACITY AND COMPETENCY TO IMPLEMENT POLICY**
1	What policies are applicable to public infrastructure and to what degree are these policies implemented?
2	What prohibits these policies from being implemented (i.e. capacity)?
3	How would it be possible to improve the implementation of these policies?
C4	**INTER-GOVERNMENT COMMUNICATION**
1	Is there sufficient communication between different government tiers and departments?
2	What opportunities exist to improve communication, and what constrains the improvement of this communication?
D1	**DROUGHTS, FLOODS, CHANGES IN SUPPLY OF RESOURCE SERVICES**
1	What is the nature of biophysical impacts on the resource and what is the significance and frequency of these impacts?
2	Are these biophysical impacts part of a natural ecosystem cycle, and to what extent can these impacts be overcome, if appropriate?
3	Do job opportunities exists in overcoming the impacts of external biophysical events?
4	Are there constraints with overcoming these impacts?
D2	**DISREGARD FOR FLUCTUATIONS**
1	To what degree do resource users plan for fluctuations and is this planning adequate?
2	What opportunities exist to improve this planning and what prohibits this planning from being improved?
D3	**DROUGHTS, FLOODS, WASH AWAYS, DESTROYED COMMUNICATIONS, LESS RESOURCES (BOTH PUBLIC AND PRIVATE SECTOR)**
1	To what degree do external shocks damage public infrastructure with regards to: knowledge, skills, aids, floods, over exploitation of resource, establishment or non-maintenance of roads, communication?
2	To what degree are these external shocks managed / prepared for (i.e. insurance, forward planning)?
3	Do job opportunities exists in managing / preparing for these external shocks?
4	Are there constraints with managing / preparing for these external shocks?
D4	**DISASTER PREPAREDNESS OR NOT**
1	Has government implemented sufficient measures to cope with external biophysical shocks (identified above)?
2	Do opportunities exists in implementing measures to cope with external biophysical shocks and are there constraints associated with implementing these measures?
E1	**POVERTY AND AFFLUENCE – OVER USE AND EXCLUSION**
1	To what extent does poverty and affluence influence / affect over use and exclusion of the resource?
2	Do opportunities exist to make the use of the resource more sustainable and what prohibits the resource from being used more sustainably?
E2	**CONFLICT, CRIME, UNCERTAINTY, CHANGES IN DEMAND**
1	Are there social and economic forces, such as conflict, crime (internal and external) and interest rates which, can limit the demand by the resource users?
2	Do opportunities exists to reduce detrimental social and economic forces and what prohibits the reduction of detrimental social and economic forces?
E3	**INCREASED USE PRESSURES**
1	Are social and economic forces (e.g. water provision, housing) creating pressure on available infrastructure that impacts on estuary based enterprises?
2	Are there opportunities to improve this and what are the constraints?
E4	**EFFECTIVENESS OF GOVERNANCE**
1	Referring to 'Governing Capital' Does governance have capacity / skills to cope with social and economic shocks to estuary linked assets (resource, access, infrastructure)?
2	Are there opportunities to improve this and what are the constraints?

Ecosystem services regularly associated with estuary social-ecological systems

Following the development of these tables the research team then identified those ecosystem services that were regularly associated with estuary social-ecological systems.

Regulatory Services – which enhance the human living environment
- Soil stability
- Sediment supply
- Soil formation and fertility
- Waste assimilation
- Waste dilution
- Flood attenuation
- Disease control
- Pest control
- Groundwater recharge
- Wind damage control
- Fire damage control
- Coastal storm damage control
- Disaster damage control

Supporting Services:
- Settlement
- Mariculture
- Recreation amenity
    - fishing
    - canoeing
    - walking
    - birding
    - sailing
    - skiing
    - swimming
    - boat launching
- Natural Heritage
- Transport

Information and Spiritual Services
- Spiritual places
- Cultural places
- Knowledge generation and learning sites
- Nursery for commercial species

Provisioning Services
- Fibres
- Wood fuel energy
- Biochemical supply
- Food (and bait collection)
- Horticultural plants
- Minerals

The Anderies et al. (2004) framework helps us to understand the elements of the system and how they relate to each other, and the matrices and ecosystem service lists direct us to source the information that will be required to make an assessment of prospects for an estuary-based enterprise. We now turn attention to how data should be assembled and interrogated for decision making.

Chapter 4: The State of and Opportunities for Estuary-based Economic Empowerment (focusing on the Eastern Cape Wild Coast)

4.1 Introduction

In South Africa, as social, political and economic reform and restitution progresses, so is there the growing need of "….assuring that all citizens benefit from the nation's wealth." (Fung and Wright, 2001). Scharmer (2009) suggests that creating basic income and entrepreneurial opportunity that accesses a nation's wealth is not only a fundamental right but an entirely necessary element in solving the current global economic crisis. Creating access to wealth, access to basic income, access to entrepreneurial opportunity – all this is fundamental to 'deepening democracy' and improving equity. It is also South African Government policy.

This imperative is acknowledged and supported by this project. Business and industry are required, through policy and legislation (Broad-Based Black Economic Empowerment Act No. 53 of 2003 and associated policies), to set and meet Black Economic Empowerment (BEE) targets. Even though it may be argued that much has yet to be achieved, organized business and the public sector have responded positively to the challenge. Increasingly ownership and control in large businesses are being assumed through BEE initiatives, and public sector employment has been a major catalyst for BEE. Even at smaller scales progress is evident, driven largely by allocation of equity in businesses and through the drive toward employment and gender equity (http://www.southafrica.info/business/success/).

The future of southern African landscapes and associated ecosystems will also be determined by the success that can be achieved with empowering local people in the economy. This is because ecosystems are sources of services (Millennium Assessment, 2005). These services are the foundations for economic opportunities and with these opportunities come better prospects for individual and community accountability for wise use. Those who have a stake in these economic opportunities are more likely to be better disposed to wise use than those who are excluded.

Estuaries are important coastal landscape features. They are not simply important ecological entities but are also valuable social and economic assets (Hay, 2007). Coastal economic development commonly concentrates itself at and around estuaries. The scale, type and intensity of this economic development can vary significantly – from Durban harbour on the one hand to a small camp-site or rural village on the other.

The Green Paper on Sustainable Coastal Development in South Africa, the White Paper that followed, the Coastal Bill that followed and, finally, the recently enacted Integrated Coastal Management Act of 2008 (Government Gazette, 2009) all recognise that:

1) estuaries are important and unique components of the coastal landscape, and
2) the benefits that accrue from estuaries and other coastal land/seascapes need to be shared more equitably by society.

In implementing the Act the State, led by the Department of Environment Affairs, has made provision for the establishment and implementation of management plans at all South Africa's estuaries, and has established guidelines for these processes. Given the under-

developed nature of economies in much of South Africa, attention is now focused on how estuaries might act as catalysts for economic development and economic empowerment.

This chapter assesses briefly the state of and opportunities for economic empowerment associated with estuary social-ecological systems located primarily on the Eastern Cape Wild Coast. The intention is to identify those factors which are the primary contributors to vulnerability of estuary-based enterprises and the opportunities that exist for estuary-based enterprises.

4.2 Some indicators that suggest economic empowerment

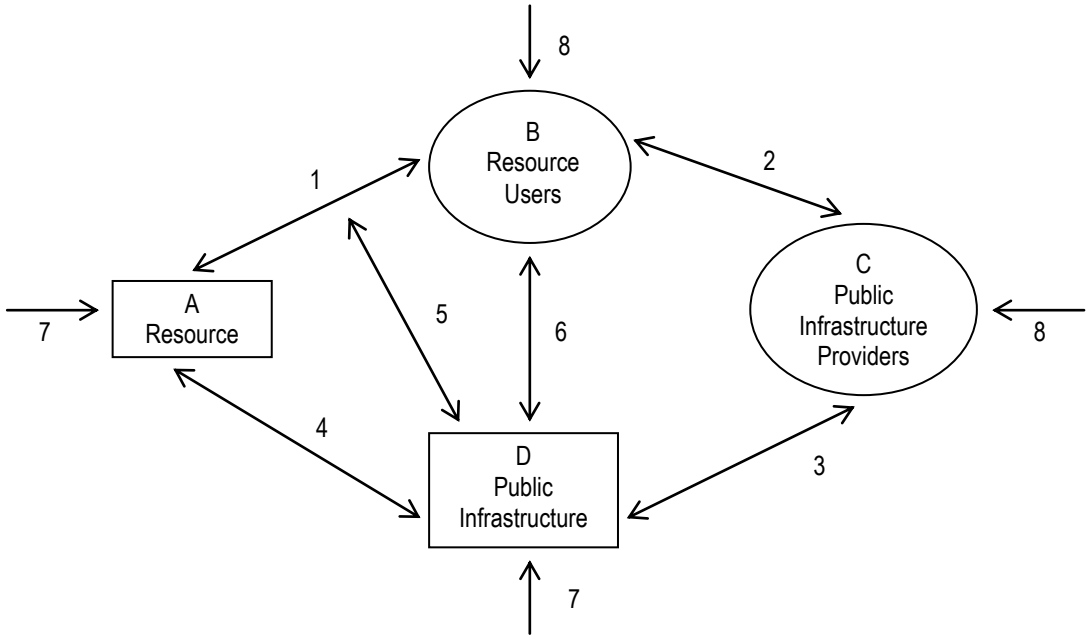

Figure 4.1: Anderies' et al (2004) conceptual model of a Social-Ecological System (SES)

What might indicate that economic empowerment is occurring in the Eastern Cape and particularly at Wild Coast estuaries? Guided by the Anderies et al (2004) framework (Fig. 4.1 above) and an understanding of the intentions of economic empowerment (Government Gazette, 2004):

- The resource is supplying ecosystem services of sufficient quality, quantity and consistency so that resource users can establish enterprises; the benefits of these enterprises are accruing to previously and currently disadvantaged individuals, particularly women, and their quality of life is improving, and that the ownership and control of the enterprises is vested increasingly with these individuals (Arrow 1).
- Public infrastructure is ensuring that the resource is maintained so that it can supply ecosystem services necessary for enterprise establishment and operation (Arrow 4)
- Public infrastructure ensures that resource users are able to establish enterprises (Arrow 6)
- Public infrastructure mediates the relationship between the resource users and the resource in support of enterprise establishment (Arrow 5)
- Public infrastructure providers are directly supporting enterprise establishment by the resource users (Arrow 2)

- Public infrastructure providers are constructing and maintaining both the social and physical infrastructure in support of enterprise establishment and resource maintenance (Arrow 3)
- Both the social-ecological system and the enterprises contained there-in are able to withstand external shocks and forces (Arrows 7 and 8)

4.3 The provincial and local government context for economic empowerment

The Eastern Cape is considered to be a province with a rich and diverse natural resource base – rainfall is relatively high, soils are fertile, landscapes are dramatic and highly appealing (Eastern Cape Government, 2004). This translates practically into enterprise opportunities in agriculture, tourism, forestry, marine resource use and recreation. However, what is encountered is somewhat different. While economic growth has taken place in the Eastern Cape (in the period 2000 – 2005 it was the most rapidly growing provincial economy) this growth was attributed largely to increased employment in the public sector, manufacturing, particularly the motor manufacturing industry and, more recently, transfer payments (social grants). Apart from these three areas the economy has been largely stagnant over the last decade. This was particularly noticeable in agriculture and outside the urban centres (Eastern Cape Government, 2004).

The proportion of households living in poverty exceeds 60% along the Wild Coast portion of the Eastern Cape and there is evidence that this percentage is increasing (ECSECC, 2005). Unemployment rates range from 40% to 70% steadily increasing from west to east and the majority of the unemployed are rural women (ECSECC, 2005).

The delivery of basic services such as water supply and sanitation, transport, health, education and electricity is occurring but with a considerable lag and in many instances off a very low base. As an example, in the OR Tambo District Municipality the population with water piped into their home doubled between 2001 and 2006 but this was only from 3% to 6%. (Statistics South Africa, 2007).

Between 2001 and 2006 emigration from the Eastern Cape was 454 442 and immigration into the Eastern Cape was only 132 945. (Statistics South Africa, 2007). These were not people emigrating from South Africa but rather in South Africa from the Eastern Cape to Gauteng and the Western Cape.

In the Provincial Growth and Development Plan for the Eastern Cape (Eastern Cape Government, 2004) there is no mention of the terms economic empowerment, black economic empowerment or broad-based black economic empowerment. The plan, by its own admission focuses on the delivery of basic services to the provincial population.

So, in summary, outside of the public employment and manufacturing sectors and government grants there has been little economic growth, poverty levels are high and increasing, unemployment levels are high particularly amongst rural women, service delivery shows limited improvement, people are dissatisfied with what opportunities there are and are moving on, and there is no institutional driver of broad-based black economic empowerment. Quite simply, the immediate outlook for broad-based black economic empowerment in the Eastern Cape is not encouraging.

The exception is within public sector itself. Since democracy there has been the creation of district and local levels of government that were previously absent. Public sector employment has taken place on a large scale. This, in itself, appears to have created economic growth, reduced unemployment (amongst the more skilled populace) and increased incomes. Examining available statistics (Statistics South Africa, 2007) it is apparent that in many rural areas this employment has not translated into improved service delivery.

As the agent of local governance, management, administration and development local municipalities have a key role to play in economic empowerment. The specific role of local municipalities in promoting and ensuring compliance with national economic empowerment strategies is not explicitly stated in any of the documents scanned. However, the Municipal Systems Act of 2000 states specifically that "A municipality exercises its legislative or executive authority by (inter alia) promoting and undertaking development." National government sees local government as the major agent of development delivery at the local level. Within this context it is expected to consider, promote and comply with all national policy and legislation. Delivering development and economic opportunities is facilitated through the Integrated Development Planning (IDP) process of a municipality.

Arising out of the previous WRC estuaries research project – "Estuaries and Integrated Development Planning" – a fundamental truth has emerged. Where local municipalities have skills, capacity and resources they are usually able to engage in the management of ecosystem services that are generated by estuaries, they are beginning to recognise the economic value of these services and they are developing mechanisms to support economic development opportunities. However, largely rural local municipalities have limited skills, capacity and resources, are unable or unwilling to engage in and lead management, and in many instances are more familiar with the benefits that estuaries supply rather than the ecosystem services that mediate the supply of these benefits (Hay, 2007).

4.4 Economic empowerment at the estuary landscape level

Is what we observe at the provincial and local government level reflected in the same way at the level of the estuary landscape (or group of estuaries landscape)? As has been indicated, estuaries on the Wild Coast are centres of and catalysts for economic activity. But does this economic activity translate into economic empowerment?

Urban and peri-urban estuaries such as Nahoon and Gonubie attract up-market residential development and associated recreational activity. This development and activity does create jobs. However, the primary beneficiaries of the services provided by the estuary are relatively affluent residents and visitors. Some urban estuaries such as the Buffalo River estuary which is a harbour are catalysts for major direct and indirect economic empowerment opportunities. However, the focus of this research is on estuaries occurring in rural areas.

Estuaries in rural areas in the Eastern Cape are currently used by subsistence and small-scale commercial harvesters, recreational/holiday users, and tourism enterprises with its associated guests.

Harvesters include amongst others:
- bait collectors,
- fisher folk,

- mangrove harvesters and
- honey collectors.

Recreational/holiday users include:
- cottage owners and their guests, and
- day visitors (the New Year's Day phenomenon).

Tourist facilities and activities include amongst others:
- resort hotels,
- campsites,
- community-based accommodation,
- horse-trails,
- hiking trails
- canoe trails,
- cycling trails,
- motorcycling/quad-bike trails,
- fishing,
- swimming,
- boating and
- cultural events.

Large revenue streams are generated by the resort hotels at estuaries in rural areas. They are also major employers of local skilled and unskilled labour. If one accepts that a major foundation of economic empowerment is employment then these facilities are significant agents of economic empowerment. Also, operators indicate that a high proportion of those employed are women (Bouwer, pers. comm.). In addition, these facilities act as catalysts for other economic activities (they are 'anchor tenants' at an estuary 'shopping centre'.) Taking Umngazi River Bungalows as an example, surrounding it are a number of associated micro-enterprises owned and operated by locals. They include horse and hiking trails, canoe trails, cultural tours, ghillies (fishing guides), bait sellers and honey production. The market is either exclusively or primarily the resort guest or the resort itself. Locals are also drawing on their experience of having worked for or observed the operation of the resort and are establishing their own community-based tourist operations. This builds on Umngazi River Bungalow's formal employment levels which exceed two hundred people, a staff to guest ratio which exceeds 1 to 1.

However, the control over and the beneficiaries of the major revenue streams associated with these resorts remain vested largely with advantaged individuals. Substantive business partnerships involving the resorts core income area (accommodation and board) have not taken place. In one or two instances there are black partners in resort ownership (Kob Inn) but they are drawn largely from the political/economic elite. The Haven Hotel is black owned but requires extensive redevelopment to reach its potential.

The Haven Hotel provides for one of the more perverse examples of economic empowerment denied. Historically, it was white owned attracting primarily recreational fishermen and their families. Through a land restitution process the local Xhosa community took ownership of the facility. However, the Eastern Cape Government and the national Department of Environmental Affairs and Tourism almost simultaneously declared the region a marine

protected area and banned recreational fishing. The hotel's occupancy has declined steadily since then.

Discussions with various Eastern Cape tourist resort operators and owners indicate that, although there have not been any significant new resort developments, the existing resorts have experienced improving occupancies and increased revenue streams over the past ten years. Associated with this has been an improvement in the road, water and electricity infrastructure to many of these resorts. This improved infrastructure has directly and indirectly benefited those living along the routes to these facilities. This would infer that realised economic empowerment has taken place and that opportunities have increased.

A key factor contributing to the success or failure of business enterprises is access to the stream of benefits (the resource or property) upon which the enterprise is based. If the stream is small and erratic the risk of failure is high. If it is large and consistent the risk of failure is much lower. The allocation of this stream of benefits is regularly mediated by, amongst others, the property rights regime in which it occurs. With that as conceptual background what is the situation on the Wild Coast and how does this situation affect estuary-based enterprises? The dominant form of property rights on the Wild Coast are described as communal land rights. Communal land is that land occupied or used by members of a community subject to the rules or custom of that community (Government Gazette, 2003). It is a form of common property rights. However, TRALSO (2005) observes that "The first issue is the lack of and/or weakness of viable institutions to champion and take custody of communal land rights." The result is competition between traditional and democratic government, and between different spheres of democratic government to regulate these rights. So, the more accurate reality is that, rather than communal land rights, there are a mosaic and overlaying of several property rights regimes. The flow of benefits from the coastal zone is regulated by customary (common property) use, open access and state regulations. In amongst this are pockets of private property secured either through free-hold, lease-hold or Permission to Occupy (PTO) arrangements. The consequences of this are:

- What Coelho et al (2009) describe as the 'anti-commons' aptly illustrated in Figure 4.2. The public infrastructure providers generate barriers to entry for enterprises – effectively preventing black entrepreneurs in optimizing their access to natural assets. Given the complexity of obtaining approval for physical development (and the number of 'gate-keepers') it is unsurprising that only one significant tourism development (Drifters Tours) has taken place on the Wild Coast over the past ten years (and most of the development approvals were obtained and much of the physical infrastructure was complete before Drifters Tours took up the development option.).
- The almost impossible task of securing essential contracts for use of various benefit flows.

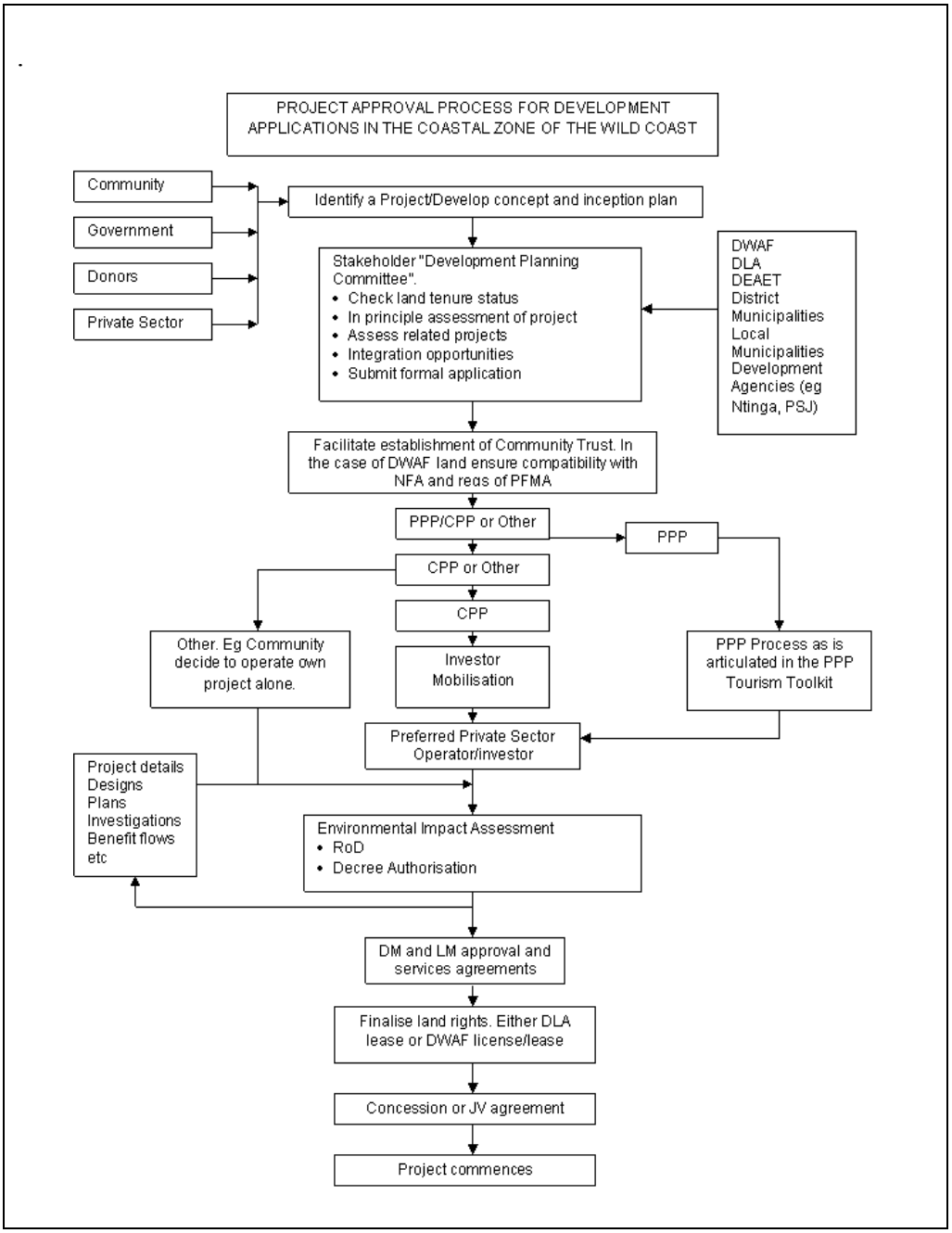

Figure 4.2: An appropriate example of what Coelho et. al. (2009) describe as the 'anti-commons'

4.5 Opportunities for estuary-base economic empowerment

An estuary-based enterprise is dependent on two things: something that is related to the estuary that can be sold or exchanged (the supply) and someone who wants it and prepared to pay for it or exchange it for something else (the demand). The interaction between supply and demand, and the context in which it happens, creates and dictates the nature of the economic opportunity.

What do Wild Coast estuaries and their immediate surrounds supply that are a realised or potential source of enterprise? The primary supply-side drivers are aesthetic appeal, a rich biodiversity, a well defined cultural landscape and lack of degradation. These primary drivers

deliver a broad range of services that are inputs of enterprises. In terms of physical goods this can include, amongst others:

- Fibre for house building, craft manufacturer and/or retail sale
- Wood as fuel energy and for construction
- Biochemical material from medicinal plant harvesting and illegal Cannabis production
- Commercial and ornamental plant species
- Food such as fish, bait, mariculture, honey, sugar and bush-meat
- Fodder for grazing
- Minerals such as sand, salt, titanium, rutile and zircon

Services can be divided practically into regulating services, information and spiritual services and supporting services. The opportunities arising out of regulating services would include, amongst others:

- Bio-engineering and maintenance payments to improve soil stability
- Beach user fees, mouth management fees and direct payments for sediment management and salinity control
- Pollution discharge (point and non-point source) license fees and levies, and solid waste collection payments for waste assimilation and dilution
- Payments for alien species eradication for pest control
- Conservation management service and habitat restoration fees/levies for wind, fire and storm damage control
- Insurance premiums for disaster management control
- Carbon sequestration payments

Opportunities from information and spiritual services include user and entrance fees and guiding services for places of natural, cultural and spiritual significance and those which serve as knowledge generation and learning sites.

Opportunities from supporting services include:

- Land sales and leasing, infrastructure sales and leasing, user/access fees, licensing fees, rates, booking fees, safety and security fees/levies, and maintenance and restoration for settlements, mariculture, tourism, recreation and habitat conservation
- Ferry, cargo, pollution insurance, biodiversity offset and pollution cleanup fees from transport activities and infrastructure.

So, the services supplied by estuaries provide for numerous economic empowerment opportunities. But, which ones are likely to be practically realizable, once realised are likely to be robust, and what conditions will be required to maintain robustness? A detailed assessment of would be context specific but a general assessment would indicate the following:

- Direct use of estuary goods, while practically realizable, are unlikely to have little long term robustness unless actively managed.
- Managing and improving the system itself (management and restoration services), while difficult to practically realise, are likely to have good long term robustness. An example that might have high economic empowerment potential is a Working for Estuaries campaign. This would be dependent on long-term investment from a number of sources.
- Use of the estuary resource for relatively passive tourism and recreation enterprises are practically realizable and robust. The level of robustness would depend largely on the

skills of the enterprise operators, the stability of access/tenure arrangements, market access and maintenance of the biophysical integrity of the system.
- Property transactions and property rating are practically realizable and robust. Estuaries are desirable locations to live and do business at and that property values around them are high. So, the income stream to both the private and public sector entities is considerable.

Who are currently the primary beneficiaries of those economic opportunities that are being realised? Those who make use of estuary resources and obtain some kind of benefit are as varied as South African society itself. The key question is who is currently obtaining the lion's share of benefit from use. A rapid scan of South African estuaries indicates the following:

- Many estuaries are sources of benefits such as fish, building material and grazing to local disadvantaged people living at or near them. These benefits are sources of direct subsistence to these people or are sources of enterprises – products and services are sold on to third parties. This trade acts as enterprise incubators.
- Many estuaries are sources of recreation and tourism. The control of these activities is vested largely with white-owned businesses or the State. The hotel and resort industry of the Wild Coast typifies this. These operations are a valuable source of jobs to local disadvantaged residents. These operations also spin off secondary service enterprises which are taken up by local residents (guiding, horse trails, canoe trails, etc.). The users (tourists and recreationists) remain predominantly white but the black component is growing (Nel, pers. comm.)
- Many estuaries are sources of residential development. These are typically primary residences or second (holiday) homes of affluent white individuals, but also include significant numbers of disadvantaged people who settle at or near an estuary. The affluent residential development is a source of jobs to local disadvantaged residents. Bushmans/Kariega and Kleinemonde typify this. The rates earned by municipalities from residential development is a source of income, allowing municipalities to hire predominately black employees, to invest in capacity building in these employees, to undertake preferential procurement for black suppliers and to provide monies for local economic development initiatives.
- Estuaries are potentially focal areas of major conservation management action. In future, sea level rise is likely to act as a catalyst for major investment in coastal areas. The concentration of this investment will be in areas of greatest human concentration, often at estuaries. While initially control of this action is likely to be vested largely with the state. This is a major source of economic opportunity for local disadvantaged residents but requires development.

4.6 Applying the framework as a system of analysis

Acknowledging that an estuary-based social ecological system is nested in a larger provincial social-ecosystem, many of the drivers operating at a provincial level will affect the estuary level.

At the local level estuaries of the Eastern Cape Wild coast, acting as a resource base, can provide numerous enterprise opportunities. These opportunities can accrue to a diverse set of resource users. However, those who were marginalized for a long time or those who are still marginalized by virtue of living in places that are geographically isolated from the main stream, remain marginalised. Previously benefits would have been allocated through local

custom (public infrastructure) by traditional leadership (public infrastructure providers) and there would have been a common and general understanding of how the estuary-based-social ecological system worked. Now we have competing and contradictory sets of public infrastructure providers – three spheres of democratic government (local, provincial and national), traditional government, private sector, NGOs – all with highly divergent views of and multiple interpretations about how the world works. They all have one thing in common – they exert significant and conflicting influence over marginalised resource users. Because not all ways of realizing benefits are compatible (e.g. subsistence use practices and accessing leisure benefits) multiple interpretations create uncertainty and undermine confidence among a people who are unfamiliar with potential economic opportunities and how these may be realized and are regulated. The result is that there are conflicting uses and uninformed decisions being taken, and uncoordinated decision making about using the same asset. Local people take decisions, municipalities take decisions, province takes decisions and national government takes decisions but no-one sits down together to acknowledge their shared relationship around the estuary – consequently, suboptimal social benefits from the ecosystem services are ensured.

The traditional institutional arrangements that regulated access and use have weakened and become ineffectual and have not been effectively replaced. Consequently governance is not understood and so regulation is not enforced and opportunistic behaviour confounds the establishment and operation of estuary-based enterprises. The social-ecological system borders on chaos (Sardar, 2009) brought on largely by the actions or inactions of public infrastructure providers. This creates high levels of inertia – very little happens and what does benefits the already empowered.

An exception to this is resident private interests – the resort hotels and, to a lesser extent, the coastal cottage industry. They together with the marginalised resource users are our ‘harbour gangs’. All have a vested, long-term and tangible interest in the resource and have devised ways of jointly securing benefits, often despite interventions by our ‘roving bandits’ – primarily the state.

Chapter 5: Applying the methodology

(Note: Sections of this Chapter are detailed in Appendix C)

5.1 Introduction

Central to post-normal science is the focus on a "more participative and ideologically open approach to knowledge-making in science." (Frame and Brown, 2008). With this in mind, the research team designed a generic, structured (yet flexible) and participative learning process (the methodology), identified two estuary based case-studies at which to apply and refine it, and then applied it to a freshwater wetland system to assess transferability to other social-ecological systems. Subsequent to this and at the request of the CAPE Estuaries Programme, the methodology was also demonstrated to Western Cape stakeholders, using Keurbooms Estuary as an example.

No specific criteria for success or failure of the methodology were developed. However, in engaging, facilitating and reflecting on the process the following indicators were considered:

- What is our overall impression of the state of and opportunities for economic empowerment in a particular context?
- What is the stakeholder reaction/response to the process?
    - Is there a sharing of information rather than simply a passing of information from 'experts' to stakeholders?
    - What is the overall response of the participants?
    - Can they relate to the exercise being conducted?
    - Does it appear that learning is taking place as a shared understanding is built?
    - Is the process sufficiently interactive or is it being dominated by experts or certain stakeholders?
    - Are participants able to maintain focus and concentration, and do they appear bored or excited?
- How easy was it to use the methodology?
- How valid was the methodology and what might be missing?
- Could the methodology be applied in diverse contexts and in different ways, and was it transferable to other natural resource-based systems?
- What were the limits of the methodology and how might it be improved?

5.2 The Process

The project team developed a process framework illustrated in Figure 5.1 below.

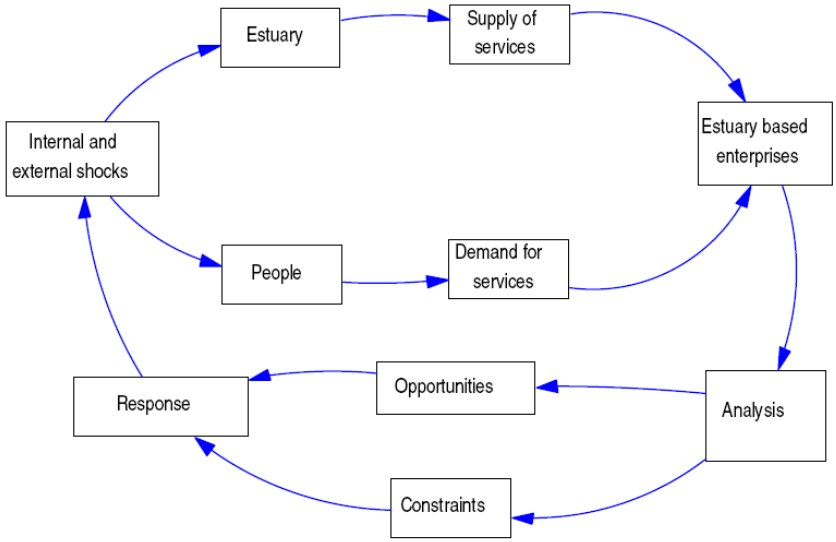

Figure 5.1: Framework designed to guide the engagement process

This was informed by the analytical frameworks discussed in Chapter 3, primarily that of Walker et al (2002). Its aim was to develop answers to the following questions:

1. Who are the key actors/stakeholders in the SES?
2. What are the spatial boundaries of a particular SES?
3. What is the supply of ecosystem services from the SES?
4. What is the (potential) demand for these ecosystem services?
5. What suite of enterprises might be appropriate given the nature of the ecosystem services supply and demand?
6. What are the risks of establishing and sustaining any one of these enterprises?

Following this process participants were also asked how the process fulfilled their expectations and how might it be improved.

The details of the process were case-study specific, but generally followed this sequence:

1. Identification of a social-ecological system where intervention is required to support economic development and empowerment (this might be pro-active or responsive)
2. Initial engagement with key actors (business people, NGOs, CBOs, government) in order to identify other actors, and familiarise oneself with the area and the issues
3. A series of working sessions where, in a participative process, the boundaries of the SES are defined; the supply of and demand for ecosystem services from the SES are established, the suite of enterprise opportunities identified, and one or more opportunities subject to risk analysis. These working sessions might range from one to four days in length and might be split into two parts depending on the commitment of participants and the level of detail required. (In the research process an additional session was incorporated to discuss the process itself. This is likely to be useful in most circumstances.)
4. Following the sessions, a report is compiled and supplied to the participants.
5. Given particular circumstances, further activities might be planned (at Mngazana/Umngazi a further two sessions were conducted and a business proposal was generated).

5.3 The case-studies

Six criteria informed the choice of case-studies

- The researchers should be familiar with the SES. There should be at least a broad understanding of the landscape, the biophysical and ecological characteristics, the people and the issues.
- There should already be relationships and a basis of trust between the key actors/stakeholders and members of the research team
- The areas should be physically accessible
- The key actors should be enthusiastic in engaging in the exercise.
- There should be obvious enterprise potential
- The estuary case studies should be in the Eastern Cape.

The four case-studies that were chosen included:

Mngazana and Umngazi Estuaries – Located approximately 20 km south of Port St John's on the Eastern Cape Wild Coast, these two estuaries and their surrounds are already catalysts for enterprise development. There is a well-established resort hotel; canoe, horse and hiking trails; various fishing related activities (guiding, bait collection, etc.), and bee-keeping in the mangroves at Mngazana. In the context of the Eastern Cape Estuaries Management Programme, researchers and partner organisations have been working with stakeholders in the area for the past nine years to support the management of the Mngazana Estuary. Within this context an estuary management training courses had been conducted in the area involving a number of stakeholders. Local stakeholders have specific interests in obtaining formal conservation status for the area, converting a cultural centre into a tourist accommodation facility and developing a tourist lodge between the two estuaries.

Buffalo City Municipality (BCM) – It comprises East London and surrounding areas. It has a coastline of 73 km with fourteen estuaries. These estuaries are located in both urban and rural settings and are subjected to various land tenure systems (communal, private, state). BCM has pro-actively established an integrated coastal management plan as part of its Integrated Development Plan and is developing management guidelines for nine of its priority estuaries. BCM Staff recognised that economic development opportunities at estuaries should form a focal point of planning and management. Also here the Eastern Cape Estuaries Management Programme had been working with local stakeholders for ten years and estuary management training courses had been conducted.

Mbongolwane Wetland – (Appendix D) This wetland is located at the source of the Amatikulu River near Entumeni and approximately 35 km west of Eshowe in northern KwaZulu-Natal. The wetland has been the subject of long-term research and management support by, amongst others, the Institute of Natural Resources, the Mondi Wetlands Project, the National Landcare Programme and University of KwaZulu-Natal. A number of locally based enterprises are reliant on the wetland. These include, amongst others, fibre-based craft production, taro (madumbe) cultivation and cattle grazing.

Keurbooms Estuary – This estuary is located immediately east of Plettenberg Bay. It is surrounded by fairly high levels of residential development in its lower reaches and could be described as a 'hard-working' system. It is of high biological conservation importance. It is the subject of an estuary planning and management process as part of the CAPE Estuaries Programme.

5.4 Key findings

Economic empowerment at estuaries – There are significant opportunities for the establishment of estuary or wetland based enterprises that can act as catalysts for economic empowerment, but there is a lack of support necessary to do this. Using the language of the Anderies et al (2004) framework, there are resources (ecosystem services), there are users and potential users, and the social aspects of the public service infrastructure (policies, laws, conventions) are generally supportive of economic empowerment. However, in the rural context the lack of physical infrastructure is often a major constraint and, in both rural and urban situations, the public service infrastructure providers (primarily local government) are either unwilling or unable to provide the necessary support. It is here where major risks lie. This accords with the findings of Kotze (2010) and Pollard and Cousins (2007).
The other major risks to enterprise establishment revolve around:

- Confused and conflicting property rights regimes which compromise security of tenure, an essential component of most enterprise operations
- Low levels of literacy, numeracy and business acumen/knowledge amongst people living in estuary and wetland based SESs in a rural context.
- The inherent instability or seasonality of both supply and demand for services (on the supply side primarily climate and on the demand side the seasonal and unpredictable nature of economic sectors such as tourism and recreation.)

However, it is recognised that not all types of economic development are sustainable or desirable. There is also general recognition that economic development should not necessarily take place at all estuaries with some being completely undeveloped so as to fulfil national biodiversity conservation objectives.

Stakeholder response – Stakeholder response was, without exception, overwhelmingly positive. A phrase stands out; translated from isiXhosa it was "our eyes have been opened", There appeared to be genuine appreciation of the structured yet flexible, participative learning process and for the content that was generated. Participants appeared to gain new insights into and appreciation of the value of the estuary or wetland. This reinforced Walker et al.'s (2002) assertion that stakeholder consultation is critical. But, it transcends consultation. It is about stakeholders as generators of knowledge and contributors to decision making.

Ease of use – The participants in the working sessions were comfortable assigning scores to the different ecosystem services supplied by estuaries or wetlands based upon their own knowledge, and to assess the demand for these services. This was despite the fact that at Mngazana/Umngazi and Mbongolwane most participants had a fairly low level of formal education and had not participated in this type of exercise before. A further feature of their participation is that they engaged freely with other participants in discussing the basis for their scores, to reach a consensus view. The process therefore contributed usefully to stimulating dialogue and helping to build a common understanding of the systems. On the risk analysis, responses were mixed. In some workshops, notably in BCM, participants engaged with ease but at Mngazana/Umngazi and Mbongolwana the participants struggled to translate their qualitative responses to each question into a score, even for those questions that seemed to be reasonably well understood. Thus, scoring was regularly undertaken by the facilitator, based upon an interpretation of the participants' narrative responses. It would appear that assigning scores for the risk elements is somewhat more abstract than assigning scores in the ecosystems services matrix. A further factor affecting the ease of use of the risk assessment questions was the fact that the framework itself provided little explicit direction to

help the user link the results of the ecosystems services matrix with the risk assessment questions, and relied on the skills and experience of the facilitator. (This is being addressed in further refinements of the toolkit.)

Validity of the methodology and missing components: The researchers were very familiar with all three case-study areas, and had been working intermittently in these areas with stakeholders for over ten years. Although the researchers did not make specific and explicit predictions on what the results of the process would be, the results did appear to conform to what the suite of possible enterprises and the risks of establishing any one of these enterprises might be. This begs the question – if the results were as expected why bother to follow an exhaustive process? The two primary reasons are objectivity and common understanding – objectivity is increased through the development of a common understanding of ecosystem services – the foundation for natural resource-based enterprises. During the course of applying the methodology at the varying sites a number of components were added:

- A process for identifying an appropriate suite of enterprises at a particular estuary or group of estuaries.
- Photographs illustrating ecosystem services which improved stakeholders' ability to conceptualise them.

Diversity of applications of the methodology: In facilitating the process it became apparent that one could apply the toolkit in a number of different ways:

1. It might operate as a proactive planning tool to determine what the most appropriate enterprises and enterprise mix at an estuary or wetland might be and what might be the risks of establishing these enterprises
2. It might act as a reactive or responsive management tool, assessing the appropriateness of an enterprise development proposal including the risks of its establishment.
3. It might guide a situation assessment of a particular SES.
4. All three of the above might be conducted as participative processes or as expert-based desk-top exercises.

Transferability: (Appendix D) The overall outcome of facilitating the process at Mbongolwane demonstrated that the methodology was readily transferable. Certain modifications to the ecosystem supply and demand, and enterprise opportunity templates were required but these we were minor adjustments. What was not considered and might limit transferability is the inherent public perception of estuaries and freshwater wetlands. Estuaries are viewed as obvious catalysts for economic development – the opportunities are usually quite direct and obvious. In most instances at wetlands the opportunities are more subtle and not necessarily as direct. It is worth noting that the transferability of the tool-kit is not surprising given that:

1. All individual wetland/inland wetland systems are located within some socio-economic context.
2. Both wetlands and estuaries each provide multiple ecosystem services.
3. Benefits from these services accrue across a wide spectrum of scales, from local to regional and global.
4. Potential exists for the establishment of enterprises based upon some of the services.
5. Both estuaries and wetlands are dynamically complex, often unpredictable, and subject to a variety of external shocks, many of which have implications for the enterprises dependent on the system.

Limitations of methodology: This methodology is not a cure-all and there are several limitations which warrant noting:

- As a participative exercise it is a lengthy, time consuming process. This is particularly so when translation is required.
- It is intellectually demanding for both facilitators and participants – it requires short sessions and long breaks.
- It assumes a certain level of cooperation at the outset or at least an absence of major tension or conflict.
- When conducted as a participative exercise it requires that the main actors be in the room and participate actively in dialogue, rather than simply supplying information. The absence of the local municipality in the Mngazana/Umngazi sessions was a major constraint.
- It requires skilled facilitators who are confident and can inspire confidence in participants, who have expertise in economics, ecology, natural resource management and sociology, who understand local dynamics and who are skilled in encouraging meaningful dialogue from a diversity of participants. There is a concern that these skills are rare and that 'training of the trainers' is required in order to roll this methodology out on a broad scale.
- It does not delve into the specific internal risks of developing and operating a business enterprise. It focuses largely on externally generated risks.
- It does not have an exit strategy.

5.5 The methodology as a participative learning tool

Subsequent to the fieldwork component of this study, the methodology was deployed in a 'real-life' situation at Mpenjati Estuary on the KwaZulu-Natal south coast. This case-study formed the basis of a paper which is currently being compiled for consideration by Water SA. A draft of this paper (without Tables and Figures) is included as Appendix E.

Chapter 6: Implications for governance and management

6.1 Introduction

Based on this research and at the request of the Department of Environmental Affairs the researchers compiled a working paper (Appendix A) designed to inform governance and management. It provides a brief commentary on:

1. What is emerging from the research
2. What ecosystem services are supplied by estuaries and what potential economic opportunities arise from the supply
3. A process of analysis and action that supports economic empowerment at estuaries
4. Some intervention principles that might be appropriate
5. Some key attributes of resilient estuary-based enterprises
6. Some practical suggestions aimed primarily at the National Department of Water and Environmental Affairs

Points 2 and 3 are well covered in previous chapters of this document. In the following sections Points 1 and 4 – 6 are summarised.

Also, it was recognised that enterprise establishment is often regulated by the Environmental Impact Assessment (EIA) processes within the overall context of a social-ecological system. It was posed that the Anderies et al (2004) framework might be a useful analytical framework contributing to improving the performance of EIAs.

6.2 What is emerging from the research?

(Note: Section 6.2 – Section 6.5 is for the most part a summary of Appendix A)

Economic empowerment based on estuary services is generally underappreciated and underdeveloped. The primary reasons for this are as follows:

- Estuaries are bio-physically highly dynamic environments and the supply of ecosystem services which form the foundation of nature based enterprises can seem to be erratic.
- There is a general lack of understanding and appreciation of the economic opportunities that estuaries offer.
- Many of the services provided by estuaries are taken for granted and consequently the benefits we derive are undervalued. The consequence is that we do not invest enough in sustaining ecosystem processes.
- Because we do not pay for many of the benefits we derive from estuaries, we do not generate the revenue that is required to sustain management.
- Many disadvantaged people living at or near estuaries are poorly educated and lack the necessary skills to initiate and operate businesses or secure jobs that utilise the ecosystem services offered by estuaries.
- Local people frequently lack the investment capital to secure equity in existing or start-up businesses.
- Many economic opportunities that have been taken up have been done so by advantaged groups or individuals, reducing opportunities for others.
- At an estuary economic opportunities are commonly in the tourism sector. This sector is particularly complex. It requires considerable human and financial capital for

infrastructure, sophisticated and expensive marketing, and markets are often unpredictable or seasonal.
- Estuaries are common property resources with poorly defined property rights. This complicates the allocation of opportunities and the benefits that arise from these opportunities. Securing tenure, a vital necessity for most economic developments to succeed, requires a level of sophistication that is currently in short supply in rural areas.
- Developing a public or private business that creates jobs and renders a return in the coastal zone is administratively and bureaucratically complex in communal areas, and where one has to interact with several government departments. This raises transaction costs to unaffordable levels for many rural people.
- Local municipal staff is poorly skilled and lack business insights. They are, for the most part, unable to assist those who wish to engage in an economic activity. Also, there appears to be little incentive for local officials to get involved in activities that support BEE.
- Corruption regularly results in either no or the sub-optimal economic development option being supported.

However, despite these difficulties, it is clear that estuaries are high value assets that supply ecosystem services from which valuable benefits accrue to local residents. There are several examples of economic empowerment in progress:
- Where there is an established business such as a resort hotel direct and indirect opportunities result. The direct opportunities would be jobs in hospitality, maintenance, administration, security and management. Indirect opportunities include guiding, trail operating, cultural activities, bait collection, life-saving and security.
- In the public sector campaigns such as Working for the Coast provide job opportunities, income and skills development for local residents.
- Permanent employment in state agencies tasked with managing and conserving estuaries is a source of economic empowerment. (Arguably, one of the greatest sources of economic empowerment in the Eastern Cape was and is public sector employment.)

If estuary-based economic empowerment is going to work it requires a systematic process of analysis and engagement involving all pertinent stakeholders in these complex situations. In this process:
- A good understanding of what opportunities exist, of what mixes of opportunities are appropriate in different contexts, and the trade-offs between different opportunities need to be developed by all parties.
- Spatial and temporal complexity needs to be recognised and built in as a key part of the process.
- Transparency, honesty, trust, positive relationships, and a common goal or identity are key success factors.
- Skills levels amongst potential beneficiaries to engage the opportunities need to be built as do the skills levels of those private, state, research and NGO sector agencies supporting this engagement.

6.3 What principles might inform intervention (Meadows, 1997)

The process of engagement is all well and good but progress is likely to be constrained if the following is not put into practice:

- Government tends to focus on regulation and control. There needs to be a shift from this position to cooperative governance and management, and supporting local groups to self-organise and self-regulate.
- Public sector employment has been an economic empowerment success story. However, it appears that this economic empowerment evolved rapidly into a culture of self-entitlement and self-enrichment. This needs to change to a culture of service delivery.
- Local groups need to empower themselves and each other. There needs to be a move from a mindset which says we can't to one that says we can if we establish a common identity and common goal around a focal area of interest.
- The rules of the system that govern the game that is being played need to be understood by all parties and made explicit, and everyone needs to play by these rules.
- Information needs to be accessible to and understood by all parties so that decision making becomes more objective and equitable.
- Feedback loops are in place to allow for effective monitoring and management of change in the system.
- Infrastructure provision and public service delivery needs to operate effectively.
- Financial investment is required to 'oil the wheels' of economic empowerment.

6.4 What are the key attributes of resilient estuary based enterprises?

At the risk of duplication and repetition, the research team developed a list of key attributes which might increase or decrease vulnerability in establishing an estuary-based enterprises. It is not exhaustive and it focuses largely on external attributes which affect a business rather than internal detailed attributes of a business itself. However, it is imperative that, when considering an enterprise, all these 'boxes are ticked':

- **A demand for the product or service**. The canoe trail at Mngazana has operated successfully and without external support or subsidy for eight years. A major contributing factor is its proximity to Umngazi River Bungalows. The hotel's average occupancy is over ninety percent and it ensures a steady supply of tourists to the trail business. It should be noted that there is a flip-side here. The canoe trail business is absolutely reliant on Umngazi, so if Umngazi fails the canoe trial fails.
- **Raw material supply.** At estuaries the ecosystem services that supply the "raw materials" of business are often erratic or seasonal. The fly-fishing operation at Mtentu encountered this. The main target species, Giant Kingfish, were only present in the system during summer and, during this time, flooding regularly interfered with fishing. This erratic supply increases enterprise vulnerability unless a greater diversity of activities that are less dependent on the erratic supply can be developed (horse riding, walking trails, cultural experiences, etc.).
- **Appropriate infrastructure and service supply**. In the past, poor road conditions and erratic supply of water and electricity regularly comprised tourist operations at estuaries on the Wild Coast. This has improved considerably and, with this, so has the robustness of these enterprises increased. As a specific example, most of the roads accessing tourist destinations on the Wild Coast are now accessible with a normal car and some have been or are in the process of being tarred.
- **Safety and security**. This applies to both the enterprise directly and to the area generally. The Wild Coast is, generally, a relatively safe place. However, most estuary related enterprises are in the tourism and recreation sector which is highly sensitive to safety and security issues. One incident potentially has a very negative effect.

- **Effective communication**. Enterprise operators need to be able to communicate effectively with their clients and customers, material and service suppliers, business partners, complimentary businesses and a host of other entities. There are two aspects to this; technical and social. At Mkambati the lack of cell-phone coverage and poor land-line coverage often compromises the booking system for accommodation. Where cell-phone coverage occurs it has revolutionized business, and appears to have conferred improved resilience. The social aspect is language and literacy. Where business operators can communicate effectively in a shared language with clients, customers, suppliers and service providers, resilience is increased. However, in rural areas of the Wild Coast the local language is isiXhosa and the language of business is English. This regularly compromises communication and reduces resilience.
- **Supportive policy environment.** Business happens within an institutional context of policies, laws, conventions and common practices. If these are supportive of business they will confer resilience to the business. Conflicting national policies were at the heart of the failed fly-fishing operation at Mtentu. One arm of government was promoting community based tourism in the area and another arm was promoting mining. These two activities were perceived to be mutually exclusive. The result was conflict and both tourism and mining opportunities have been compromised.
- **Sufficient investment and implementation support**. The time, money, expertise and effort required to conceptualise, plan, develop and sustain a business enterprise is usually underestimated. An example is the tourist facility on the Tyolomnqa Estuary. For valid reasons the target market for this facility changed during the development phase. However, this significantly increased the cost of infrastructure. Five years on, the facility is still not operational because the required funding to complete the infrastructure and sustain initial operations has not been forthcoming.

6.5 Some practical suggestions

Based on discussions with staff of the Department of Environmental Affairs and CapeNature, following are some practical suggestions that might be worthy of consideration:

- Chapter 4 of the Integrated Coastal Management Act (Celliers et al. 2009) provides for the establishment of a National Estuary Management Protocol. Key elements of this research might be included in the protocol as well as the planning guidelines that emanate from the protocol.
- The estuaries and economic empowerment 'tool-kit' might be used to organise and focus information collected during the situation assessment phase of the estuary planning and management process.
- Previous research conducted in the context of the Eastern Cape Estuaries Management Programme resulted in an estuaries management education and training course. This course is currently being taught by several service providers in South Africa. It might be useful to develop and include two modules: one on estuaries and ecosystem services and a second (linked to the first) on estuaries and economic empowerment/economic development.
- DWEA (MCM) might consider commissioning further case-studies to apply and refine the estuaries and economic empowerment 'toolkit'. Of particular interest would be the application of the toolkit in other ecosystem/landscape contexts.
- A general observation is that there is insufficient investment in the maintenance of ecosystem services. DWEA (MCM) might consider investigating what public sector

employment opportunities there might be which would result in increased investment and improved maintenance.

- We all agree that the commitment and capacity of local government in certain rural areas is limited. DWAE might consider developing policies that facilitate more direct engagement with civil society groups. (DWAE is doing this anyway but in the absence of any policy guidance. It needs to be regularized and legitimized.)

6.6 The Framework and EIAs

(Note: This is the abstract of the draft paper included as Appendix B)

Social-ecological Systems (SES) are complex and multidimensional, as they comprise geographical, physical, biological, social, economic and cultural aspects. Due to the complex nature of SESs, it is difficult to predict the consequences of land-use and development decisions on the functioning of a system. The degree to which a complex SES is considered when conducting Environmental Impact Assessments (EIAs) varies throughout the world. South Africa is one example where the EIA legislation supports the assessment of six different environmental aspects. However, frequently EIAs in South Africa do not adequately address all six environmental aspects, nor do they consider the linkages between the aspects. The aim of this paper is to develop a comprehensive overarching analytical framework which promotes the consideration of the impacts that a proposed development will have on a complex SES. The analytical framework requires that the boundaries of a SES are first defined, through the identification of the different ecological habitats, and thus ecosystems services, and users thereof being identified. Following this, identification of the public infrastructure, which is made up of the social, cultural and built environments is then performed. The supply and demand of the ecosystem services associated with the public infrastructure are then assessed. This is followed by identification of those bodies that are responsible for providing the public infrastructure. An understanding of the economic environment is then obtained, in order to determine whether the proposed development is economically viable. Following this the framework promotes the consideration of what impacts the proposed development will have on the functioning of each of the six environmental aspects. This framework is intended to be used in those countries and for those developments which require EIAs to consider not only the non-human biophysical environment, but also the other environmental aspects listed above.

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Appendix A

Estuaries and Economic Empowerment: A Working Paper that Informs Policy and Practice in South Africa

April 2010

Final Draft

Compiled for the Department of Water and Environmental Affairs

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Acknowledgements

The authors acknowledge the contributions of the following individuals and institutions to this working paper:

- The Water Research Commission (WRC) for funding and particularly Dr Steve Mitchell for his support
- Ayanda Matoti and Dr Alan Boyd of the Department of Water and Environmental Affairs (DWEA) for requesting that this research project contribute to informing policy and practice around estuary management
- The participants at the Cape Town workshop of 12 March 2010 for their knowledge contributions.

Abstract

The future of southern African countries will be determined by the success that can be achieved with empowering local people, particularly the disadvantaged majority, in the economy. The future of southern African landscapes and associated ecosystems will also be determined by the success that can be achieved with empowering local people in the economy. Estuaries are important features of coastal landscapes and are catalysts of economic activity. However, observations indicate that disadvantaged rural people living at or near estuaries are commonly sidelined in economic development initiatives.

This working paper is a product of a research project being conducted by the University of KwaZulu-Natal and funded by the Water Research Commission. It provides a brief commentary on what is emerging from the research, particular the institutional inadequacies

that are limiting economic empowerment and the undervaluing of ecosystem services that supply economic opportunities. It then lists what ecosystem services exist and the potential economic opportunities arising from these services. It then details a process of analysis and engagement, based on the Anderies et al (2004) framework for analysing the resilience of social ecological systems. Following this it lists some key intervention principles and some key attributes of resilient estuary-based enterprises. It concludes with some practical suggestions aimed primarily at the National Department of Water and Environmental Affairs (DWAE): Marine and Coastal Management division.

1. Introduction

The future of southern African countries will be determined by the success that can be achieved with empowering local people, particularly the disadvantaged majority, in the economy. This imperative is acknowledged in South Africa where business and industry are required through policy and legislation (Broad-Based Black Economic Empowerment Act No. 53 of 2003 and associated policies) to set and meet Black Economic Empowerment (BEE) targets. Even though it may be argued that much has yet to be achieved, organized business and the public sector have responded positively to the challenge. Increasingly ownership and control in macro business are being assumed through BEE initiatives, and public sector employment has been a major catalyst for BEE. Even at smaller scales progress is evident, driven largely by allocation of equity in businesses and through the drive toward employment and gender equity.

The future of southern African landscapes and associated ecosystems will also be determined by the success that can be achieved with empowering local people in the economy. This is because ecosystems are sources of services. These services are the foundations for economic opportunities and with these opportunities come better prospects for individual and community accountability for wise use. Those who have a stake in these economic opportunities are likely to be better disposed to wise use than do those who are excluded.

Estuaries are important coastal landscape features. They are not simply important ecological entities but are also valuable social and economic assets. Coastal economic development commonly concentrates itself at and around estuaries. The scale, type and intensity of this economic development can vary significantly – from Durban harbour on the one hand to a small camp-site or rural village on the other.

The Green Paper on Sustainable Coastal Development in South Africa, the White Paper that followed, the Coastal Bill that followed and, finally, the recently enacted Integrated Coastal Management Act all recognise that:

3) estuaries are important and unique components of the coastal landscape, and
4) the benefits that accrue from estuaries and other coastal land/seascapes need to be shared more equitably by society.

In implementing the Act the State, led by the Department of Water and Environment Affairs, has made provision for the establishment and implementation of management plans at all South Africa's estuaries, and has established guidelines for these processes. Given the under-developed nature of economies in many of South Africa's rural coastal areas, attention is now focused on how estuaries might act as catalysts for economic development and economic empowerment.

In conducting research on and supporting the management of estuaries, primarily in the Eastern Cape, researchers hosted by the University of KwaZulu-Natal became aware that, while estuaries can act as strong catalysts for economic development, they might not be acting as effective catalysts for economic empowerment – it appears that poor, disadvantaged people living at or near estuaries continue to be sidelined in the economic development process. With the support of the Water Research Commission these researchers embarked on a study to, amongst others:

- Determine the state of economic empowerment at estuaries.
- Identify the opportunities for economic empowerment at estuaries.
- Elucidate a process that will support improved access to economic opportunities of poor/disadvantaged individuals living at or near estuaries.

Following is a brief commentary on:

- What is emerging from the research
- What ecosystem services are supplied by estuaries and what potential economic opportunities arise from the supply
- A process of analysis and action that supports economic empowerment at estuaries
- Some intervention principles that might be appropriate
- Some key attributes of resilient estuary-based enterprises
- Some practical suggestions aimed primarily at the National Department of Water and Environmental Affairs

The focus is rural and results are based on a literature review, theoretical research, three field-based case studies and general experience of working with stakeholders at estuaries, primarily on the Eastern Cape Coast over the past ten years.

2. What is emerging?

Economic empowerment based on estuary services is generally underappreciated and underdeveloped. The primary reasons for this are as follows (in no particular order of importance):

- Estuaries are bio-physically highly dynamic environments and the supply of ecosystem services which form the foundation of nature based enterprises can seem to be erratic.
- There is a general lack of understanding and appreciation of the economic opportunities that estuaries offer.
- Many of the services provided by estuaries (such as processing waste; providing bait and fish for example) are taken for granted and consequently the benefits we derive are undervalued. The consequence is that we do not invest enough in sustaining ecosystem processes.
- Because we do not pay for many of the benefits we derive from estuaries, we do not generate the revenue that is required to sustain management.
- Many disadvantaged people living at or near estuaries are poorly educated and lack the necessary skills to initiate and operate businesses or secure jobs that utilise the ecosystem services offered by estuaries.
- Local people frequently lack the investment capital to secure equity in existing or start-up businesses.
- Many economic opportunities that have been taken up have been done so by advantaged groups or individuals, reducing opportunities for others.

- At an estuary economic opportunities are commonly in the tourism sector. This sector is particularly complex. It requires considerable human and financial capital for infrastructure, sophisticated and expensive marketing, and markets are often unpredictable or seasonal.
- Estuaries are common property resources with poorly defined property rights. This complicates the allocation of opportunities and the benefits that arise from these opportunities. Securing tenure, a vital necessity for most economic developments to succeed, requires a level of sophistication that is currently in short supply in rural areas.
- Developing a public or private business that creates jobs and renders a return in the coastal zone is administratively and bureaucratically complex in communal areas, and where one has to interact with several government departments. This raises transaction costs to unaffordable levels for many rural people.
- Local municipal staff are poorly skilled and lack business insights. They are, for the most part, unable to assist those who wish to engage in an economic activity. Also, there appears to be little incentive for local officials to get involved in activities that support BEE.
- Corruption regularly results in either no or the sub-optimal economic development option being supported.

However, despite these difficulties, it is clear that estuaries are high value assets that supply ecosystem services from which valuable benefits accrue to local residents. There are several examples of economic empowerment in progress:

- Where there is an established business such as a resort hotel direct and indirect opportunities result. The direct opportunities would be jobs in hospitality, maintenance, administration, security and management. Indirect opportunities include guiding, trail operating, cultural activities, bait collection, life-saving and security.
- In the public sector campaigns such as Working for the Coast provide job opportunities, income and skills development for local residents.
- Permanent employment in state agencies tasked with managing and conserving estuaries is a source of economic empowerment. (Arguably, one of the greatest sources of economic empowerment in the Eastern Cape was and is public sector employment.)

If estuary-based economic empowerment is going to work it requires a systematic process of analysis and engagement involving all pertinent stakeholders in these complex situations. In this process:

- A good understanding of what opportunities exist, of what mixes of opportunities are appropriate in different contexts, and the trade-offs between different opportunities need to be developed by all parties.
- Spatial and temporal complexity needs to be recognised and built in as a key part of the process.
- Transparency, honesty, trust, positive relationships, and a common goal or identity are key success factors.
- Skills levels amongst potential beneficiaries to engage the opportunities need to be built as do the skills levels of those private, state, research and NGO sector agencies supporting this engagement.

3. The opportunities for economic empowerment at estuaries

Many large coastal cities are built on estuaries. As examples London, New York, Sydney, Durban and Buffalo City were all established on estuaries because the estuaries were regarded as high value assets (facilitating trade, providing food, providing protection, providing recreation). They are high value because of the variety of natural habitats they contain or are associated with. A typical estuary will contain or be associated with a river, a beach, the ocean, reed-beds, mud flats, sandy banks, open water, mangroves, and the associated dryland – such as grasslands and forests. Importantly, all these habitats offer different people different economic opportunities.

Estuaries are commonly highly productive ecosystems The meeting of the sea, river and land also generates land formation processes that create suitable spaces ideal for a combination of settlement and transport (land, river or sea). As a result of the ecological fertility, suitable settlement spaces and easy transport and access, estuaries have been and still are a focus of human settlement and economic development. Clearly estuaries offer economic development opportunities. So the question then remains – how can the empowerment of poor people be promoted in and around estuaries?

So what are the opportunities at estuaries that will generate an income, and benefit those who were or are currently disadvantaged? In order to understand what benefits might accrue and what economic opportunities exist we need to understand what ecosystem services an estuary supplies and how these ecosystem services might form the basis of economic empowerment opportunities. The following table outlines the services and associated opportunities.

Estuary ecosystem services	**Economic empowerment – opportunities and economic activities**
Plant production	Plant fibres for trade, craft manufacture and décor manufacture – jobs, business incubators, enterprises, manufacturing, retail
Food supply services – fish, crustaceans, molluscs	Food products – wild stocks harvesting or mariculture for trading – jobs, business incubators, enterprises, mariculture, retail
Soil stability services	Bank stabilization using natural plant populations or bio-engineering for protecting infrastructure and property – jobs, enterprises, cultivation, protection, monitoring
Waste assimilation and dilution, and disease control services	Water quality and health maintenance – solid waste collection, increased freshwater base-flows through watershed management – jobs, enterprises, recycling
Pest control services	Alien plant pests management – alien plant removal, biogas production – jobs, enterprise incubators, processing
Storm damage control services	Wave damage protection using natural plant populations or bio-engineering for protecting infrastructure and property – jobs, enterprises, cultivation, protection, monitoring
Natural and cultural heritage conservation services	Management of estuary habitats – jobs, enterprises, cultivation, protection, monitoring
Fish and crustacea nursery services	Securing nursery services for commercial fishing and angling industry – jobs, enterprises, protection, monitoring

Estuary ecosystem services	Economic empowerment – opportunities and economic activities
Angling recreation services	Servicing recreation angling – guiding, transport, security – jobs, enterprise incubators
Birding recreation services	Servicing recreation birding – guiding, transport, security – jobs, enterprise incubators
Canoeing / boating recreation services	Servicing recreation canoeing and boating – guiding, transport, security – jobs, enterprise incubators
Bait supply services	Servicing recreation angling – bait supply – jobs, enterprise incubators
Flood attenuation services	Maintaining undeveloped floodplains – jobs, alien plant control
Education services	Servicing environmental education activities – guiding, teaching, research support, monitoring, mentoring, security – jobs, enterprises
Hospitality services	Servicing tourist accommodation needs – catering, accommodation (construction, maintenance, servicing), transport, security – jobs, enterprises,
Residential services	Servicing residential accommodation needs – accommodation (construction, maintenance, servicing), transport, security – jobs, enterprises,

4. A process of analysis and engagement

The project's tools (an analysis and engagement process) have been developed and tested. They are based on the Anderies et al (2004) framework for analysing resilience in social-ecological systems (see Figure 1). The process disaggregates social-ecological systems into resources, resource users, public infrastructure (physical and social) and public infrastructure providers. Following that there is an analysis of the relationship between these components and also the impact of various external shocks or forces on these components. Using an adapted form of the framework and a process of structured engagement with stakeholders one can achieve a working understanding of:

- What ecosystem services an estuary and its surrounding landscape can provide and a way of rating or scaling the services so that one could consider realistic prospects for an enterprise
- The economic opportunities that arise from the utilization of these ecosystem services
- The mix of opportunities that might be appropriate for a particular system, and
- The risks inherent in developing any particular economic opportunity.

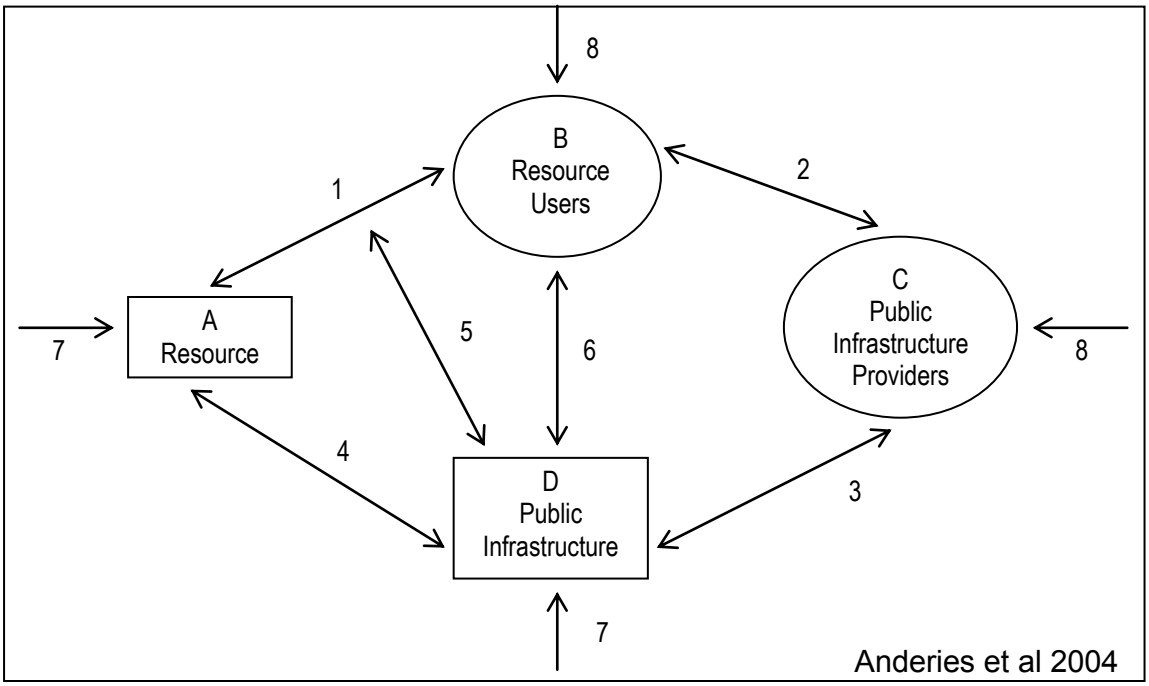

Figure 1: A conceptual framework of a social-ecological system (from Anderies et al 2004)

Importantly:

- The absence of the main players (local government, traditional authorities, local business interests, influential NGOs and CBOs, etc.) is prejudicial to both the process and the outcomes.
- This is not a recipe based approach. It can and should be adapted for specific circumstances and contexts.
- The engagement is a joint learning process that results in better-informed choices.
- It is a vehicle for building a common goal and common identity based on the estuary, and is a catalyst for building relationships and trust.
- It should form an integral part of the estuary management and planning process, particularly where the estuary is located in an economically under-developed area.
- The risk analysis component is a useful tool for assessing the appropriateness of development applications that are being proposed (the process can be both pro-active and responsive).
- Practitioners and/or researchers leading these processes need to be well versed in estuaries management, resource economics and public sector engagement.

We need to emphasize that all enterprises based on ecosystem services are exposed to risk emanating from the inherent variability of ecosystems, from the variability of the social-economic context and from incompetent management.

5. Intervention principles (based on Meadows, 1997)

The process outlined above is all well and good but progress is likely to be constrained if the following is not put into practice:

- Government tends to focus on regulation and control. There needs to be a shift from this position to cooperative governance and management, and supporting local groups to self-organise and self-regulate.
- Public sector employment has been an economic empowerment success story. However, it appears that this economic empowerment evolved rapidly into a culture of self-entitlement and self-enrichment. This needs to change to a culture of service delivery.
- Local groups need to empower themselves and each other. There needs to be a move from a mindset which says we can't to one that says we can if we establish a common identity and common goal around a focal area of interest.
- The rules of the system that govern the game that is being played need to be understood by all parties and made explicit, and everyone needs to play by these rules.
- Information needs to be accessible to and understood by all parties so that decision making becomes more objective and equitable.
- Feedback loops are in place to allow for effective monitoring and management of change in the system.
- Infrastructure provision and public service delivery needs to operate effectively.
- Financial investment is required to 'oil the wheels' of economic empowerment.

6. Key attributes of resilient estuary based enterprises

At the risk of duplication and repetition following is a list of key attributes which confer or compromise resilience to estuary-based enterprises. It is not exhaustive and it focuses largely on external attributes which affect a business rather than internal detailed attributes of a business itself:

- **A demand for the product or service**. The canoe trail at Mngazana has operated successfully and without external support or subsidy for eight years. A major contributing factor is its proximity to Umngazi River Bungalows. The hotel's average occupancy is over ninety percent and it ensures a steady supply of tourists to the trail business. It should be noted that there is a flip-side here. The canoe trail business is absolutely reliant on Umngazi so if Umngazi fails the canoe trial fails.
- **Raw material supply.** At estuaries the ecosystem services that supply the "raw materials" of business are often erratic or seasonal. The fly-fishing operation at Mtentu encountered this. The main target species, Giant Kingfish, were only present in the system during summer and, during this time, flooding regularly interfered with fishing. This erratic supply reduces enterprise resilience unless a greater diversity of activities that are less dependent on the erratic supply can be developed (horse riding, walking trails, cultural experiences, etc.).
- **Appropriate infrastructure and service supply**. In the past poor road conditions and erratic supply of water and electricity regularly comprised tourist operations at estuaries on the Wild Coast. This has improved considerably and, with this, so has the resilience of these enterprises increased. Infrastructure includes policies and herein lies one of the problems. Local scale policies are not enterprise/entrepreneur friendly.
- **Safety and security**. This applies to both the enterprise directly and to the area generally. The Wild Coast is, generally, a very safe place. However, most estuary related enterprises are in the tourism and recreation sector which is highly sensitive to safety and security issues. One incident has a very negative effect.
- **Effective communication**. Enterprise operators need to be able to communicate effectively with their clients and customers, material and service suppliers, business

partners, complimentary businesses and a host of other entities. There are two aspects to this; technical and social. At Mkambati the lack of cell-phone coverage and poor land-line coverage often compromises the booking system for accommodation. Where cell-phone coverage occurs it has revolutionized business and appears to have conferred improved resilience. The social aspect relates to language and literacy. Where business operators can communicate effectively in a shared language with clients, customers, suppliers and service providers, resilience is increased. However, in rural areas of the Wild Coast the local language is isiXhosa and the language of business is English. This regularly compromises communication and reduces resilience.

- **Supportive policy environment.** Business happens within an institutional context of policies, laws, conventions and common practices. If these are supportive of business they will confer resilience to the business. Conflicting national policies were at the heart of the failed fly-fishing operation at Mtentu. One arm of government was promoting community based tourism in the area and another arm was promoting mining. These two activities were perceived to be mutually exclusive. The result was conflict and both tourism and mining opportunities have been compromised.
- **Sufficient investment and implementation support**. The time, money, expertise and effort required to conceptualise, plan, develop and sustain a business enterprise is usually underestimated. An example is the tourist facility on the Tyolomnqa Estuary. For valid reasons the target market for this facility changed during the development phase. However, this significantly increased the cost of infrastructure. Five years on the facility is still not operational because the required funding to complete the infrastructure and sustain initial operations has not been forthcoming.

7. Moving forward – some practical suggestions

Following are some practical suggestions that might be worthy of consideration:

- Chapter 4 of the Integrated Coastal Management Act provides for the establishment of a National Estuary Management Protocol. Key elements of this research might be included in the protocol as well as the planning guidelines that emanate from the protocol.
- The estuaries and economic empowerment 'tool-kit' might be used to organise and focus information collected during the situation assessment phase of the estuary planning and management process.
- Previous research conducted in the context of the Eastern Cape Estuaries Management Programme resulted in an estuaries management education and training course. This course is currently being taught by several service providers in South Africa. It might be useful to develop and include two modules: one on estuaries and ecosystem services and a second (linked to the first) on estuaries and economic empowerment/economic development.
- DWEA (MCM) might consider commissioning further case-studies to apply and refine the estuaries and economic empowerment 'toolkit'. Of particular interest would be the application of the toolkit in other ecosystem/landscape contexts.
- A general observation is that there is insufficient investment in the maintenance of ecosystem services. DWEA (MCM) might consider investigating what public sector employment opportunities there might be which would result in increased investment and improved maintenance.
- We all agree that the commitment and capacity of local government in certain rural areas is limited. DWAE might consider developing policies that facilitate more direct

engagement with civil society groups. (DWAE is doing this anyway but in the absence of any policy guidance. It needs to be regularized and legitimized.)

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Appendix B

Towards an analytical framework for understanding complex social ecological systems when conducting Environmental Impact Assessments in South Africa

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Rebecca Bowd
In 2001 Rebecca obtained a B.A. (Hons) in Geography and Environmental Science from University College Chichester, UK. The focus of this degree was on rural livelihoods and developing world issues. Following a year spent working with communities in West Africa and a year spent travelling the world, Rebecca obtained a Masters degree in Environmental Management (MEnvDev) from the University of KwaZulu-Natal, South Africa. Rebecca is a member of the International Association for Impact Assessment (IAIA) and is registered as an Environmental Assessment Practitioner with the interim board of Environmental Assessment Practitioners of South Africa (EAPSA). Since 2004, Rebecca has practiced as an Environmental Assessment Practitioner, both locally and internationally, in the following sectors: industrial, agriculture, residential, and service infrastructure (e.g. sewage treatment plants, bridges, roads). Rebecca owns and manages an environmental consultancy which is based in Pietermaritzburg, KwaZulu-Natal, and is currently studying towards her PhD with the Centre for Environment and Development at the University of KwaZulu-Natal.

Donovan Kotze
The focus of Donovan's training and professional work over the last 18years has been on wetland ecology and the sustainable use of wetland systems. He has gained considerable experience in working in a great variety of wetlands under many different land-uses, from communal traditional use to intensively used private land. He is especially interested in wetlands within an agricultural context, and has worked working extensively on the assessment of wetland ecosystem services and integrity for a variety of purposes, including rehabilitation and management planning and impact assessment for proposed developments. He collaborates with many different government and non-government organizations involved with wetland projects and research.

Duncan Hay
Duncan is an independent consultant and formerly a senior lecturer at the University of KwaZulu-Natal. He has an MSc in Zoology from the University of Natal and a post-graduate diploma in Environmental Security from the University of Cambridge. For twenty years he has engaged in and led research, educational and application-based projects and programmes in the fields of natural resource management and rural development. Three of these programmes and projects have garnered national and international awards. In the specific context of this paper he leads the Eastern Cape Estuaries Management Programme. He has taught post-graduate courses in biodiversity conservation and integrated catchment management, supervise post-graduate students and examine theses. In addition, Duncan serves on several reference group committees of the Water Research Commission. Duncan recently authored and coordinated the publication of two handbooks related rural craft business development.

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Nevil Quinn holds a BSc(Hons) in Hydrology (University of Natal, 1987), a PhD in the management of freshwater flow to estuaries (1998) and a LLM (Environmental Law) (2008). He worked for the Institute of Natural Resources for several years before joining UKZN to lead the Masters of Environment and Development programme. Since 2004 he has developed new degree programmes in river and coastal engineering at the University of the West of England, Bristol, and is also an Associate Head of the

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Myles Mander
Myles obtained a Conservation Diploma at Pretoria Technikon in 1982 and thereafter became a game ranger for the Natal Parks Board between 1981-1990. In 1990 he went to Natal University where he studied for a Social Science Honours degree, in Economics and Geography. After graduating in 1993 he started a resource economics consultancy. In 2004 he developed another business, Futureworks with several partners, which has successfully consulted in the environment management and urban planning sectors since then. Myles focuses on ecosystem services – identification, measurement, valuation, management and trading.

Towards an analytical framework for understanding complex social ecological systems when conducting Environmental Impact Assessments in South Africa

Abstract

Social-ecological Systems (SES) are complex and multidimensional, as they comprise geographical, physical, biological, social, economic and cultural aspects. Due to the complex nature of SESs, it is difficult to predict the consequences of land-use and development decisions on the functioning of a system. The degree to which a complex SES is considered when conducting Environmental Impact Assessments (EIAs) varies throughout the world. South Africa is one example where the EIA legislation supports the assessment of six different environmental aspects. However, frequently EIAs in South Africa do not adequately address all six environmental aspects, nor do they consider the linkages between the aspects. The aim of this paper is to develop a comprehensive overarching analytical framework which promotes the consideration of the impacts that a proposed development will have on a complex SES. The analytical framework requires that the boundaries of a SES are first defined, through the identification of the different ecological habitats, and thus ecosystems services, and users thereof being identified. Following this, identification of the public infrastructure, which is made up of the social, cultural and built environments is then performed. The supply and demand of the ecosystem services associated with the public infrastructure are then assessed. This is followed by identification of those bodies that are responsible for providing the public infrastructure. An understanding of the economic environment is then obtained, in order to determine whether the proposed development is economically viable. Following this the framework promotes the consideration of what impacts the proposed development will have on the functioning of each of the six environmental aspects. This framework is intended to be used in those countries and for those developments which require EIAs to consider not only the non-human biophysical environment, but also the other environmental aspects listed above.

Keywords: Environmental Impact Assessment (EIAs), Framework, Sustainability, Social-ecological Systems, South Africa

1. Introduction

Consideration of the interrelationships between the social, economic and biophysical aspects of a project has been recognised as a key principle of EIA for over a decade (IAIA 1999); indeed early principles for the design and development of effective EIA processes (Fuller 1999: 57) acknowledged that the scope of such processes should extend to 'all aspects of a proposal, including cumulative effects, interrelated socio-economic, cultural and health factors and sustainability implications'. Similarly, the International Principles for Social Impact Assessment (SIA) (Vanclay 2003: 6) consider that good practice in SIA 'accepts that social economic and biophysical impacts are inherently and inextricably interconnected'. While the rationale for this is unequivocal, the means to achieve this is much less clear. Social-ecological Systems (SESs) can be viewed as a nested hierarchy of geographical, physical, biological, social, economic and cultural subsystems that interact interdependently, and at different temporal and spatial scales, and wherein some of the interdependent relationships with humans are mediated through interactions with ecological units (Walker et al. 2002; Anderies et al 2004). They are, therefore, complex and multidimensional. If the interrelationships between the social, economic and biophysical aspects of a project are to be fully considered in an EIA project, then it is clear that a framework to describe and analyse

SESs is required. This paper aims to identify such an analytical framework and implement it in a case study of Mngazana estuary in the Eastern Cape of South Africa.

2. Consideration of SESs in environmental assessments

Given the patchwork evolution of EIA processes globally, it is not unsurprising that there is significant variation in the extent to which SESs are explicitly acknowledged and assessed. In the USA for example, the scope of impacts covered by NEPA is relatively broad (e.g. changes in land-use patterns, conflicts with land-use plans, policies or controls, impacts on historical and cultural quality and socio-economic and environmental justice effects). In contrast, biophysical (including architectural and archaeological) impacts are emphasised in the European Directive but social and economic impacts are not specifically included (Wood 2003a). Globally, different environmental policy drivers and EIA practice has lead to confusion in terminology and a lack of clarity on the extent to which SESs are effectively considered within the context of an EIA. However, Hacking and Guthrie (2008) present a framework that helps resolve some of these semantic issues but also provides a trajectory from moving from traditional biophysical EIA to a more comprehensive, integrated and strategic 'sustainability analysis'. Clearly the latter would also require understanding and analysis of SESs. In this study, the Hacking and Guthrie framework has been adapted to illustrate the difference between present and desired EIA practice in South Africa (Figure 1).

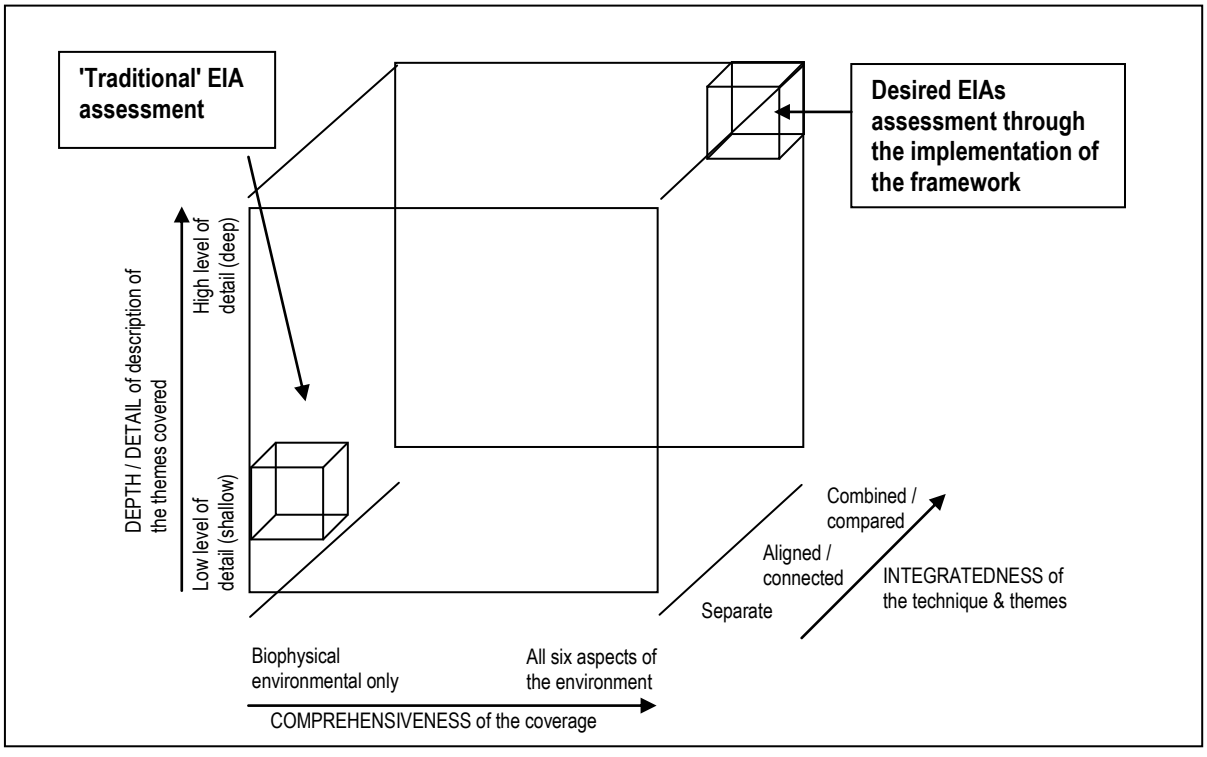


Figure 1: How the implementation of the analytical framework will result in improved comprehensiveness, integratedness and detail / depth of Environmental Impact Assessments in South Africa (adapted from Hacking and Guthrie (2008)

3. EIA policy and practice in South Africa – bridging the SES hiatus

Wood (2003a) commends, in principle at least, the approach of South Africa where the National Environmental Management Act 1998 (NEMA) requires that and EIA must include assessment of the six different environments (geographical, physical, biological, social, economic and cultural). Somewhat uniquely for environmental legislation, NEMA includes a set of environmental principles explicitly requiring that 'the social, economic and environmental impact of activities must be considered, assessed and evaluated and decisions must be appropriate in the light of such consideration and assessment'. The complex nature of these systems is also recognised, 'environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into effects of decisions on all aspects of the environment and all people in the environment'. On the face of it therefore, there is an explicit requirement for the EIA process in South Africa to embrace the complexities of SESs and there is the expectation that EIA practice would be located in the top right corner of the Hacking and Guthrie (2008) framework.

In reality however, there is a significant hiatus between policy and practice as EIAs in South Africa frequently do not fully consider all these environmental aspects (Hacking and Guthrie 2008; Sandhan and Pretorius 2008; Kidd and Retief 2009). Nor do EIAs generally take into consideration the linkages between the different environmental aspects. An example of a linkage could be how the social environment (e.g. crafters who use wetland resources to make goods to sell) will be impacted upon by changes to the ecological environment (e.g. a loss of crafting material) as a consequence of a proposed development (e.g. the damming of a wetland area to create a dam to irrigate new pastures).

There are several reasons for this. Firstly, in South Africa, EIAs are conducted by Environmental Assessment Practitioners (EAPs), many of whom enter EIA practice with a natural sciences academic background (Pers. Obs. Bowd). This has lead to ecologically focused EIAs, which consider biophysical aspects in isolation, without taking into account social or economic impacts, or the linkages between the different aspects. When social or economic impacts are included in these assessments, they are often appended to the report, and are not incorporated into the actual impact assessment (Burdge 2003; Barbour 2007).

Secondly, at present there is no legislated certification board for the EAP profession in South Africa (Ebisemiju 1993; Brownlie and Wynberg 2001; Mosakong Management 2008). With no set of standards for EAPs to subscribe to, the content of EIAs not being monitored by a professional independent body, and a lack of capacity at government level to assess EIAs (Kakonge and Imevbore 1993; Wood 2003a; Mosakong Management 2008), it is not unexpected that deficient assessments are being conducted.

A third factor is also significant. Since the establishment of a democratic government in 1994, international investment into South Africa has significantly increased (DEAT 1999; Bureau of African Affairs 2011). Due to the pressure for development to take place (Dowling et. al. 2010) and developments being shaped more by their funder's interests than by the needs and priorities of the recipients (Horberry 1985), development projects are not always successful and frequently fail (Riddell 2007). There are many examples in South Africa (and in other developing countries) where community facilities have been constructed (e.g. community halls, ecotourism markets) but stand unused due to their unsuitable location or

function as a result of inadequate assessment before commissioning. Development failures are symptomatic of a failure in understanding complex SESs.

Most significantly, however, is the lack of a framework in which complex SESs can be understood and analysed. Without such a framework, it is, for example, difficult to predict the consequence of land use change on the functioning of the system and sometimes even more difficult to communicate these impacts to affected communities. Clearly a framework which helps map out interrelationships and interdependencies in SESs, whilst also providing a means of assessing and communicating impacts would be of significant value in helping improve IEM practice in South Africa. Such a framework should:

- promote consideration of all six aspects of the environment, and how they interlink with one another;
- assist EAPs with conducting comprehensive EIAs (when necessary);
- assist Government Environmental Officers to evaluate if an EIA has thoroughly considered all environmental aspects and their linkages; and
- be applicable to all types of development (e.g. from oil refineries to road upgrades).

The analytical framework should be able to be used by:

- practicing EAPs who have a reasonable knowledge of all six environmental aspects;
- Government Environmental Officers who have varying skills and experience with reviewing EIAs;
- Investors, Funding Agencies and Developers who assess the thoroughness of an EIA before further time and monies are invested.

Other users of the framework might include:

- Local Municipalities to help determine whether a proposed development should be supported by the Municipality, or not;
- Those seeking the support of Investors or Funding Agencies to help demonstrate the viability of a project and thus promoting confidence when appealing for financial support;
- Local communities which, in its simplest form, may be able to use the framework to play a more active role in the Public Participation phase of an EIA.

4. Identifying an analytical framework for SESs

Review of the literature reveals a number of 'EIA tools' that have been developed, ranging from matrices, weighting-scaling and checklists (Canter, 1996), multicriteria / multiattribute decision analysis (MCDA / MADA) (McDaniels, 1996; Rogers and Bruen, 1998; Salminen et al. 1998; Pun et al. 2003), input–output analysis (Lenzen et al. 2003), life cycle assessment (LCA) (Tukker, 2000), Rapid Impact Assessment Matrix (RIAM) (Pastakia and Jensen, 1998), and to the evidential reasoning (ER) approach (Wang et al. 2006). Although these tools assist with analyzing the data collected for an EIA, they do not individually or collectively constitute a holistic framework for analysing complex SESs. However two relatively recent approaches from the SES and complex systems literature appear to address EIA needs more directly:

1. Ostrom (2007) – Framework for identifying the social-ecological variables that affect the resilience of a SES; and
2. Anderies et al. (2004) – Framework for the studying the robustness of SESs, and recommendations for the governance of robust SESs.

Both Ostrom (2007) and the Anderies et al. (2004) frameworks separate a SES into four main components. The Ostrom (2007) framework allows analyses of how the attributes of (i) a resource system; (ii) the resource units generated by that system (iii) the users of that system, and (iv) the governance system, affect interactions (both directly and indirectly) within an SES. This framework also allows identification of how these attributes can affect, and be affected, by both small and large scale socio-economic, political and ecological impacts.

The Anderies et al. (2004) framework provides a simple structured mechanism for disaggregating the components of a SES and promotes the identification of the relationships between the different components. The Anderies et al. (2004) framework separates a SES into the following four components (i) the resource; (ii) the resource users; (iii) public infrastructure and (iv) public infrastructure providers and is presented in Figure 2. The Anderies et al. (2004) framework in Figure 2 has been adapted to include EIA relevant examples of the four different framework components. "Resource users" and "public infrastructure providers" are both human and can be the same individuals. This is entirely dependent on the social systems governing and managing the SES. "Public infrastructure" features two forms of human capital – built physical (engineered works, e.g. irrigation canals) and social (Costanza et al. 2001). Social capital refers to social networks and rules used by those governing, managing, and using the system, as well as those factors that affect monitoring and enforcement of those rules (Ostrom and Ahn 2003).

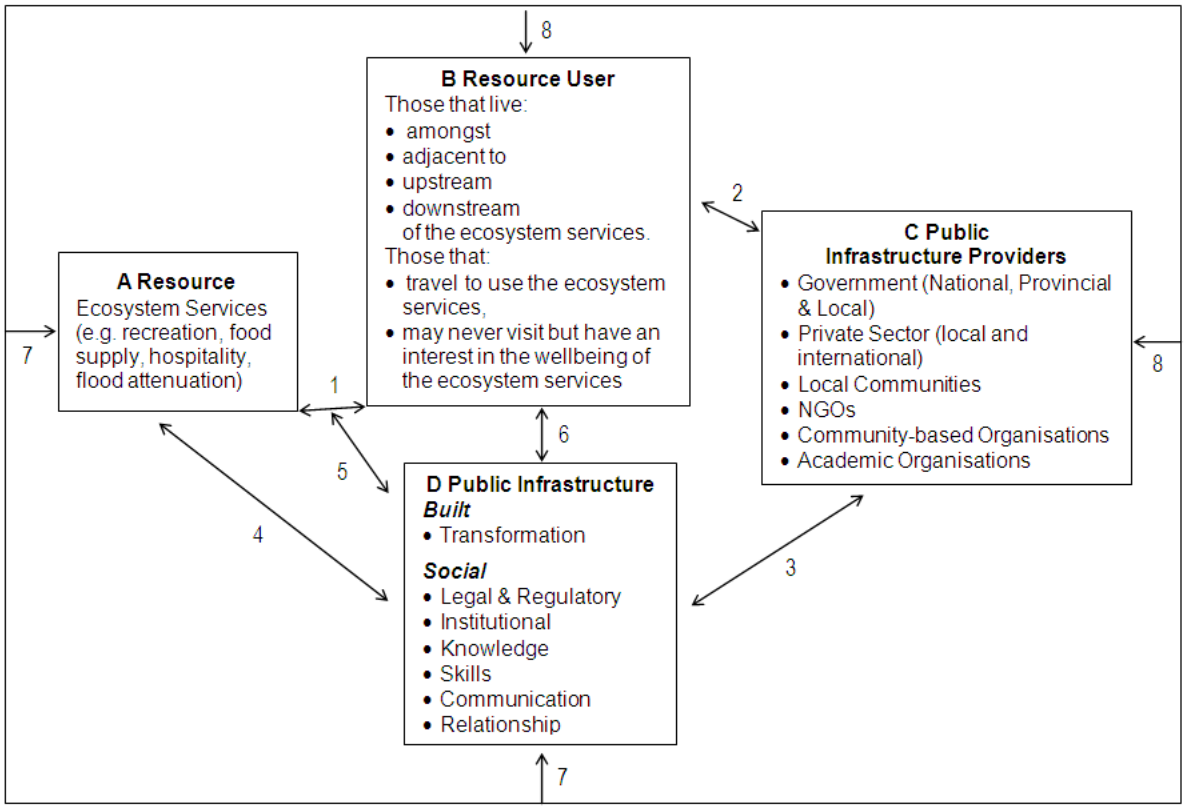


Figure 2: Adaptation of the Anderies et al. (2004) framework showing examples of how it relates to an estuarine system

Anderies' et al. (2004) framework considers two types of disturbance, external and internal. External disturbances can be physical in nature and thus directly affect the resource and the public infrastructure (represented by Arrow 7). These might include floods or new roads. External disturbances can also be social or economic in nature and thus directly affect the

resource users and the public infrastructure providers. Examples of these include population increases, economic changes, and political changes (Arrow 8). Internal disturbances refer to the reorganization of the ecological or social system caused by the subsystems of the ecological or social system (Arrows 1 to 6).

Within their study Anderies et al. (2004) develop a list of all possible entities which make-up their SES, providing examples and potential problems associated between and within each entity (Table 1). Anderies et al. (2004) also provide the links between the different entities within an SES, together with examples and potential problems thereof (Table 2).

Table 1: Entities involved in Social-ecological Systems together with examples and potential problems as identified by Anderies et al. (2004)

Entities	**Examples**	**Potential problems**
A Resource	Water source	Uncertainty
	Fishery	Complexity / Uncertainty
B Resource Users	Farmers using irrigation	Stealing water, getting a free ride on maintenance
	Fishers harvesting from inshore fishery	Over harvesting
C Public infrastructure providers	Executive and council of local users' association	Internal conflict or indecision about which polices to adopt
	Government bureau	Information loss
D Public infrastructure	Engineering works	Wear out over time
Institutional rules	Memory loss over time, deliberate cheating	-
External Environmental	Weather, economy, political system	Sudden changes as well as slow changes that are not noticed

Table 2: Links between the different entities within an SES, together with examples and potential problems as identified by Anderies at al. (2004)

Link	**Examples**	**Potential Problems**
(1) Between resource and resource users	Availability of water at time of need / availability of fish	Too much or too little water / too many uneconomic fishing
(2) Between users and public infrastructure providers	Voting for providers Contributing resources Recommending policies Monitoring performance of providers	Indeterminacy / lack of participation Free riding Rent seeking Lack of information / free riding
(3) Between public infrastructure providers and public infrastructure	Building initial physical structure Regular maintenance	Overcapitalization or undercapitalization Disrupting, temporal and spatial patterns of resource use
	Monitoring and enforcing rules	Cost / corruption
(4) Between public infrastructure and resource	Impact of infrastructure on the resource level	Ineffective
(5) Between public infrastructure and resource dynamics	Impact of infrastructure on the feedback structure of resource-harvest dynamics	Ineffective, unintended consequences
(6) Between resource users and public infrastructure	Co production of infrastructure itself, maintenance of works, monitoring and sanctioning	No incentives / free riding
(7) External forces on resource and infrastructure	Severe weather, earthquake, landslide, new roads	Destroys resource and infrastructure

Link	Examples	Potential Problems
(8) External forces on social actors	Major changes in political system, migration, commodity prices, and regulation	Conflict, uncertainty, migration, greatly increased demand

Anderies et al. (2004) note the difficulties in defining the appropriate scale of analysis. For example, a small-scale resource might collapse in order to maintain a desired function of a larger scale resource (e.g. the loss of a small area of grassland to make way for a lodge, whose revenue will help obtain funds for the maintenance (i.e. alien vegetation removal) of a newly proclaimed nature reserve).

Both frameworks investigated require that the resource is defined and the resource users are identified. Of the two approaches examined, that of Anderies et al. (2004) proved to be the most applicable for understanding the complexity of SESs, and thus was considered to be the most appropriate system on which to base the extended analytical framework used in this case study.

The four components identified by Anderies et al. (2004) and the Ostrom (2007) frameworks have been incorporated into the framework. This incorporation ensures that the SES is holistically considered when using the framework. The six different environmental aspects listed in the South African EIA Regulations have been assigned to one of the four different components, in order for the user to understand how the different aspects and components relate to one another. The 'resource' considers the geographical, biological and natural physical environment, the 'resource users' and the 'public infrastructure providers' consider the social and economic environments, and the 'public infrastructure' considers the built physical and cultural environments. Unlike the Anderies et al. (2004) and the Ostrom (2007) approaches, the extended framework organises the four components, and six environmental aspects, into a process flow. The extended Anderies et al. (2004) framework thus introduces the consideration of supply and demand of the identified ecosystem services, and adapts it as an EIA tool by providing a systematic method for implementing the framework.

4.1. Application of the Framework to Understand an SES when Conducting an EIA

In order to illustrate the application of the framework, an estuarine case study has been used. Estuaries are useful when understanding SESs, as they provide multiple services to a wide range of stakeholders, and are also subject to a variety of different environmental impacts (McLusky and Elliot 2004). The case study site is located at Mngazana, an estuary which is located in the Eastern Cape, South Africa. The local Cwebeni Community, which is located adjacent to a well established hotel, wished to establish and manage its own community-based accommodation facility. The hotel regularly uses bird, fishing and canoe guides from the Cwebeni community to accommodate their guests. The hotel is in support of the community-based accommodation, as they are of the opinion that staying a night with the community would enrich their guests experience and would encourage guests to return.

The Resource

The resource is defined through the identification of the system's boundaries. Boundaries can be defined by the identification of ecological systems from which the social system (stakeholders) benefits (Anderies et al. 2004). Boundary identification is conducted by:

1. Identification of the different habitats contained within the ecological system; and
2. Identification of the different ecosystem services supplied by the different habitats contained within the ecological system.

The identification of the boundaries of a SES requires the consideration of the 'resource' (the geographical, biological and natural physical environment) and the 'resource users' (the social and economic environment).

In the case of an estuary, ecological habitats can include mangroves, reedbeds, salt marshes and water surface. In addition, an estuary basin (the area of the landscape which drains directly into the estuary) can feature grasslands, forests, and streams. Adjacent coastal habitats (e.g. beaches) can also be viewed as an integral part of an estuary's ecological system. Possible estuary linked ecosystem services supplied by the different habitats include food provision, hospitality, recreation and flood attenuation. In order to enable these services to be derived from the habitats of the ecological system, transformations need to have occurred. These transformations can include bridges, roads, buildings, harvesting nets and ploughed fields.

Resource Users

Resource users' can originate from a wide range of locations, and can influence and / or are influenced by the ecosystem services supplied by the system. There are six main categories of 'resource user' (Figure 2). Due to the emphasis on public participation in the South African EIA legislation (Government Gazette 33306, GNR 543) it is essential that all stakeholders which could be affected by a development are identified and considered. Estuarine related 'resource users' can include local residents, tourists, neighbouring communities, farmers, fishermen and conservation NGOs.

Public Infrastructure

Public infrastructure enables a 'resources user' to use a 'resource', and consists of all social and economic capital associated with a SES. Public infrastructure can come in a variety of different forms. For this study Public infrastructure has been divided into seven different infrastructures (refer to Figure 2 and Table 3). The transformations identified in the 'resource' (above) must be included in this section.

Table 3: The seven different types of public infrastructure with examples from an estuarine case study

Type of public Infrastructure	**Description of each type of public infrastructure**	**Examples of estuarine related public infrastructure**
Transformation infrastructure	All man-made alterations made to a landscape	Roads, bridges and causeways provide access for the resource users to utilize the estuary.
Legal and regulatory infrastructure	Laws in the form of Acts, regulations, policy documents, customary regulations	Within the Community anyone wishing to acquire land must convey this request through a hierarchical social structure which involves indunas (headmen), elders and an inkhosi (chief).
Institutional infrastructure	Private / business structures	The Community intends to provide hotel guests with the opportunity of a night's accommodation in a traditional environment.
	Social structures	The Community has strong traditional ties which will help in creating a traditional experience for the guests.
	Government / Political structures	The Department of Transport is responsible for the provision and maintenance of the access roads.
Knowledge infrastructure	Indigenous / cultural knowledge	The guides employed by the hotel have local understanding of the fish and bird populations, as well as knowledge of the river for canoeing. If the guests have a rewarding experience with the guides, they will be more inclined to experience the community accommodation.
	Scientific / technical knowledge	At the hotel there was concern that the sewage treatment plant was not functioning properly. Specialist scientific knowledge was required in order to collect and process water quality samples, and to understand the functioning of the plant. Odour from this works could discourage guests from staying at the hotel, and thus reduce demand for the community accommodation.
Skills infrastructure	The skills of those involved in each type of infrastructure	The professionalism of the community guides will impact on the experience of the guests. If the guests have a pleasant experience with the hotel staff, they will be more inclined to experience the community accommodation.
Communication infrastructure	Transportation	It is proposed that guests staying at the hotel will be transported to the community-based accommodation by vehicle.
	telephonic / digital communication	The hotel management contacts the community bird, canoe and fishing guides for their services via mobile phone.
Relationship infrastructure	The relationship amongst and between all the different types of infrastructures	The community-based accommodation will initially rely on guests staying at the hotel to use their facility. In order for this arrangement to function successfully, a variety of different public infrastructure types are requires to work together: i) roads, bridges and vehicles are requires to move the guests between the hotel and the community; ii) South African laws and regulations govern the health and safety standards of the community facility; iii) there needs to be a trusted business structure between the hotel and the community accommodation operators; and iv) the community must use their traditional knowledge to provide a traditional experience for the guests.

Public Infrastructure Providers

The 'public infrastructure providers' are those that are responsible for the development and implementation of 'Public infrastructure'. The list of different Public infrastructure types (Table 3) can be used to help identify the different groups of 'public infrastructure providers'. It is also useful to refer to the list of ‘resource users’, as these can be the same people.

Understanding the linkages between the four different components of an SES

In order to develop an understanding of the potential linkages between the four organising components of the SES, a matrix has been prepared (Table 4). The matrix demonstrates the nature of the possible relationships that may be operating amongst the four components of the system, together with estuarine examples. Also included in this matrix are the external biophysical, social and economic forces that may generate perturbations in the local system. The matrix must be interpreted by how the components along the x axis are impacted upon by the components on the y axis. The ‘resource’ has been omitted from the y axis, as the resource is generally impacted upon by external impacts, and this is addressed by the addition of ‘biophysical forces’ along the y axis of the matrix.

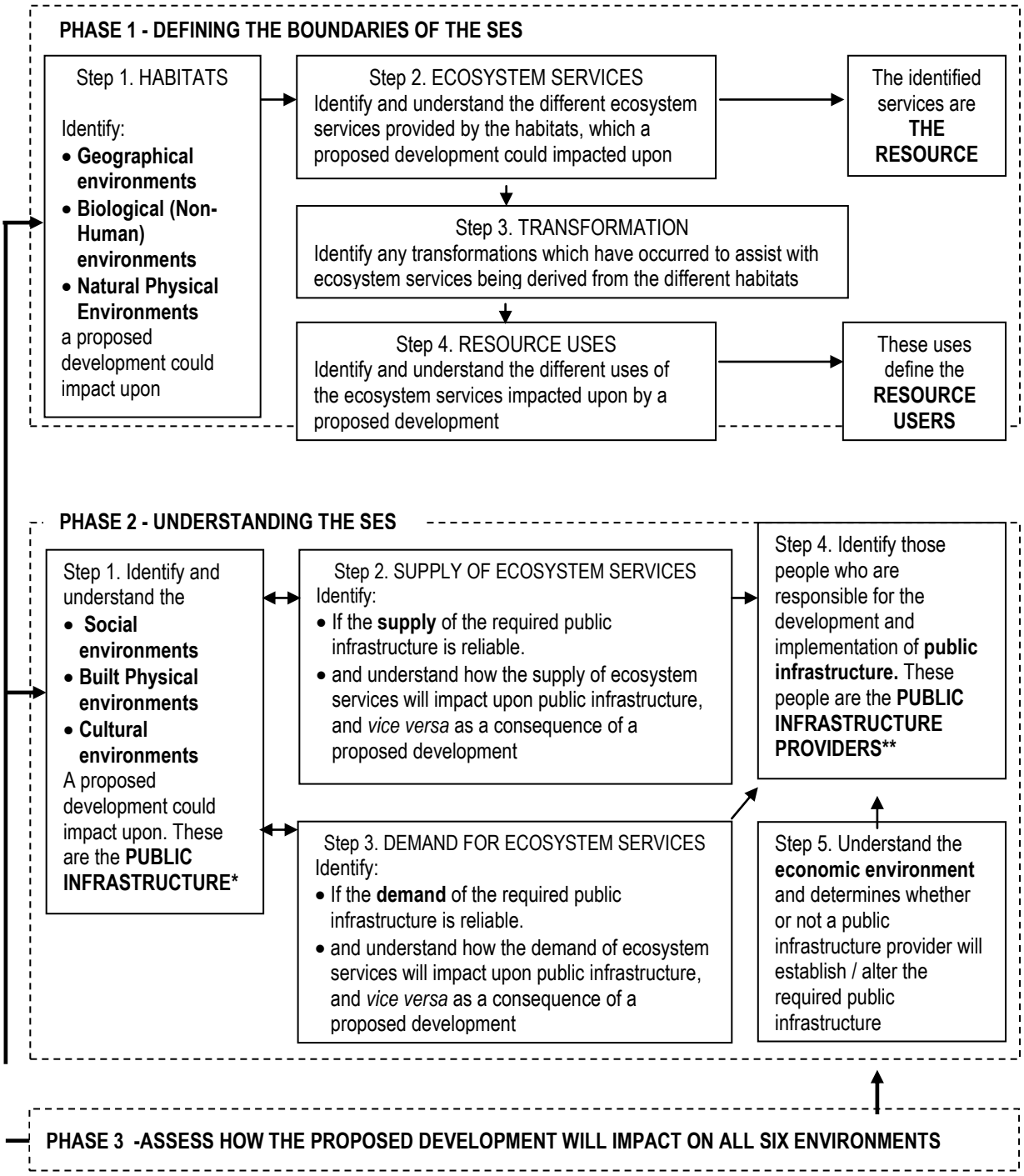
Table 4: Matrix showing the linkages between the four main components of an SES, and how biophysical, social and economic forces relate to the four different components. Estuarine examples of the linkages have also been provided

		RESOURCE	**RESOURCE USER**	**PUBLIC INFRASTRUCTURE**	**PUBLIC INFRASTRUCTURE PROVIDER**
Internal disturbances	**Resource user**	The resource supplies ecosystem services to the resource users. Over-exploitation of these ecosystem services will have a detrimental impact on the resource, thus the functioning of the resource will be impaired	Resource users can have neutral, positive and/or negative relationships between each other over the use of the resource. A positive example is when communities remove alien trees for fire wood and thus help reduce alien vegetation	Public infrastructure is used by the resource users, and can have both positive and negative impacts on its users. (e.g. a well-maintained road may benefit a tourist enterprise which may not have succeeded if the road was frequently impassable)	Public infrastructure providers generally provide public infrastructure to meet the needs of resource users. (e.g. a municipality may be forced to build a bridge to allow access to an inaccessible place within an estuary, due to pressure from a developer)
	Public infrastructure	The condition of a resource is dependent on what public infrastructure is available and/or implemented. (e.g. the tarring of a road could have a negative impact on an estuary, as it could facilitate access, resulting in intensive fishing)	Resource user activities and allocation of resources are influenced by the availability of public infrastructure. (e.g. the implementation of BEE legislation creates preferential access, and thus opportunities, for historically-disadvantaged individuals)	The implementation of one type of public infrastructure may detract from another type of public infrastructure. (e.g. if a public parking lot is established adjacent to an exclusive lodge, the parking lot could have a negativity impact on the appeal and success of the lodge)	The public infrastructure that a public infrastructure provider provides is often influenced by the public infrastructure which is currently in place. (e.g. a hotel chain maybe more likely to establish a new hotel if a tarred road is already in place)
	Public infrastructure provider	The resource can both benefit and be detrimentally impacted upon by public infrastructure providers, (e.g. a hotel could monitor the state of water quality in the estuary and take the necessary rectification action if required. However it might be the hotel which is causing the pollution)	Public infrastructure providers do not always meet the needs of the different resource users. There can be conflict between what the resource user and public infrastructure providers want. Co-management of assets (both built and natural) between resource users and public infrastructure providers can occur	The implementation of public infrastructure is completely reliant on the capacity and competency of the public infrastructure providers. (e.g. there may be good policy on solid waste disposal, but if the municipality is not able to implement it, solid waste will remain a problem	Public infrastructure providers could work together and also against one another. An example of the latter, is when one department is promoting economic growth using development (e.g. the establishment of a hatchery within an estuary), and another department is promoting conservation
External disturbances	**Biophysical forces (Biological, non-human and natural physical forces)**	It is inevitable that natural resources are impacted upon by external biophysical forces. These include droughts, floods and unexpected natural events. These events can change the quantity of ecosystem services	A resource user is usually negatively impacted upon if they have not considered fluctuations in the supply of ecosystem services. However, the opposite may occur. (e.g. if climatic conditions result in increased availability of material for crafters)	Biophysical forces can influence public infrastructure. (e.g. natural disasters can cause wash-aways and destroyed communications, limiting access to enterprises and causing financial losses	Public infrastructure providers can be prepared or ill-prepared for unexpected biophysical forces. (e.g. the roads department may have made financial provision for the repairing of roads after a major flood event, knowing that flooding was likely to occur)

	Social and economic forces (Social, economic and cultural forces)	External social and economic forces can alter the resource base. Poverty and affluence can result in over use and exclusion of access to a resource. (e.g. poor people may over use fish stocks, or affluent people may displace poor users, such as a fishing concession which excludes local fishermen from previously used sites)	External social and economic forces can influence resource users. Conflict, crime and uncertainty can influence changes in the demand for local services. (e.g. dangerous driving on access routes may discourage tourists from visiting the Eastern Cape estuaries)	External social and economic forces can have both positive and negative impacts on public infrastructure, (e.g. if a new road is established, it is likely to result in greater accessibility to estuaries. This is likely to lead to increased tourist facilities which have the potential to cause ground and surface water pollution if their sewage systems are not maintained)	The delivery of public infrastructure from public infrastructure providers is reliant on social and economic forces. Public infrastructure providers are required to respond to and meet the need of social and economic forces. (e.g. a municipality must demonstrate sound fiscal management to attract foreign investors, who could provide investment for the area)

5. Presentation of the analytical framework

The developed analytical framework is presented in Figure 3. The framework gives the user a systematic understanding of how the four different components (resource, resource users, public infrastructure and public infrastructure providers) incorporate the six different environmental aspects (geographical, physical, biological, social, economic, cultural) that make up a complex SES (Phase 1 and 2). The framework has separated the physical environment into 'natural physical environment', which contributes to identifying the different ecosystem habitats, and 'built physical environment', which contributes to identifying the public infrastructure. The framework encourages the user to consider how the different environmental aspects interlink when assessing how a proposed development will impact on each of the six environmental aspects. It is during Phase 3 that existing EIA tools could be applied, as an understanding of the dynamics of the SES has been obtained through implementing Phase 1 and 2 of the framework. Such tools might include a Rapid Impact Assessment Matrix (RIAM) (Pastakia and Jensen, 1998) and Cumulative Effects Assessment (CEA) (Smit and Spaling 1995).



*Any transformations identified in Phase 1, step 3 must be included.
** Identify whether the public infrastructure providers are resource users.

Figure 3: The developed analytical framework (refer to Figure 2 for estuarine examples of the resource, resource users, public infrastructure and public infrastructure providers)

6. Discussion and Conclusion

The extended analytical framework presented here assists with obtaining a greater understanding of how a proposed development will impact on a complex SES. It represents an extension of the four main components of an SES, as defined by Anderies et al. (2004), through introduction of the six environmental aspects and their interrelationship with the four Anderies et al. (2004) components. The analytical framework has not adopted the specific separation of external biophysical and socio-economic disturbances, as presented by Anderies et al. (2004), as the environmental disturbances are dealt with as all being within the boundaries of a SES, and external influences have not been isolated.

The framework places social and economic impact at the same level of importance as the 'commonly considered' biological (non-human), natural physical environments. However it should be noted that equally assessing the impacts of a proposed development on all six environments is not always desirable, and that the degree to which each environmental aspect is assessed must be evaluated at a project specific level.

Sub section 2d of regulation 22 and 31, contained within Chapter 3 of GNR 543 states that an EIA must provide a description of the "manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity". Step 1 of Phase 1 of the framework requires that the geographical, biological and natural physical environments a proposed development will impact upon be identified. Step 1 of Phase 2 of the framework required that the social, built physical and cultural environments a proposed development will impact upon be identified. Chapter 6 of GNR 543 is concerned with the EIA Public Participation Process, and lists numerous methods of identifying relevant stakeholders. These methods include the placement of newspaper adverts and site posters. Regulation 54 2e requires that the EAP gives notice of a proposed development "using reasonable alternative methods… where a person is desiring of but unable to participate in the process due to— (i) illiteracy; (ii) disability; or (iii) any other disadvantage". Step 2 to 4 of Phase 1 of the framework encourages the EAP to be proactive in identifying all those stakeholders who use the ecosystem services a proposed development may impact upon. Without the framework the EAP may only rely on stakeholder response from traditional notification methods (e.g. site posters, newspaper adverts), and thus not complying with Regulation 54 2e. For example, if a proposed development was likely to impact upon the availability of craft material in a wetland, and the crafters were illiterate, the crafters may not be identified, and thus not considered when assessing the impacts of the proposed development.

Sub section 2i of Regulation 22 and 2l of Regulation 31 requires a description and assessment of the significance of any environmental impacts, including— (i) cumulative impacts, that may occur as a result of the undertaking of the activity… Step 2 to 5 of Phase 2, and Phase 3 encourages the EAP to consider what impacts the proposed development will have on the supply and demand of the public infrastructure a proposed development impacts upon. For example, a proposed hotel may require reliable road access in order to be successful. If the hotel is accessed by a publicly owned bridge which services other amenities and the Government does not have funds to maintain this infrastructure, the hotel will not be sustainable and the other amenities will be negatively impacted upon.

Initially the framework was intended to be transferable between the developed and developing world context. However it has become evident that as developed countries generally focus their EIAs on the assessment of non-human biological impacts, as opposed to social and economic impacts, the framework would need to be adapted from its current form for use in the developed world context. In order to adapt the framework, time would need to be spent on determining which of the six environments could be omitted or rearranged within the framework. Although South Africa has been considered as being both developed and developing (Wood 2003a), it is apparent that the framework is only applicable to this country due to it legislation catering for its developing world aspects.

Comparing South Africa's previous EIA legislation (Government Gazette 28753, GNR 385; Environmental Conservation Act No. 73 of 1989) with the recently promulgated amendments (Government Gazette 33306, GNR 543), it is evident that the government want to encourage the involvement of the previously disadvantaged community in the EIA public participation process. In its simplest form and with the development of a pictorial version, there is potential for the framework to encourage those less literate to participate in the EIA process.

The framework addresses the three criteria which were assessed by Hacking and Guthrie (2008). The framework considers 'comprehensiveness' by promoting the consideration of all six environmental aspects when conducting an EIA. The framework also promotes 'integratedness' by displaying how the six environmental aspects interlink to form an SES. The framework addresses 'depth / detail' (Figure 1) by encouraging an EAP to understand the environmental implications of a development at a broad scale through prompting consideration of the dynamics of an entire SES, a proposed development has the potential to impact upon.

It is intended that the limited appropriate experience and qualifications of practicing EAPs can, to some degree, be overcome with the implementation of this framework, in that it encourages an EAP to consider all environments which make-up an SES, and how they interlink when conducting an EIA. It must be noted that the proposed analytical framework is not meant to be a substitute for EIAs, but its purpose is to encourage EAPs, government officials, funding agencies, etc. to holistically consider the impacts that a proposed development will have on complex SESs. It is recommended that tools based on this framework are developed for direct use in EIAs. These tools can be applied within Phase 3 of the framework.

In the South Africa context, it is hoped that this framework will help unify the skills of government officials, which will lead to a standardizing of the reviewing of EIAs. It is expected that the availability of this framework will encourage EAPs to not only consider those issues raised by I&APs, or which are linked to their specialized field, but to assess the impacts of a development holistically. Although a certain level of skill is required to apply the framework, it is hoped that this framework will improve the overall quality of EIAs.

In summary, the framework is aligned with currently EIA requirements and will contribute towards an improved standard of EIAs. It is hoped that this framework will encourage a wider array of stakeholders to participate in the EIA process. This will be achieved through the framework ensuring that all resource users and public infrastructure providers are

identified. In addition, a simplified version of the framework may encourage less literate people to become involved. A wider array of stakeholders being involved in an EIA will help towards the sustainability of developments, as the framework has added a more rigorous assessment of the six environmental aspects during the EIA.

7. Acknowledgements

Dr Steve Mitchell of the South African Water Research Commission and Mr. Andrew Mather of eThekwini Municipality for their valuable input into the development of this framework. Funding for this project came from the South African Water Research Commission: Estuaries and Economic Empowerment project.

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Appendix C

TITLE
The identification of potential resilient estuary-based enterprises to encourage economic empowerment in South Africa: A toolkit approach

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CHOSEN JOURNAL
Ecology and society

ABSTRACT
It has been argued that ecosystem services can be used as the foundation to provide economic opportunities to empower the previously disadvantaged. The Ecosystem Services Framework (ESF) approach for poverty alleviation, which balances resource conservation and human resource use, has received much attention in the literature. However, few projects have successfully achieved both conservation and economic objectives. This is partly due to there being a hiatus between theory and practice, due to the absence of tools which help make the transition between conceptual frameworks and theory to practical integration of ecosystem services into decision-making.

To address this hiatus the an existing conceptual framework for analyzing the robustness of social ecological systems was translated into a practical toolkit to help understand the complexity of social ecological systems (SES), and which can be used by a diversity of stakeholders as a decision-making aid for assessing ecosystem services supply and demand and enterprise opportunities.

The toolkit is participatory and combines both a generic "top-down" scientific approach with a case-specific "bottom-up" approach. It promotes a shared understanding of the utilization of ecosystem services, which is the foundation of identifying resilient enterprises. The toolkit comprises four steps: i) Ecosystem services supply and demand assessment; ii) Roles identification; iii) Enterprise opportunity identification; and vi) Enterprise risk assessment, and was tested at two estuary study sites. Implementation of the toolkit requires the populating of preprogrammed Excel worksheets through the holding of workshops which are attended by stakeholders associated with the ecosystems.

It was concluded that in order for an enterprise to be resilient, it must be resilient at an external SES level (which the toolkit addresses) and at an internal business functioning level (e.g. social dynamics amongst personnel, skills and literacy levels). Although the toolkit does not address the internal resilience level of an enterprise, it does indicate which enterprises show potential resilience given current SES conditions.

INTRODUCTION
Despite transition to democracy in 1994, the gap between wealthy and poor in South Africa continues to increase. For example, between 1997 and 2007, inequality in South Africa increased by 5% (SAIRR 2008). Recent studies suggest South Africa's inequality levels are amongst the highest in the world (Fosu 2011) and during the period 1993-2008, income has been increasingly concentrated in the top decile (Leibbrandt et al. 2010). Rural communities experience relatively greater poverty (Leibbrant et al. 2010), and nowhere is this more the case than the Eastern Cape Province of South Africa, where concern has been expressed, not just in relation to standard poverty metrics (Dzivakwi and Jacobs 2010), but also people's vulnerability to poverty (Baiyegunhi and Fraser 2010).

It has been argued that ecosystem services can be employed as both a 'common language' for ecosystem-based management (Granek et al. 2009), and as the foundation to providing economic opportunities to empower the previously disadvantaged (Millennium Assessment 2005). Although both the wealthy and the poor rely on the functioning of ecosystems (Batabyal 1994, Scheffe et al. 2000, Millennium Assessment 2005), the poor are often more directly reliant on these goods, services and benefits than the affluent. As noted by Tallis et al. (2008:9459), 'for the rural poor, at the local level, the status of ecosystem services can make a big difference in their daily lives'.

The potential application of the Ecosystem Services Framework (ESF) approach for poverty alleviation, which balances resource conservation and use according to how society values consumptive and non-consumptive services provided by an ecosystem, has received much attention in the literature (Brown et al. 2008, Tallis et al. 2008, Shackleton et al. 2008). The ESF approach is currently the focus of a significant research endeavor known as ESPA (Ecosystem Services for Poverty Alleviation see http://www.espa.ac.uk/). Other initiatives, such as the Natural Capital Project (see http://www.naturalcapitalproject.org/home04.html) have also focused on the potential for aligning conservation and economics via the ESF (Turner and Daily 2007).

However, projects that have successfully achieved both conservation and economic objectives are relatively rare. For example, in an analysis of World Bank projects that had the dual aims of poverty alleviation and biodiversity conservation, Tallis et al. (2008) found that only 16% made significant progress on both objectives. Part of the reason for this has been the hiatus between theory and practice. As suggested by Turner and Daily (2007:25), despite this attention in the literature, 'an operational decision support system' for implementing an ESF has been 'slow to emerge'. Daily and Matson (2008:9456) put the challenge more strongly '(r)adical transformations will be required to move from conceptual frameworks and theory to practical integration of ecosystem services into decision-making, in a way that is credible, replicable, scalable and sustainable'.

This paper attempts to address this challenge by presenting an approach for applying an ESF to assist in the identification of opportunities for economic empowerment at two estuary study sites in the Eastern Cape Province, South Africa. In so doing, it also provides an example of how an ESF can be used towards the aim of poverty alleviation.

METHODOLOGY AND DEVELOPMENT

Selection of study sites

Estuaries, in particular, are a useful context in which to develop and test ideas regarding ESFs. Collett and Hutchings (1977) define estuaries as the tidal portions of river mouths, bays and coastal lagoons, irrespective of whether they are dominated by hypersaline, marine or fresh water conditions. Estuaries are ecosystems comprising of a number of different habitats, such as mangroves, tidal flats and reedbeds, which can provide food, building material and protection; are catalysts for residential, commercial, tourism and recreational development, and can ameliorate floods and assimilate waste (Gunderson et al. 2006, Hay 2007, Barbier et al. 2011). Estuaries are therefore complex and dynamic social-ecological systems (SES) (Anderies et al. 2004), where interactions occur between:

- Ecological elements (e.g. fish eating crabs, which eat algae, which grow on mangrove roots);
- ecological and human elements (e.g. humans abstracting upstream freshwater which reduces fish productivity); and
- human elements (e.g. provincial government building roads which allow local communities to visit estuaries).

In South Africa (Turpie and Daily 2007), and globally (Barbier et al. 2011), estuaries are clearly valuable economic, environmental and social assets that can provide economic empowerment, including job creation for disadvantaged people living at or near them (Turpie and Clark 2007). Many of the services provided by estuaries are taken for granted and consequently the derived benefits are undervalued. Estuaries are highly dynamic environments which are unpredictable and erratic in nature. Given their high productivity, they are often subject to very high levels of use, and given their location in the lowermost point in the catchment, are often subject to some of the greatest anthropogenic disturbances.

Estuaries are also common property resources with poorly defined property rights. This complicates the allocation of opportunities and the benefits that arise from these opportunities. Securing tenure, a vital necessity for most economic developments to succeed, requires a level of sophistication that is currently in short supply in many rural parts of South Africa.

Two estuaries located in the Eastern Cape Province of South Africa were chosen to apply the toolkit. The Umngazi estuary, located near to Port St. John, and the Tyolomnqa estuary, located near to East London. Both sites currently provide a variety of ecosystem services but differ with respect to their respective social systems. The Tyolomnqa estuary's social system is large and complex, and comprises prominent local and provincial governmental bodies, non-governmental agencies and general service users (e.g. local and visiting fishermen). This system is relatively close in proximity to the urban centre of East London, and the policing of activities are high. In contrast, the Umngazi system is rural in nature and is less complex, as there are fewer stakeholders. Although local and provincial governmental bodies operate

in the area, their presence is not strong. The dominant stakeholders are the local community, a well established hotel and tourists.

Criteria for developing the ESF Toolkit

Turner and Daily (2007:26) identify three constraints in making an ESF approach operational. Firstly there is what they describe as 'information failure', which is the lack of detailed information about the way in which people benefit from ecosystem services, and at a scale that is relevant to decision-makers. The second is 'institutional failure'. This arises as a result of the failure to consider local socio-ecological contexts (including property rights and institutions) and the fact that those who benefit from ecosystem transformation are not the same as recipients of ecosystem services. Finally 'market failure' arises because of the public-good nature of benefits and as many of the benefits cannot be quantified or be measured in a single currency.

Turner and Daily's (2007) critique has therefore informed the identification of a set of four criteria that would be instrumental in a successful ESF approach. The first criterion is that public participation should be an integral part. This relates strongly to 'information failure' and 'institutional failure' constraints (see (i) below). Secondly, it is evident that one of the fundamental attributes of an operational ESF should be a mechanism which allows the particular services to be discussed, understood and valued in a common currency. In other words the ESF should provide a platform for discussion by providing detailed information on ecosystem services (see (ii) below). Thirdly the toolkit must have the ability to gauge a system's resilience, as the purpose of this study is to have a framework which identifies potential resilient estuary-based enterprises (see (iii)). Finally, the toolkit must contribute to obtaining a thorough understanding of the complex socio-ecological context (see (iv) below). This too, would help address the 'institutional failure' and the 'market failure' constraints.

i. An ESF Toolkit for economic empowerment must be participative

In recent years stakeholder engagement has moved from being a 'marginal concern' to a 'driving force' (Lynam et al. 2007). Furthermore a dichotomy has been recognized between the commonly used "top-down" generic scientific tools (which are frequently developed without input from the local stakeholders), and the case-specific customized "bottom-up" tools (which are generally driven by local needs) (Fall et al. 2001, Sturtevant et al. 2007). Gunderson et al. (2006) identify five factors for constructive communication to take place: a) the development and maintenance of open communication channels (Berkes and Folke 1998, Folke et al. 2005); b) identification of the roles of the different stakeholders through scientific activities or social communication (Fazey et al. 2005); c) the designation of a meeting place at which discussions can take place between the different stakeholders; d) the establishment of trust between the stakeholders; and e) the establishment of leadership, as this is required to integrate social and ecological understanding, and to delegate responsibility to ensure that progress is made. Participation characterized by constructive communication must therefore be a central criterion.

ii. An ESF Toolkit for economic empowerment must provide detailed information on ecosystem services

An early challenge in the ecosystem services debate was defining and categorizing the nature and scope of these services. For example, Hein et al. (2006) present a generically applicable framework based on earlier contributions (Pearce and Turner 1990, Costanza et al. 1997, de Groot et al. 2002, Millennium Ecosystem Assessment 2003). This framework defines three types of services (production, regulation and cultural). Production services refer to goods and services produced in an ecosystem (e.g. food, fuel timber); regulation services result from the capacity of ecosystems to regulate a variety of biological processes (e.g. erosion, storm protection); and cultural services relate to the benefits people obtain from ecosystems through recreation, cognitive development, relaxation, and spiritual reflection. It differs from the Millennium Ecosystem Assessment (2003), in that it does not differentiate supporting services. Supporting services represent the ecological processes that underlie the functioning of an ecosystem, and Hein et al. (2006) are of the opinion that the inclusion of supporting services could result in the 'double counting' of services, and thus affect the valuation, as they will feature in one of the other three types of services. The Resilience Alliance (2007) modified the Hein et al. (2006) framework by adding

'regeneration services' to the regulation services. This was done to emphasize the importance of services, such as soil fertility maintenance (Resilience Alliance 2007).

In South Africa much work on describing and classifying estuary ecosystem services has been conducted. Turpie and Daily (2007) documents estuary associated goods, services and attributes and defines 'goods' as harvested resources (such as fish), 'services' as processes that contribute to economic production or save costs (such as water purification) and 'attributes' as relating to the structure and organization of biodiversity (such as beauty, rarity or diversity) that generate less tangible benefits, such as spiritual, educational, cultural and recreational values.

Based on these contributions a comprehensive list of estuary ecosystem services was developed. The term 'services' has been used to encompass goods, services, attributes and benefits, as per Resilience Alliance (2007), Hein et al. (2006) and Bowd et al. (in prep). Each of these services is related to the presence of suitable estuary habitat(s) and consequently it was important to identify the full range of estuary habitats. For South African estuaries ten habitat types were recognized, each of which was associated with one or more services (Table 1).

iii. An ESF Toolkit for economic empowerment must consider resilience

As all ecosystem services are subject to the influences of natural and anthropogenic processes that are highly variable, supplies of services are seldom uniform. Whilst some services may seem to be constant over time, others can exhibit wide variations, even over short time scales. Thus every enterprise that is founded on ecosystem services must anticipate changes over time and space as a consequence of both natural and human influences. Some of these influences may be controlled by society (e.g. pollution) however others (e.g. large floods) cannot. The viability of ecosystem-based enterprises will equally be influenced by fluctuations in the demand for services. These demands may be very variable over time and in space, and furthermore, not all demands are compatible and cannot necessarily be accommodated at the same time, and in the same place. This lack of control of interaction places resilience at the forefront of conceptualizing, designing, establishing and operating estuary-based enterprises. Resilient estuary-based enterprises are those that are able to continue profitability under conditions of varying supply of, and demand for, the services upon which they are dependent.

Since the 1970s a variety of definitions and interpretations of resilience have appeared (Pimm 1991, Grimm and Wissel 1997, Neubert and Caswell 1997, Walker et al. 2004). Ecological resilience is generally defined as the amount of disturbance that a system can absorb without a change in its 'state', usually defined by its structure and composition (Holling 1996, Carpenter et al. 2001, Walker et al. 2006).

There were a number of reasons why the concept of resilience is seen as being key to the approach. Firstly, resilience has been applied widely to SESs and is increasingly being used to help understand, manage and govern complex SES (Walker et al. 2002, Anderies et al. 2004, Folke et al. 2004, Ostrom 2007). For example it has been applied to political ecology and resource management (Berkes and Folke 1998, Berkes 1999), as well as to a variety of specific ecosystems which include: rangelands (Anderies et al. 2002, Janssen et al. 2004); lakes and wetlands (Gunderson 2001, Olsson et al. 2004); and coral reefs (Hughes et al. 2005).

Secondly, resilience theory suggests that the major entities of an SES, and the level at which they interact, are identified through approaches that involve constructive communication between experts and stakeholders who understand the SES at different scales and perspectives (Walker et al. 2002, Westley et al. 2002). Thirdly, resilience theory emphasizes the need to consider human adaptability (Gunderson and Holling 2002, Walker et al. 2006). Human adaptability is key when assessing the resilience of an enterprise and the SES on which an enterprise is dependent upon.

iv. An ESF Toolkit for economic empowerment must accommodate complex socio-ecological contexts

Anderies et al. (2004) derived a framework for analyzing the robustness of SESs from an institutional perspective. This framework provides a mechanism for disaggregating the entities of a SES and promotes

the identification of the relationships between the different entities. The SES is separated into the following four entities (a) the resource; (b) the resource users; (c) public infrastructure and (d) public infrastructure providers, and considers two types of disturbance, external and internal (Figure 2). Table 2 provides examples of each of these entities, together with the typical management challenges that characterize them, while Table 3 explores the links between each entity and their associated problems. Although the Anderies et al. (2004) approach is based on 'robustness' and not resilience, we do not need to distinguish between the two as we consider robustness and resilience to have the same attributes for the purposes of this study

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Table 1: Comprehensive list of estuary habitats and associated ecosystem services found in South Africa (y=yes, n=no)

Ecosystem Services	Estuary Habitats									
	River estuary interface	Mangroves	Reedbeds	Salt marshes	Surface and column	Intertidal banks	Intertidal flats	Subtidal sediments	Deep water sediments	Estuary mouth
Angling	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Bait harvesting	N	Y	N	Y	Y	Y	Y	Y	N	Y
Birding	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Boat launching and transport	Y	N	N	N	Y	Y	N	N	N	Y
Canoeing	Y	Y	Y	N	Y	Y	Y	N	N	Y
Cultural places	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Disease control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fibres	Y	Y	Y	Y	N	Y	N	N	N	N
Flood and storm flow attenuation	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Food	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General recreation	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Knowledge generation and learning sites	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Minerals	Y	Y	Y	Y	N	Y	Y	Y	Y	N
Natural Heritage	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nursery for fish/crustacean species	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Pest control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sailing	N	N	N	N	Y	N	Y	N	N	Y
Sediment supply	N	Y	Y	Y	N	Y	Y	Y	Y	Y
Settlement	Y	N	N	N	Y	N	N	N	N	N
Skiing	N	N	N	N	Y	N	Y	N	N	N
Swimming	Y	N	N	N	Y	Y	Y	N	Y	Y
Visual amenity	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Waste assimilation	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Waste dilution	Y	Y	Y	Y	Y	N	N	N	Y	Y
Wind damage control	N	Y	Y	Y	N	Y	N	N	N	N

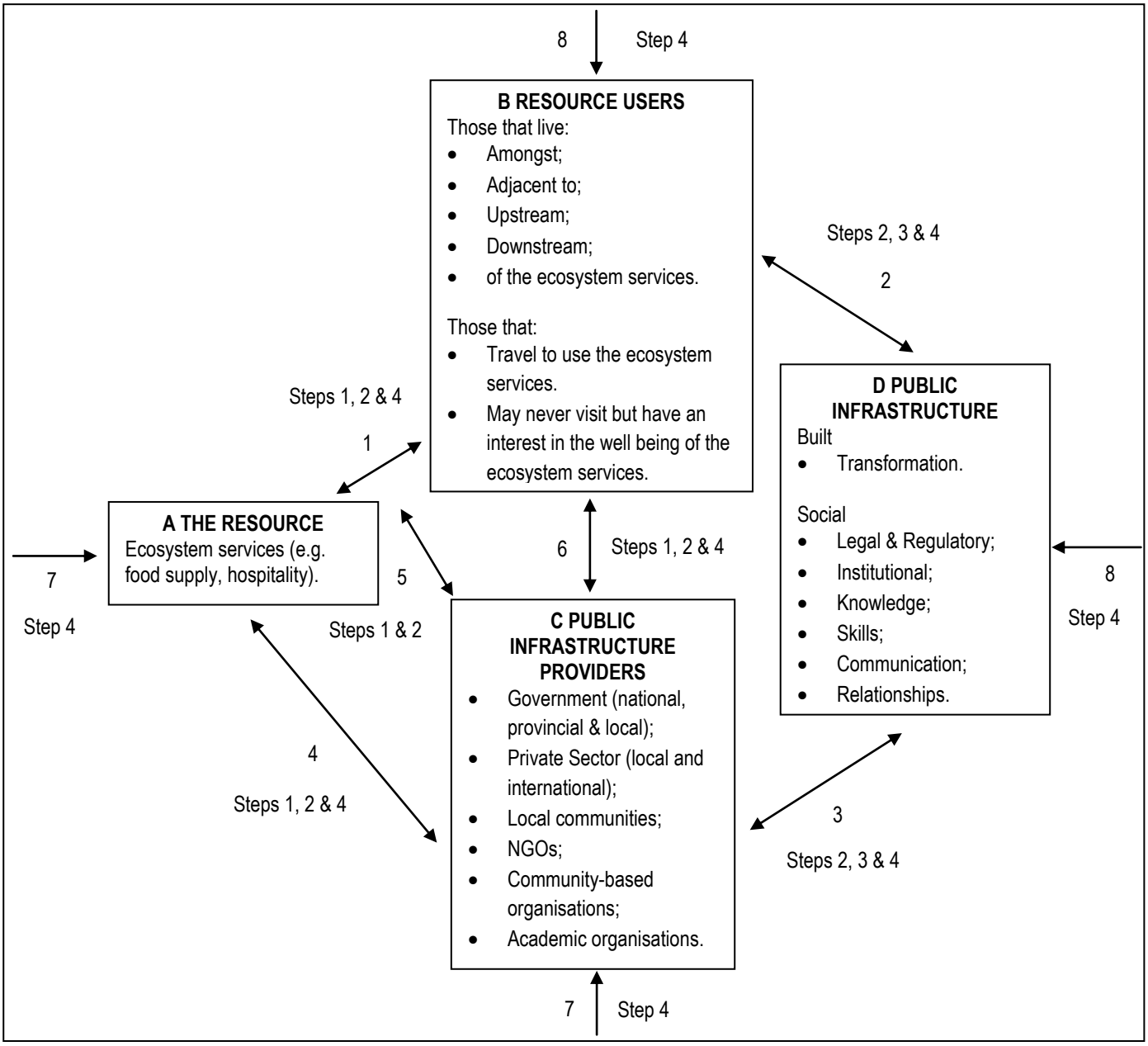

Figure 1: Adaptation of the Anderies et al. (2004) framework showing i) examples of how it relates to an estuarine system as presented in Bowd et al. (in prep); and ii) how the toolkit links with the Anderies et al. (2004) framework where Step 1– Ecosystem services supply and demand assessment; Step 2 – Future estuary roles identification; Step 3 – Enterprise opportunity identification; Step 4 – Enterprise risk assessment

Table 2: Entities involved in Social-ecological Systems together with examples and potential problems as identified by Anderies et al. (2004)

Entities	Examples	Potential problems
A Resource	Water source	Uncertainty
	Fishery	Complexity / Uncertainty
B Resource Users	Farmers using irrigation	Stealing water, getting a free ride on maintenance
	Fishers harvesting from inshore fishery	Over harvesting
C Public infrastructure providers	Executive and council of local users' association	Internal conflict or indecision about which polices to adopt
	Government bureau	Information loss
D Public infrastructure	Engineering works	Wear out over time
Institutional rules	Memory loss over time, deliberate cheating	-
External Environmental	Weather, economy, political system	Sudden changes as well as slow changes that are not noticed

Table 3: Links between the different entities within an SES, together with examples and potential problems as defined by Anderies et al. (2004)

Link	Examples	Potential Problems
(1) Between resource and resource users	Availability of water at time of need / availability of fish	Too much or too little water / too many uneconomic fishing
(2) Between users and public infrastructure providers	Voting for providers Contributing resources Recommending policies Monitoring performance of providers	Indeterminacy / lack of participation Free riding Rent seeking Lack of information / free riding
(3) Between public infrastructure providers and public infrastructure	Building initial physical structure Regular maintenance	Overcapitalization or undercapitalization Disrupting, temporal and spatial patterns of resource use
	Monitoring and enforcing rules	Cost / corruption
(4) Between public infrastructure and resource	Impact of infrastructure on the resource level	Ineffective
(5) Between public infrastructure and resource dynamics	Impact of infrastructure on the feedback structure of resource-harvest dynamics	Ineffective, unintended consequences
(6) Between resource users and public infrastructure	Co production of infrastructure itself, maintenance of works, monitoring and sanctioning	No incentives / free riding
(7) External forces on resource and infrastructure	Severe weather, earthquake, landslide, new roads	Destroys resource and infrastructure
(8) External forces on social actors	Major changes in political system, migration, commodity prices, and regulation	Conflict, uncertainty, migration, greatly increased demand

Developing the ESF Toolkit: Structure
The toolkit comprises four steps which are supported using a preprogrammed Excel worksheet, linked with the four entities off the Anderies et al. (2004) framework (Figure 2).

Step 1: Ecosystem services supply and demand assessment
This step requires that the estuary habitats are confirmed and their functionality assessed. In order to identify these habitats, the boundaries of the SES first need to be identified (e.g. areas accessible on foot from the estuary mouth). The functionality of each of the habitats is then calculated, by assessing its condition (0 – 3, three being the best condition), size (area given in ha) and prominence of the ecosystem within the landscape (0 – 3, three being the most prominent). While condition and size are the key determinants of service levels, the landscape context is less important and so is only weighted at 10% of the other two scores in the functionality calculation.

Next, the level of supply of the ecosystem services associated with each of the different habitats is scored (0 – 3, three being high, 0 being no supply). The scores are given as if the habitats are pristine. The service supply score is then multiplied by the functionality score, to give a relative service supply level for each service. It is recommended that the issue of seasonal variations in the supply of services is raised before scoring commences. It may be assumed that those services which have a high overall supply level are the services which enterprises should be based around.
Whereas the previous is concerned with the supply of services, the next focuses on the potential demand for services. Service demand at the local, downstream, provincial, and national and international levels are estimated. Estimated figures of users are shown as orders of magnitude (e.g. 0, 100, 1000). Following this the users of the services are listed, followed by the dependence of each of the difference services being scored between 0 (no impact on welfare) and three (critical for welfare).

As the toolkit is presented in a preprogrammed Excel worksheet, the following information is automatically calculated for each service: total supply score, total number of beneficiaries, average dependency, total demand summary, combined total score. These data are then consolidated for use in Step 2.

Step 2: Future estuary roles identification
The endpoint of the previous step is a ranking, in order of priority, of services which currently have high supply and low demand at a local, downstream, provincial, and national and international level. Using the knowledge and common understanding of the status quo gained though implementing Step 1, the desired roles for the estuary and possible conflicting uses (at local, downstream, provincial and national and international levels) are then determined through discussion. Where supply is low (either intrinsically or due to poor conditions) but demand is high should be identified as this could indicate potential management actions which in themselves could represent enterprises (e.g. restoration).

Step 3: Enterprise opportunity identification
The worksheet associated with this step provides space to document discussions around current and desired roles of the estuary, and possible conflicting uses. The worksheet provides different types of service use and possible estuary management categories to assist with identifying possible enterprise opportunities.

Step 4: Enterprise risk assessment
This step is supported by two worksheets and is conducted for each enterprise. This step consists of a variety of questions which demonstrate the nature of possible relationships that may operate amongst the four entities of a SES (as identified by Anderies et al. 2004). Also included in this matrix are the external biophysical, social and economic forces that may generate perturbations in a SES. The questions are based on those compiled by Bowd et al. (in prep) who used the Anderies et al. (2004) framework to develop an analytical framework for understanding complex SES when conducting Environmental Impact Assessments in South Africa (Table 4).

Table 4: Risk Assessment (source: Bowd et al. in prep)

RELATIONSHIPS	Nature of the risk
RELATIONSHIP BETWEEN RESOURCES USERS	
Could some of the resource users deplete the resource and are they reliant on the resource – making it difficult to change patterns of use?	Resource depletion
Are there conflicts between and / or within the different user groups already?	In ability to manage excessive resource harvesting
Is the estuary and its available services located within a clearly defined spatial boundary that can exclude users without legal rights?	Cannot enforce the right of exclusive use by owners
Are the people with rights to resource use a clearly defined group separate to those without rights of resource use?	Cannot enforce the right of exclusive use by owners
Does everybody in the community with use rights participate in the resource use?	Unequal incentives for community to manage the estuary
Are there good relationships between all the users who have a right of use?	Prohibitive transaction costs in establishing resource management
THE INFRASTRUCTURE, ECONOMIC, SOCIAL AND INSTITUTIONAL ASSETS AVAILABLE	
To what extent is the built infrastructure developed and maintained?	Poor quality infrastructure can limit access
Considering current infrastructure, is user safety secure all year round?	Threat to personal security
Does the built infrastructure meet current demand for access (the type, size and quality of infrastructure)?	Unsatisfactory access to the site
What are the levels of skills (education, knowledge, communication, hospitality) amongst the resource users?	Inadequate skills to anticipate and resolve problems
What are the levels of skills (education, knowledge, communication, hospitality) amongst the resource managers/government?	Inadequate skills to anticipate and resolve problems
How adaptable are the resource users to i) changes in the availability of the resource; ii) changes in demand; iii) pursuing other activities to sustain livelihoods, etc.?	Poor adaptability to change
What rules of law (local, provincial, national, international) are applicable to the resource users?	Partial application of laws
To what extent are these rules of law enforced?	Uncertainty for investors and users regarding their investments
To what degree are cell, telephone, email, fax available to the resource users; and to what degree are these facilities necessary?	Poor communications – no clients
RESOURCES FOR MANAGEMENT	
To what degree is government contributing to the management of resource users with regards to: i) the	Public services not being supplied to

RELATIONSHIPS	Nature of the risk
resource; ii) research; iii) infrastructure; iv) skills / knowledge; v) security; vi) communication?	management – with risks to resource depletion
IMPACT OF INFRASTRUCTURE ON RESOURCE LEVELS	
What are the impacts of i) knowledge / skills; ii) infrastructure; iii) security / governance; and vi) communication on the resource?	Depleted resources
POLICY IMPLICATIONS	
What policies are applicable to the resource users and what implications do these policies have on the resource users?	Lack of investors
To what extent do these policies give i) adequate protection to the resource; ii) give adequate security (i.e. access, availability) of the resource for the resource users?	Diminished access to resources
INTEGRATED IMPLEMENTATION OF DEVELOPMENTS	
Are there conflicts between government actions and / or government infrastructure?	Reduced or limited access to enterprise inputs
MONITORING THE STATE OF THE ASSET	
To what extent is the state of the resource monitored and who is responsible for this monitoring?	Inadequate knowledge for effective resource management
Is there evidence, and if so to what extent, are the findings of any monitoring efforts used to evaluate management, and thus influence future actions (adaptive management)?	Management is not responsive to changes
CO-MANAGEMENT OF BUILT OR NATURAL ASSETS	
How adequate is the cooperation between the resource users and government to manage the i) built environment; ii) social / cultural environment; iii) natural environment?	Poor operating environment for enterprise – heightened uncertainty for entrepreneurs
Can upstream river users who may influence the ecosystem functioning and therefore the supply levels of services be excluded or influenced?	Asset can be run-down – with diminish services availability
CAPACITY AND COMPETENCY TO IMPLEMENT POLICY	
What policies are applicable to public and private infrastructure and to what degree are these policies implemented?	No support for enterprises from government
INTER-GOVERNMENT COMMUNICATION	
Is there sufficient communication between different government tiers and departments?	High costs to do business
DROUGHTS, FLOODS, CHANGES IN SUPPLY OF RESOURCE SERVICES	
What is the nature of severe biophysical impacts on the resource and what is the significance and frequency of these impacts?	Inability to supply services demanded
DISREGARD FOR RESOURCE FLUCTUATIONS	
To what degree do resource users plan for fluctuations and is this planning adequate?	Insufficient revenue to cover costs

RELATIONSHIPS	Nature of the risk
DROUGHTS, FLOODS, WASH AWAYS, DESTROYED COMMUNICATIONS	
To what degree do external shocks damage public infrastructure with regards to: knowledge, skills, aids, floods, over exploitation of resource, establishment or non-maintenance of roads, communication?	Prevention of clients accessing the enterprise site or threats to user safety
To what degree are these external shocks managed / prepared for (i.e. insurance, forward planning)?	Insufficient revenue to cover costs
POVERTY AND AFFLUENCE – OVER USE AND EXCLUSION	
To what extent does poverty and/or affluence influence / affect over use and exclusion of the resource?	Asset can be run-down, diminish services
Can one user group's actions reduce the levels of services available to a different user group?	Asset can be run-down, diminish services
Do high transaction costs exclude key stakeholders from the decision making process?	Unequal incentives to manage the estuary
CONFLICT, CRIME, UNCERTAINTY, CHANGES IN DEMAND	
Are there social and economic forces, such as conflict, crime (internal and external) and interest rates, which can limit the demand by the resource users?	Reduced numbers of clients
Have the rules of resource use and benefit sharing been understood and agreed to by all people who have rights of use before use commences?	Effort can be unrewarded – abandonment of enterprise
INCREASED USE PRESSURES	
Are there external social and economic forces (e.g. water provision, housing) creating pressure on available infrastructure that impacts on estuary based enterprises?	Asset can be run-down, diminish services
EFFECTIVENESS OF GOVERNANCE	
Does government have capacity / skills to cope with social and economic shocks to estuary linked assets (resource, access, infrastructure)?	Prevention of clients accessing the enterprise or threat to personal safety or security
Are the rules of access and management duties well understood by all estuary resource users?	Asset can be run-down, diminish services

The first worksheet requires that the severity and likelihood of each risk is scored (0-3, three being very severe). A risk with a high severity of impact and a high likelihood of occurrence is considered to pose a major risk to enterprise resilience. The severity and likelihood scores are summed to provide each risk with a semi-quantitative value.

The second worksheet automatically ranks the risks according to the magnitude of risks identified previously. Once ranked, the priority risks are then assessed and mitigating actions identified and noted. If severe risks cannot be mitigated, then the proposed enterprise has a strong possibility of failure.

TESTING THE TOOLKIT

Development and testing process

As recommended by Pickett et al. (1999), Scheffer et al. (2000), Anderies et al. (2006) and Sturtevant et al. (2007), a multidisciplinary team was involved in developing and testing the approach, including ecological, economic and social scientists.

The importance of a participative approach was recognized as an explicit requirement from the outset, as noted by Walker (1992), the greater the diversity of stakeholders involved in a process, the greater the chance of understanding the resilience of a system. Leemans (2000) identifies stakeholder groups at a number of different levels. For the implementing and testing phase we adopted the following:

- Individual, family and municipal stakeholders were grouped as 'local level' stakeholders (knowledge from this group is considered invaluable when obtaining a sound understandings of the dynamics of a SES (Olsson et al. 2004));
- A down-stream level of stakeholder were introduced, this group refers to those who utilize services which could be negatively affected by activities up-stream. This group is likely to be individuals and families, however in some instances it may impact on international, national, provincial and municipal level stakeholders;
- Provincial and national level stakeholders, which include provincial and national level government departments (e.g. National Department of Environmental Affairs); and
- International level stakeholders, which include International Conservation Non-governmental Organizations (e.g. World Wildlife Fund).

The toolkit was applied at Umngazi over two, two-day workshops and at Tyolomnqa over one, two-day workshop. A full suite of stakeholders were invited to each workshop (Table 5).

At each study site the first step was to define the boundaries of the SES. This was done by participants visiting the estuarine system and then continuing on to discussing the currently established estuary-based enterprises, the supply and demand of the required estuary services and potential enterprise opportunities. Site visits facilitated a greater understanding of the system being considered and promoted a shared understanding of the different estuary uses (Deconchat et al. 2007).

Following the site visits workshops for the participants were held where the project team methodically introduced and applied the toolkit. Although the toolkit provided structured questions, discussions around the different questions and between the different stakeholders was encouraged in order to gain a greater understand of the SES, and for the different stakeholders to understand each other's perspective. During the workshop the toolkit worksheets were completed, and useful qualitative information documented.

Estuary-specific findings

Through implementing Step 1 at the Umngazi estuary, a total of 12 possible estuary-based enterprises were identified. Through implementing the subsequent steps, four were identified as priority enterprises (Table 5).

Table 5: Concise results from testing the toolkit at Umngazi Estuary and the Tyolomnqa Estuary workshops

Information	Study site	
	Umngazi Estuary	**Tyolomnqa Estuary**
Representatives present:		
National government	Yes (e.g. National Environmental Department)	No
Provincial government	Yes (e.g. Provincial Development Agency)	Yes (Provincial Conservation Department)
Local government	Yes (e.g. Local Municipality)	Yes (e.g. Local Municipality)
Private business interests	Yes (e.g. Hotel representative, horse trail guide)	No
Non-governmental Organizations	No	Yes (Wildlife and Environmental Society of South Africa)
Community representatives	Yes (from Umngazi Community)	Yes (from Tyolomnqa Community)
Tribal authorities	No	N/A
Research / academic institutions	Yes (two South African Universities, Water Research Commission)	Yes (South African University, Water Research Commission)
Step 1: Possible estuary-base enterprises (where there is high supply and low demand or low supply and high demand for services)	Bird watching Restaurant Crayfish factory Craft production Mangrove harvesting Village accommodation (as part of a destination package) Labour intensive government funded estuary rehabilitation programme Block making Bee keeping Sand mining Horse trails Canoe trails	Seaweed harvesting Residential settlements Fishing Boating Canoeing (races and recreational) Wilderness camp Brick making 4X4 trails
Steps 2 and 3: Priority enterprises determined through discussion on current, desired and conflicting roles	Canoe trails Horse trails Village-based tourist accommodation Labour intensive government funded estuary rehabilitation programme	Boating 4X4 trails Wilderness Camp

Step 4: Chosen enterprise for Risk Assessment	Village-based tourist accommodation		Wilderness Camp	
	Main risks	**Mitigation**	**Main risks**	**Mitigation**
	Communication difficulties	Establish internet linkages with the nearby established hotel	Intensity of users is controlled by provincial and national government departments which lack regulating capacity	Improve regulatory capacity of provincial and national government departments. However this is unlikely to occur in the short term
	Inland communities have less demand as tourists like access to beach	Sell a package which includes visiting the beach	Poor legislation implementation has resulted in poor water quality standards due to informal settlements being located near to the estuary and the nearby waste water treatment works not being adequately maintained	Improve maintenance of waste water treatment works and establish formal sanitation for the informal settlements. However limited funds are available
	Declining quality of attractions due to sand mining and mangrove harvesting	Improve community awareness of the importance of a healthy ecosystem, and the long-term consequences if sand mining and mangrove harvesting continue	Access to the estuary is limited and security is poor	Remove illegal fencing along the estuary and improve security presence. However limited funds are available for these operations
			Approximately 50% of the river has been transformed and as a result bank stabilization for development has caused habitat destruction	Municipality to take back control of the banks and rehabilitate. However limited are available for this operation

The village-based tourist accommodation (as part of a destination package) was selected for the risk assessment as the consensus of the participants was that this enterprise would benefit a greater proportion of the community compared to the canoe and horse trails. In addition, the success of the accommodation enterprise predominantly rested with the community and the management of the well established and successful hotel, thus its success was semi-controlled by the participants. Although an estuary rehabilitation programme may result in a larger cash injection into the community in the short-term, similar programmes have been established in the area and, due to inconsistent implementation, the community was wary of these types of enterprises.

Although a number of risks were identified for the accommodation possible actions to reduce these risks were provided (Table 5).

Through implementing Step 1 at the Tyolomnqa estuary, a total of eight possible estuary-based enterprises were identified. Through implementing the remaining steps there was consensus between the participants that a wilderness camp would be used in Step 4 (Table 5).

It was concluded that the identified risks were of a magnitude which could not be mitigated or easily controlled, thus the wilderness camp was not pursued further. When the Risk Assessment concludes that an enterprise does not show potential resilience, the Risk Assessment can be repeated to assess an alternative enterprise. However, in this instance the identified risks at Tyolomnqa are likely to affect the supply of the services on which any estuary enterprise is based. The risk assessment highlighted to the provincial planning authority, which were in attendance, that in order to give an estuary-based enterprise the greatest chance of survival, some or all of the above risks should be addressed before any new enterprise is pursued.

In reflecting on a potential wider application, the provincial planning authority was of the opinion that the toolkit could be:

- Run for each estuary in the province in order to compare and highlight which estuaries offer the highest service levels, and thus where development should be focused;
- Used to match activities to the most appropriate estuary, as implementing the toolkit effectively revealed how different activities were matched to the estuary; and
- Used to guide policy making and demonstrate the need for compliance, as the implementation of the toolkit highlighted specific policy needs for the estuary (e.g. development control) and where the greatest specific needs were for compliance (e.g. water quality).

In summary the workshops identified that there are significant opportunities for the establishment of estuary-based enterprises that can act as catalysts for economic empowerment. However, currently the public service infrastructure providers (primarily local government) are either unwilling or unable to provide the necessary support required to improve the likelihood of an estuary-based enterprise being resilient. It is here where the major risks lie.

DISCUSSION AND CONCLUSION

In this section we consider application of the toolkit in view of the four criteria and Turner and Daily's (2007) critique.

The first constraint identified by Turner and Daily (2007) was that of 'information failure'. The toolkit addresses this constraint because it is participant focused and promotes direct communication between the different stakeholders, some of whom are decision-makers. The toolkit combines both a generic "top-down" scientific approach (as the pre-programmed worksheet and risk assessment are founded on theory and scientific knowledge), with a case-specific "bottom-up" approach, which is obtained though a diversity of stakeholders actively engaging in discussion and reaching consensus on the scoring of the supply and demand of ecosystems services at a site specific level.

At the Umngazi study site the results of the first three steps indicated that an estuary rehabilitation programme would have created greater economic upliftment compared to the community-based

accommodation. However the community was strongly against this type of enterprise as similar enterprises had failed in the past. It is likely that without the participation of the community, decision-makers would have pursued the estuary rehabilitation programme. Based on the negative reactions of the community, it is likely that this enterprise would not have been supported.

The toolkit provides a methodical process for obtaining both qualitative and semi-quantitative information, and a shared understanding of the way in which stakeholders benefit from ecosystem services. At Umngazi this mutual understanding is likely to help improve the resilience for the community-based accommodation enterprise, as the participants understood why this particular enterprise had been chosen and what services were required for it to be successful. It is likely that with the depth of understanding gained through implementing the toolkit, those in decision-making positions (e.g. government officials) will help to ensure the protection of the ecosystems the community-based accommodation is reliant on (e.g. basic infrastructure to service the accommodation – electricity, water, access road).

The use of numerical values as relative measures in the toolkit helps to subjectively select which enterprises should be selected for the risk assessment, as the scores are ascribed with consensus from the participants. Having a broad scope of enterprises which needed to be scored helped prevent participants getting fixated on one particular enterprise. In addition, numerical illustration steered discussions towards obtaining relevant qualitative data, thus time was not lost on irrelevant discussions.

The second constraint identified by Turner and Daily (2007) was that of 'institutional failure'. Before the workshop at the Tyolomnqa estuary the provincial planning authority were of the opinion that there were likely to be many estuary-based enterprise opportunities, due to the estuary being utilized for a wide range of activities and by a relatively high number of people. However, the risk assessment highlighted a wide range of constraints (e.g. a lack of regulating capacity, poor water quality standards, habitat destruction, limited access and poor security) which the provincial planning authority were previously unaware. This emphasizes the value of the toolkit in promoting discussion based on structured consideration of ecosystem services. The third constraint identified by Turner and Daily (2007) was that of 'market failure'. Although there is neither a universal currency to value the services provided by the estuary, nor quantification of services in currency terms, the use of relative scoring allowed services to be given nominal values to facilitate comparisons to be made.

The collated data on the supply and demand of the ecosystem services highlighted to all participants at both study sites that the estuary is a common pool which is utilized by many. As the toolkit promotes a shared understanding of the resource and resource users, enterprises which do not affect or have limited impact on the availability of the services used by other resource users, and vice versa, were able to be identified. This knowledge is the foundation for identifying resilient enterprises.

There was a reasonable variety of stakeholders present at the workshops for both study sites, and all stakeholders participated. However, some participants were more dominant than others. At Umngazi the community and the provincial level planning authorities were much more dominant and enthusiastic compared to the other stakeholders. In comparison the local authorities and hotel representatives were less committed. At Tyolomnqa the provincial planning authority were the most dominant by far. Although some stakeholders were more dominant than others, it was concluded that the toolkit facilitated a diversity of stakeholders to actively participate in a joint decision-making process. All those in attendance at Umngazi were supportive of the community-based accommodation. At Tyolomnqa, all those in attendance became aware of the environmental constraints which needed to be addressed before a new estuary-based enterprise was established.

Through applying the toolkit a number of participatory lessons were learnt. These lessons have been tabulated and have been grouped into i) facilitator; ii) stakeholder; and iii) workshop procedure lessons (Table 6).

Table 6: Participatoroy lessons learned from applying the toolkit

Lessons for Facilitators

- Applying the toolkit takes between six to eight hours, thus facilitators must be able to stimulate communication between stakeholders but keep discussion strategic and prevent it from becoming too detailed. It is recommended that as implementing the toolkit is intellectually demanding for both facilitators and stakeholders short sessions and long breaks are recommended.
- Due to a range of different stakeholders participating in the toolkit, it is beneficial for facilitators to have previous experience with implementing participatory tools and communication methods with a range of stakeholder type (Kinzig 2001, Bradshaw and Bekoff 2001).
- As one type of enterprise may result in financial gain for certain stakeholders and potential lose for others (e.g. the establishment of village-based accommodation will benefit some community members however the hotel may lose bed nights) facilitators must be aware of and take into consideration any hidden agendas (e.g. economic interests) (Kenney 1999).
- Some stakeholders dominated the discussions more than others. Thus facilitators should be aware of informal and personal characteristics of the different stakeholders, as these can have a significant influence on the information which populates the toolkit (Jakobsen et al. 2004; Lyman et al. 2007).
- Due to having a wide variety of stakeholders participating (e.g. National Government, community hiking guides) an imbalance of power amongst the stakeholders was noted (McCloskey 1996; Lyman et al. 2007). Only facilitators can address this issue, as the tools by themselves are not able to (Lyman et al. 2007). One method to combat this biased is to introduce quality control methods, such as cross-checking by asking the same questions in a multiple of ways (Lyman et al. 2007).
- Facilitators should be confident and able to inspire confidence in participant.

Lessons for Stakeholders

- The accuracy of the data obtained from the toolkit is dependent on the representativeness of the stakeholder groups at the workshops.
- It is imperative that people who are actively involved with currently established local enterprises are involved in the SES. These stakeholders provide imperative information when applying the toolkit. However most successful businessmen are unable to engage in these processes as they are too busy and that is why they are successful.
- Trust must be established between the stakeholders. Trust can only be achieved if i) all stakeholders put their egos aside; ii) workshops have a patient facilitator; and iii) stakeholders are given sufficient time to get to know and understand each other (Deconchat et al. 2007).
- Two workshops were held at Umngazi approximately five months apart. As the toolkit involved stakeholder engagement over a prolonged period of time, problems arose with new stakeholders joining the second workshop, and dominant stakeholders not being present at the second workshop (e.g. Provincial Government officials transferred between different Provinces). These changes led to: i) time needed to be spent on regaining trust between the participants; ii) previous discussions having to be repeated, which was time-consuming; and iii) newcomers not agreeing with consensus views obtained from the previous workshop. To address this, a continuous effort must be made between the stakeholders to ensure collective coherence (Roybin et al. 2001).
- If unexpected or conflicting information is given by a stakeholder clarification must be sought, as this can highlight incorrect assumptions and provide new insights (Sheil and Liswanti 2007).

Lessons for Workshop Procedures

- As the success of implementing the toolkit is based on mutual trust, it is important that before conducting the workshop, the facilitator makes clear what the purpose of the toolkit is, and what can be achieved (Sturtevant et al. 2007).
- It is important that all participates feel included and equally valued, thus the workshops must be conducted so that all those present can understand what is being discussed and, if necessary, methods must be employed to overcome language and literacy barriers. Language must be keep as simple and concise as possible, and concepts should be illustrated through locally relevant examples.

The toolkit has demonstrated that it can be used to help identify potential estuary-based enterprises which can function under current ecosystem service supply and demand conditions. However supply and demand are constantly changing and in order for an enterprise to have the greatest chance being resilient, it must be adaptable. The adaptability of an enterprise is difficult to gauge without an enterprise first being established. The adaptability of an enterprise is human driven and this highlights a gap in the toolkit. In order for an enterprise to be resilient, it must be resilient at an external SES level (which the toolkit addresses) and at an internal business functioning level (which includes social dynamics amongst personnel, skills and literacy levels).

Although the toolkit does not address the internal resilience of an enterprise, it does indicate which enterprises show potential resilience, given current SES conditions. Establishing whether or not an enterprise is resilient in terms of external SES conditions must always been done before an enterprise is established, for without external resilience an internally resilient enterprise will still not succeed. If the internal operation of an enterprise is not resilient, for example if the market demands beach holidays and the holiday package is not being adapted to offer beach visits due to a lack of market knowledge, it is possible to educate personnel to provide this service. However, it is much more challenging to alter external level factors which impact on the supply and demand of ecosystem services, such as providing and maintaining access roads to the beach.

In summary this paper documents how the theory of the Anderies et al. (2004) framework has been translated into a practical toolkit which can be used by a diversity of stakeholders, as a decision-making aid, for assessing ecosystem services supply and demand and enterprise opportunities. Thus, the toolkit addresses the hiatus previously referred to by providing an operational decision support system for the practical integration of ecosystem services into decision-making processes.

It is impossible to accurately predict if a proposed enterprise will be resilient or not, however the toolkit provides a structured mechanism for identifying enterprises which have the potential to be resilient. The toolkit does not include steps to monitor the impacts of the enterprise once established, on the receiving SES. Additional work is required in this area.

As our findings are based primarily on estuarine SESs, and as ecosystems greatly differ in terms of species composition, service provision, and resilience thresholds (Scheffer et al. 2000), it is not possible to directly transfer this framework to other ecosystems (e.g. wetlands, grasslands, forests). However, given the fact that only step 1 of the toolkit directly deals with ecosystem services and is tailored specifically to estuaries, the toolkit is likely to be readily adapted for other ecosystem types.

ACKNOWLEDGEMENT
Dr. Steve Mitchell of the South African Water Research Commission and Mr. Andrew Mather of eThekwini Municipality for their valuable input into the development of this toolkit. The participants of the Umngazi and Tyolomnqa workshops for sharing their knowledge. Funding for this project came from the South African Water Research Commission: Estuaries and Economic Empowerment project.

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Appendix D

TITLE: Testing the transferability of a toolkit developed for the identification of resilient estuary-based enterprises on an established enterprise in an inland wetland, KwaZulu-Natal, South Africa

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ABSTRACT:
This is the second of two papers which document the development of a toolkit which can be used to help identify and assess ecosystem-based enterprises and promote the benefits, and thus wise use, of ecosystems. The initial paper documents a toolkit which was developed for the identification of resilient estuary-based enterprises in order to encourage socio-economic empowerment. This paper documents the transferability of parts of this toolkit (ecosystem services supply and demand inventory and risk assessment) for use on an established rural inland wetland resource-based craft agency which produces wetland fibre products. The need to be able to assess the impacts of an existing ecosystem-based enterprise is paramount, as established enterprises have the potential to degrade ecosystems through a combination of poor management practices and high demand.

It was concluded that the toolkit, with slight amendment, is transferable for use when assessing the resilience of an established inland wetland-based enterprise. Although the toolkit risk assessment did highlight that there was internal conflict between members of the enterprise, it is recommended that a

separate internal risk assessment should be compiled to complement the external risk assessment presented in this paper. The toolkit can easily be made transferable to other natural resources.

INTRODUCTION:

In 2008 the South African Institute for Race Relations (SAIRR) recognized that the gap between the wealthy and the poor in South Africa was continuing to increase, and that this situation was not sustainable. Although the poorer population is generally more directly reliant on services provided by different ecosystems for survival, in comparison to more affluent communities (Tallis et al. 2008), both the wealthy and the poor rely on ecosystems to provide services (Batabyal 1994, Scheffe et al. 2000, Millennium Assessment 2005). Many enterprises are built directly or indirectly around these services (Scheffe et al. 2000) which are finite and are increasingly diminishing and are being compromised through a combination of demand for the services exceeding supply and a lack of management knowledge (Batabyal 1994, Scheffe et al. 2000). Ecosystems are defined as the individuals, species and populations within a spatially defined area, the interactions among them, and those between the organisms and the abiotic environment (Likens 1992).

This is the second of two papers which document the development of a toolkit which can be used to help identify and assess ecosystem-based enterprises and promote the benefits, and thus wise use, of ecosystems. The initial paper (Bowd et al. in prep a) documents the development of a toolkit which was developed for the identification of resilient estuary-based enterprises in order to encourage socio-economic empowerment for the previously disadvantaged community in South Africa. Bowd et al. (in prep a) noted that poverty elevation projects were rarely successful when their aims included both conservation and economic objectives (Tallis et al. 2008), and attributed this lack of success to there being a hiatus between theory and practice. The Bowd et al. (in prep a) toolkit made fair progress towards addressing this hiatus. The Bowd et al. (in prep a) toolkit is based on the Bowd et al. (in prep b) analytical framework which is centered on Social Ecological Systems (SES), and builds on the Anderies et al. (2004) framework for analyzing the robustness of SES from an institutional perspective, and the Ostrom (2007) framework for identifying the social-ecological variables that affect the resilience of a SES.

Bowd et al. (in prep a) recognizes that if economic opportunities for the previously disadvantaged are to be based on ecosystem services, it is imperative that these services are not negatively impacted upon by an enterprise. The Bowd et al. (in prep a) toolkit comprises the following steps which collectively assist with determining the availability of the services required for a proposed enterprise:

- Compile an ecosystem services supply and demand inventory;
- Identify potential ecosystem related enterprises; and
- Conduct a risk assessment for identified ecosystem related enterprises.

Bowd et al. (in prep a) chose estuarine ecosystems on which to base the development of the toolkit, as estuaries are often subject to very high levels of use, and given their location in the lowermost point in the catchment, are often subject to some of the greatest anthropogenic disturbances.

This paper documents the transferability of the toolkit for use on an inland wetland system, as during the development of the estuarine toolkit (Bowd et al. in prep a) it became apparent that the 'risk assessment' step', with some amendments, could be used to assess the impacts associated with an existing ecosystem-based enterprise. The need to be able to assess the impacts of an existing ecosystem-based enterprise is paramount, as established enterprises have the potential to degrade ecosystems through a combination of poor management practices and high demand.

Wetlands are valuable resources that supply many ecosystem services to people, including water quality enhancement, erosion control, water storage, flood attenuation, stream flow regulation and maintenance of biodiversity (Lannas and Turpie 2009, Hails 1996). Wetlands also provide plant,

water, food, medicinal and livelihood resources to rural communities, and play a key role in grazing, tourism, subsistence farming, and environmental awareness and education, and thus have significant social and economic value (Lannas and Turpie 2009).

Ecosystem-based enterprises are founded within complex and dynamic SES (Anderies et al. 2004), where interactions occur between ecological elements, ecological and human elements, and human elements. These interactions are not always predicable, and are responsible for influencing the supply and demand of ecosystem services. This lack of predictability places the concepts of risk and resilience at the forefront of designing, establishing and operating ecosystem-based enterprises (Bowd et al. in prep a). Resilient ecosystem-based enterprises are those that are able to continue profitability under conditions of varying supply and demand of the services upon which they are dependent.

Resilience is defined by Holling (1996) as '*the measure of a disturbance that can be absorbed before a system changes its stable states*', and is increasingly being used to help understand, manage and govern complex SES (Folke et al. 2004). Resilience theory has widely been applied to SESs (Walker et al. 2002, Ostrom, 2007, Anderies et al, 2004) as it considers both social and ecological elements.

The natural resource and established enterprise chosen to test the transferability of the toolkit on is a rural inland wetland resource-based craft agency which produces wetland fibre products. The craft agency collects material from the Mbongolwane wetland system, which is located near to Entumeni and is approximately 30 km inland of Eshowe, KwaZulu-Natal, South Africa. The craft agency was originally established in 1997 and at that time it focused mainly on producing traditional Zulu sleeping mats which were predominantly made from *Cyperus latifolius* (iKhwane) and *Juncus kraussii* (iNcema). In 2000 a new market opportunity emerged for producing conference bags which were made from iKhwane which grows in abundance at the Mbongolwane wetland. Although iKhwane is not ideally suited to the making of conference bags, due to its lack of durability in comparison to other wetland plants (iNcema), it was selected as it was far more widely available at the wetland in comparison to the other wetland plant species. Efforts were made to cultivate iNcema at the wetland to meet the demand for the conference bags, however this was unsuccessful.

The craft agency supplied the niche market for conference bags until 2007 when at such time a craft agency from elsewhere, who had ready access to *Cyperus involucratus* (iNduma) (which does not grow at Mbongolwane) and iNcema, began producing conference bags. As these plants are more suited to the making of conference bags, their product became generally more favoured than those produced by the Mbongolwane craft agency. This resulted in a decline in the quantity of conference bags being purchased from the Mbongolwane craft agency. In an effort to counteract this loss of revenue the craft agency developed other products, such as pin-boards and table mats. However, these products were much less successful in comparison to the conference bags. A further contributing factor was the loss of the novelty value of the conference bags after they had been produced for a few years.

In order to gauge the transferability of the toolkit, the following criteria have been derived:

1. To what extent did the participants actively engaged in the application of the toolkit?
2. To what extend was the originally development estuary risk assessment transferable to an established wetland-based enterprise in assessing its resilience?
3. How readily can any deficiencies identified in the responses to the above criteria (if any) be addressed?

The first section of this paper presents the methodology used to adapt and assess the transferability of the toolkit. The second section provides brief details of the Bowd et al. (in prep a) toolkit and how it was originally developed. It must be noted that only detailed information on the relevant sections of the Bowd et al. (in prep a) toolkit are provided in this paper, and that the toolkit in its entirety can be found in Appendix C of this document. The third section documents the testing of the toolkit at the study site and the amendments made. The fourth section evaluates the transferability of the toolkit against the criteria posed in this paper.

METHODOLOGY

It was beneficial to identify an appropriate wetland and existing enterprise at the beginning of the study, as it enabled the researchers to visualize a real world scenario when amending the toolkit. The Mbongolwane wetland system was selected as:

- Research has been conducted at the site for the past ten years and good relationships between researchers and local residents have been established;
- Several wetland-based enterprises operate in the area, amongst them agricultural and craft production; and
- The wetland is used for a wide variety of activities and the majority of the community directly or indirectly benefits from wetland services.

The established craft agency was chosen as:

- One of the researchers has worked with the agency for a number of years and has good relationships and insight into the dynamics of the enterprise;
- The enterprise is directly reliant on wetland resources; and
- There is known competition for the wetland resources used by the agency.

In order to obtain a thorough understanding of the dynamics of the Mbongolwane wetland system (uses and users); and the craft agency, detailed background research which took the form of an extensive literature review on work previously conducted at Mbongolwane, and a series of interviews, were performed. Detailed information on the wetland and craft agency was required in order to evaluate how representative of the situation the data obtained from the toolkit was.

Structured and semi-structured interviews were conducted at Mbongolwane with the general community and the crafters on 22 May 2007, 4-6 December 2007 and 17 September 2009. The purpose of these interviews was to determine the supply and demand of the ecosystem services being utilized from the Mbongolwane wetland system; and the performance of the craft agency. A concern of only conducting a single interview was that information on the recent past will predominantly be obtained, as this information is the 'freshest' in the interviewee's minds. The timing of three interviews over 28 months enabled the researchers to gain a good understanding of key issues and trends which have occurred over time. It should be noted that what makes a resilient enterprise is that it can recover over time, thus obtaining accurate historical data was paramount.

The adapted toolkit was tested at a workshop which was held with a representative group of craft agency members at Mbongolwane on 22 September 2009. Although the toolkit requires that input is obtained from a variety of different stakeholder groups who use the wetland services (Bowd et al. in prep a; Walker 1992), only those linked to the craft agency attended. Due to data being gathered from other wetland users during the detailed background research, the absence of other stakeholders groups at the workshop was not considered to have significant detrimental implications for this research. It should be noted that although it would have been preferable to have a variety of stakeholders present at the workshop, the purpose of this paper is to test how the data obtained through implementing the risk assessment provides a representative understanding of the situation at the test site. The purpose of the paper is not to assess the performance of the toolkit at the workshop in isolation.

THE BOWD ET AL. (in prep a) TOOLKIT AND HOW IT WAS ORIGINALLY DEVELOPED

The original toolkit was developed to assist in the identification of potentially resilient estuary-based enterprises. This toolkit combines quantitative and qualitative information gathering, and is largely based on stakeholder engagement. Stakeholder engagement is the main focus of the toolkit for two main reasons. Firstly, in recent years stakeholder engagement has gone from being a 'marginal concern' to a 'driving force' (Lynam et al. 2007) with research tools, and it has become apparent that case-specific customized "bottom-up" tools (which are generally driven by local needs) (Fall et al. 2001, Sturtevant et al. 2007) are more successfully implemented compared to the commonly used "top-down" generic scientific tools (which are frequently developed without input from local

stakeholders). Secondly, resilience theory suggests that the major entities of an SES are identified through approaches that involve constructive communication between experts and stakeholders who understand the SES (Walker et al. 2002, Westley et al. 2002).

The toolkit was developed by a multidisciplinary research team (as recommended by Pickett et al. 1999 and Sturtevant et al. 2007) comprising scientists from three different disciplines: ecological, economic and social. This toolkit was predominantly based on the Anderies et al. (2004) framework for analyzing the robustness of SESs from an institutional perspective. Although the Anderies et al. (2004) framework is based on 'robustness' and not 'resilience', Bowd et al. (in prep a) were of the opinion that there was no need to distinguish between the two as they are considered to have the same attributes for the purpose of developing the toolkit.

The Anderies et al. (2004) framework provides a mechanism for disaggregating the entities of a SES and promotes the identification of the relationships between the different entities. The SES is separated into the following four entities: (a) the resource; (b) the resource users; (c) public infrastructure and (d) public infrastructure providers (which is similar the Ostrom (2007) framework), and considers two types of disturbance, external and internal (Figure 1). Table 1 provides examples of each of these entities, together with the typical management challenges that characterize them, while Table 2 explores the links between each entity and their associated problems.

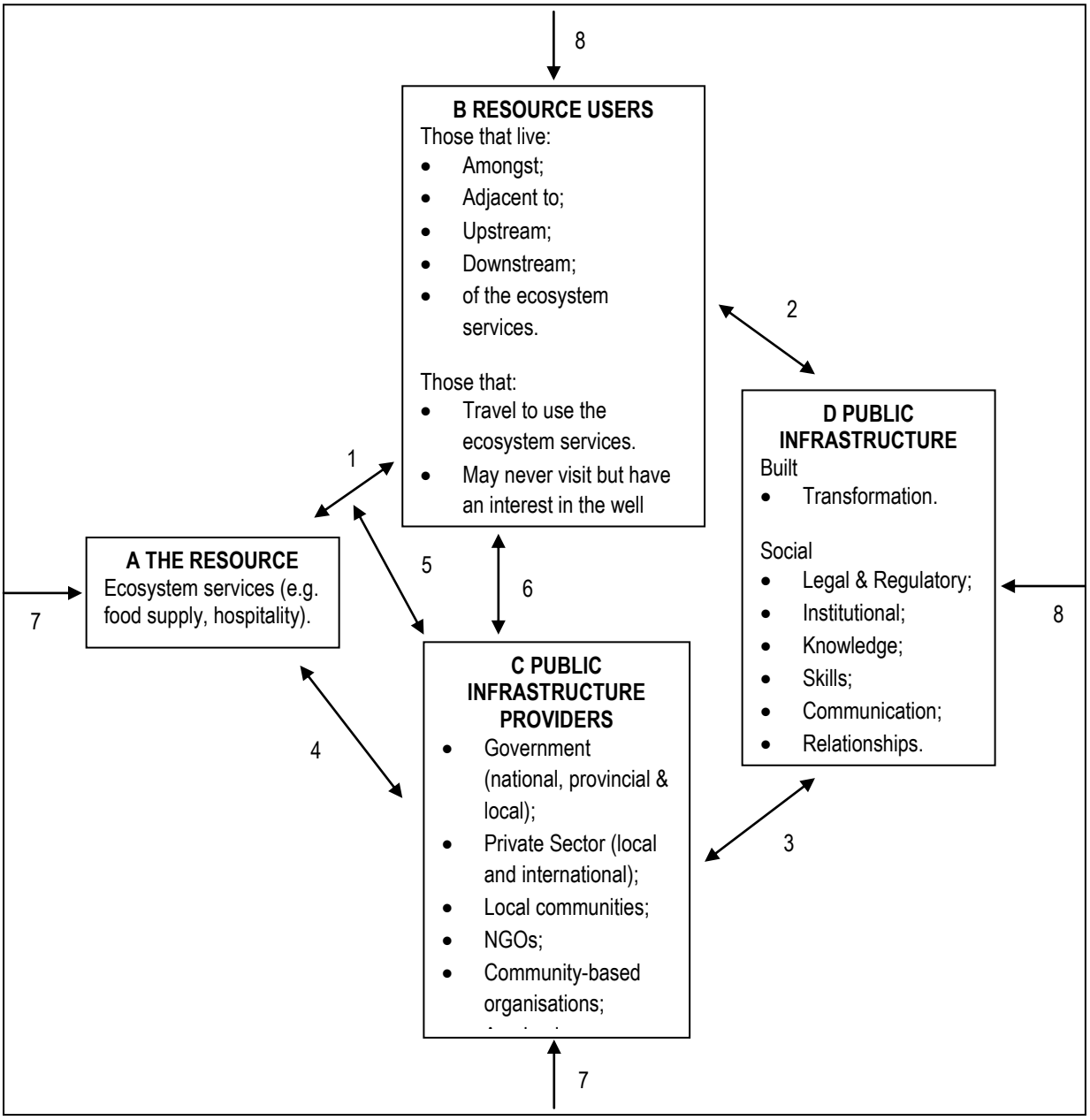

Figure 1: Adaptation of the Anderies et al. (2004) framework showing i) examples of how it relates to an estuarine system as presented in Bowd et al. (in prep a)

Table 1: Entities involved in Social-ecological Systems together with examples and potential problems as identified by Anderies et al. (2004)

Entities	Examples	Potential problems
A Resource	Water source	Uncertainty
	Fishery	Complexity / Uncertainty
B Resource Users	Farmers using irrigation	Stealing water, getting a free ride on maintenance
	Fishers harvesting from inshore fishery	Over harvesting
C Public infrastructure providers	Executive and council of local users' association	Internal conflict or indecision about which polices to adopt
	Government bureau	Information loss
D Public infrastructure	Engineering works	Wear out over time
Institutional rules	Memory loss over time, deliberate cheating	-
External Environmental	Weather, economy, political system	Sudden changes as well as slow changes that are not noticed

Table 2: Links between the different entities within an SES, together with examples and potential problems as defined by Anderies et al. (2004)

Link	Examples	Potential Problems
(1) Between resource and resource users	Availability of water at time of need / availability of fish	Too much or too little water / too many uneconomic fishing
(2) Between users and public infrastructure providers	Voting for providers Contributing resources Recommending policies Monitoring performance of providers	Indeterminacy / lack of participation Free riding Rent seeking Lack of information / free riding
(3) Between public infrastructure providers and public infrastructure	Building initial physical structure Regular maintenance	Overcapitalization or undercapitalization Disrupting, temporal and spatial patterns of resource use
	Monitoring and enforcing rules	Cost / corruption
(4) Between public infrastructure and resource	Impact of infrastructure on the resource level	Ineffective
(5) Between public infrastructure and resource dynamics	Impact of infrastructure on the feedback structure of resource-harvest dynamics	Ineffective, unintended consequences
(6) Between resource users and public infrastructure	Co production of infrastructure itself, maintenance of works, monitoring and sanctioning	No incentives / free riding
(7) External forces on resource and infrastructure	Severe weather, earthquake, landslide, new roads	Destroys resource and infrastructure
(8) External forces on social actors	Major changes in political system, migration, commodity prices, and regulation	Conflict, uncertainty, migration, greatly increased demand

The original generic estuary ecosystem services inventory was compiled using Turpie and Clark (2007) and Hein et al. (2006). This list was used to identify relevant estuarine stakeholders which were separated into four groups: i) local level stakeholders (e.g. individual, family and municipal); ii) provincial and national level stakeholders; iii) international stakeholders (e.g. conservation groups); and iv) down-stream stakeholders (those who utilize services which could be negatively affected by activities up-stream).

Using the ecosystem services inventory and list of possible stakeholders, the toolkit, which comprises four steps and which is supported using a pre-programmed Excel worksheet, was compiled:
Step 1: Ecosystem services supply and demand assessment
Step 2: Future estuary roles identification
Step 3: Enterprise opportunity identification
Step 4: Enterprise risk assessment

Steps 2 and 3 are not relevant when testing the toolkit on an established enterprise, thus these steps are not further discussed in this paper.

Step 1: Ecosystem services supply and demand assessment
The ecosystem services supply and demand assessment first requires that the habitats are confirmed and their functionality assessed. Functionality is assessed as there is the assumption that habitat functionality affects the functionality of ecosystem services. In order to identify the different habitats, the boundaries of the SES first need to be identified. An example of how a SES boundary can be defined is by identifying those areas which can be accessed on foot from the mouth of an estuary.

The functionality of each of the habitats is then calculated, by assessing its condition (0 – 3, three being the best condition), size (area given in hectares) and prominence within the landscape (0 – 3, three being the most prominent). While condition and size are the key determinants of service levels, the landscape context is less important and so is only weighted at 10% of the other two scores in the functionality calculation.

The level of supply the ecosystem services associated with each of the different habitats is scored (0 – 3, three being high, 0 being no supply). The scores are given as if the habitats are pristine. The service supply score is then multiplied by the functionality score, to give a relative service supply level for each service.

Step 1 then requires that the current demand of services is assessed. The toolkit requires that service demands at the local, downstream, provincial and national level are estimated. Estimated figures of users are shown as an order of magnitude (e.g. 0, 100, 1000). Following this the users of the services are then required to be listed, followed by the dependence of each of the difference services being scored between 0 (no impact on welfare) and three (critical for welfare).

Steps 4: Enterprise risk assessment
The risk assessment highlights and provides an integrated overview of potential risks to an enterprise. It also provides practical ways to address the identified risks (Table 3). The risk assessment is conducted for a single enterprise and firstly requires that the severity and likelihood of each risk is scored (0-3, three being very severe / likely to occur), where applicable. A risk with a high severity of impact and a high likelihood of occurrence is considered to pose a major risk to enterprise resilience. The severity and likelihood scores are multiplied to provide each risk with a semi-quantitative value. When complete, the preprogrammed spreadsheet automatically ranks the risks according to the magnitude of risks. Following this the priority risks are then assessed and mitigating actions identified and noted. If severe risks cannot be mitigated, then the proposed enterprise has a strong possibility of failure.

RESULTS: AMENDMENTS TO AND TESTING OF THE TOOLKIT

A comprehensive list of wetland habitats and ecosystem services was compiled (Table 4). It emerged that there are numerous ecosystem services which are provided by both estuaries and wetlands. These include cultural places, recreation and fibre extraction.

The aspect of the toolkit for assessing the functionality of the different habitats remained unchanged, thus condition and prominence of each wetland habitat within the landscape was scored out of three, and size was given in hectares. However taking into consideration the: i) type and scale of enterprise being assessed at the test site; ii) the amount of time and effort required to conduct this aspect of the toolkit; and iii) the irrelevant detail of data obtained, the researchers concluded that at this test site, this aspect would have been more effective if participants had had a shared understanding of the different habitats which make-up a wetland, and that the overall condition of the wetland and its prominence within the landscape was scored; and the size of the entire wetland was noted. This is not to say that when using the toolkit to assess an established enterprise scoring should always be done at a 'wetland' level. Whether different habitats or an entire ecosystem is scored is enterprise and situation specific. An example of an enterprise where scoring should be ascribed at a 'habitat' level is a hotel, which may use services which are provided by a variety of different wetland habitats, such as surface water for recreational sports (to attract visitors) and vegetation to aid in the purification of water used for laundry.

The purpose of the ecosystem services inventory in the original estuary toolkit was to screen for available ecosystem services which could be used to base an enterprise on. However, when using the toolkit to assess an established enterprise, the ecosystem services inventory is used by the participants to stimulate knowledge of the broader context of the wetland supporting the enterprise.

At the test site the ecosystem services inventory was made site specific. This was done by first orienting participants using aerial photographs, maps and landscape photographs of the SES, and then deleting the irrelevant services contained within the comprehensive ecosystem service inventory.

Similarly to the functionality scoring aspect of the toolkit, each habitat was scored (out of three) for each habitat within the ecosystem services inventory. Again this was done to provide participants with a broad context within which to better understand the extent of the wetlands usage. However at the test site it became evident that the different habitats did not need to be identified and assessed separately. This was because this level of detail did not contribute to the implementation of the toolkit for an established enterprise of that nature. Thus at the test site it would have been preferable to have grouped the habitats and score each ecosystem service at a 'wetland' level. This is not to say that when using the toolkit to assess an established enterprise scoring should always be done at a 'wetland' level. Whether ecosystem services are scored at a habitat or at an entire ecosystem level is enterprise and situation specific.

The assessing the service supply level aspect of the toolkit remained unchanged, thus the service supply level of each of the ecosystems services supplied by each of the different ecosystems was scored between 0 and three (three being high, 0 being no supply).

The original estuary toolkit separates stakeholders into four groups: i) local level, ii) provincial and national level; iii) international; and iv) down-stream. Although these groups were initially used at the test site, it became apparent that the following stakeholder groups were more applicable: i) permanent on-site demand; ii) fluctuating visitor on-site demand; and iii) provincial and national demand. Permanent and fluctuating on-site demand were differentiated as it was known that the demand for some of the services was seasonally influenced (e.g. fibre harvesting), and that this needed to be taken into consideration due to the nature of the enterprise being assessed. Down-stream users were not deemed to be applicable for the Mbongolwane scenario as none could be identified. Similarly to the functionality and ecosystem service scoring, determining which stakeholders groups are appropriate when implementing the toolkit is enterprise and situation specific. To assist with determining appropriate stakeholder groups, a number of questions were introduced into the toolkit (Table 5).

The estuarine toolkit requires that service demand be estimated and shown as an order of magnitude (e.g. 0, 100, 1000). However due to the relatively small size of the Mbongolwane wetland system, this type of scoring was not deemed appropriate. However the researchers saw merit in obtaining data on the current and predicted demand for services. Thus additional questions and scoring were introduced into the toolkit (Table 5). Determining an appropriate 'order of magnitude' when using the toolkit to assess an established enterprise is enterprise and situation specific.

The estuary risk assessment aspect of the toolkit, which is the main focus of this paper, was amended in order to make it applicable for use on an established enterprise (Table 3). Due to the limited literacy level of the participants, not all questions were asked during the workshop. However, where possible, missing technical information (such as 'impact of infrastructure on resource levels') to populate the risk assessment was obtained through discussions with local government officials and interviews with the crafters and community. As stated previously, the purpose of this paper is not to assess the performance of the toolkit at the workshop in isolation, but to test how the data obtained through implementing the risk assessment provides a representative understanding of the situation at the test site.

Table 3: Established wetland-based enterprise risk assessment showing amendments made to the estuary risk assessment and data obtained from the test site A=Severity of impact on enterprise (score 0 to 3, 3=most severe); B=Likelihood of occurrence to enterprise (score 0 to 3, 3=most likely to occur); and C=Risk to enterprise (severity x likelihood). Mitigatory actions were only provided for risks which scored over 6 (C). N.B. where applicable, 'enterprise' has been substituted for general 'user groups'.

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
Relationship between the resource and the resource users						
Addressed in the ecosystem services supply and demand assessment. Details of the amendments made to this aspect of the toolkit are provided in the paper.						
Relationship between the different resource users						
Could the enterprise user group deplete the resource?	Original question split into two	It is unlikely that any of the resource users could deplete the availability of iKhwane in the wetland, as research shows that that the abundance of the resource is high in relation to amount harvested, and it is very resilient to harvesting and re-grows rapidly after being cut (Kotze et al. 2002; Traynor et al. 2010). However if iNcema, which is currently in short-supply at the wetland, is used to make crafts, it unlikely that the availability of these materials will support the demand.	3	3	9	The craft agency should focus on developing products which specifically build on the strengths of iKhwane, namely that of the plaited coil (Kotze and Traynor in press).
Are there conflicts between the enterprise user group and other user groups?	Question made specific to consider conflicts between the enterprise and other user groups.	The Mbongolwane wetland system is used to collect reeds, sedges (ikhwane) and grass, medicinal plants, domestic water, and is a place for religious ceremonies, research and subsistence cultivation. However the main conflict comes from cattle trampling on the ikhwane material whilst grazing. Although there is always iKhwane available, the areas which are easy to access are the same areas where the cattle prefer to graze. For the availability iNcema grazing is a major threat.	3	3	9	Material is and should continue to be collected and stored for use when orders are taken. The cattle owners should communicate to the craft agency when and where grazing will occur, in order to allow the harvester's time to collect raw material before it is trampled. In addition, separate harvesting and grazing areas in the wetland should be negotiated.
If there are conflicts between the enterprise user group and other resource user groups, are the other user groups reliant on the resource?	Second part of an original question but with amendments	The cattle benefit hugely from grazing in the wetland, as that is where the most nutritious grazing is, however they are not entirely reliant on using the wetland.	2	1	2	

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
Is the wetland and its available services located within a clearly defined spatial boundary that can exclude users without legal rights?	Unchanged	The wetland's harvestable material is located within a clearly defined spatial boundary. For many years outsider harvesters have come to collect huge quantities of iKhwane as the Mbongolwane system has the largest stock of this material in the area. Those who come from outside the area are required to have a stamped letter from the iNkosi of the KwaNtuli Traditional Authority (KTA). In recent years the iNkosi has been considering the introduction of charging outsiders to collect from the wetland. The consensus was that this charging system would be implementable.	N/A			
Are the people with rights to resource use a clearly defined group separate to those without rights of resource use?	Unchanged	Currently, to some degree, as the principle rights to use the wetland resource lie with those residing in the KTA area. However the introduction of a charging system will further define rights to the resource.	N/A			
Does everybody in the community with user rights participate in the resource use?	Unchanged	In a survey of 50 households living near the wetland, 70% of households were found to use craft plants in the wetland (Kotze et al. 2002).	N/A			
Are there any positive relationships between the users groups who have a right to use the resource?	Unchanged	Although there is conflict between the cattle owners and the crafters, many cattle owners know people who do craft and understand the importance of the material.	N/A			
Can one user group's actions reduce the levels of services available to the enterprise user group?	Unchanged	Yes. Burning to promote plant growth for cattle grazing reduces the availability of harvestable material (temporarily), however i) material can be collected from elsewhere; and ii) burning may improve the quality of craft material.	2	2	4	
The availability of infrastructure, economic, social and institutional services						
What built infrastructure is available and to what extent is it developed and maintained?	Unchanged	The craft agency has a centre where the crafter can go to weave and attend meetings. The centre also provides a place to store the products and raw material. The centre is generally well maintained, however once products were damaged when the roof of the centre leaked. This occurred as initially profits from craft sales were not reinvested into the maintenance of the centre. The centre is located in a	2	1	3	

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
		central position on the community and is next to a well maintained road. There is cell phone coverage in the area.				
Considering current infrastructure, is the safety of the enterprise user group secure all year round?	Unchanged	Yes. The roads to distribute the product and collect the raw material are accessible all year round.	0	0	0	
Does the built infrastructure meet current demand for access (the type, size and quality of infrastructure)?	Unchanged	Although cell phone coverage in the area is very good, the cost of using this infrastructure limits communication between the crafters and their clients. There are a number of reasons for this: i) the cell phones are privately owned by individuals who feel it is unfair why they should use their own phone for the benefit of the whole agency; ii) language barriers between the crafters and the clients; iii) low literacy level and a lack of marketing skills.	3	3	9	A dedicated craft agency phone must be arranged and collectively paid for by the crafters. Literacy and skills training should be introduced. Ideally a computer should be introduced to: i) reduce the cost of phone calls (skype); ii) allow better access to clients (existing and potential); and iii) obtain a better understanding of market demand. However the introduction of a computer can also bring challenges, such as having an asset which can be stolen and the cost of electricity and ongoing maintenance.
What are the levels of skills (education, knowledge, communication) amongst the enterprise user group?	Unchanged	While the business skills within the enterprise are very limited, there is good local knowledge concerning the resource (e.g. when is the best time of year to harvest) and factors potentially impacting negatively on the resource (e.g. livestock grazing).	2	2	4	
What are the levels of skills (education, knowledge, communication) amongst the resource managers / government?	Unchanged	The government has a high level of skill, however the resource users note that government presence in the KTA is very limited.	3	2	6	The craft agency should request assistance, in the form of small enterprise skills training and on natural resource-based management, from the relevant government departments.

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
How adaptable is the enterprise user group to i) changes in the availability of the resource; ii) changes in demand; iii) pursuing other activities to sustain livelihoods, etc.?	Unchanged	The craft agency has shown great adaptability to changes in the availability of the crafting material by producing a product which is made from an abundant material in the wetland, and stockpiling raw material to ensure that further orders can be met. When there is a drop in product demand, the crafter shift to other income generating activities, such as vegetable gardening. When product demand increases other family members are given the task of tending to the vegetables.	0	0	0	
What rules of law (local, provincial, national, international) are applicable to the enterprise resource users?	Unchanged	At Mbongolwane it is taboo to collect iKhwane before the end of April (summer). If harvesting does occur there is the belief that a big storm and a seven headed serpent will emerge from the wetland. The end of summer is when the plants naturally die back, and harvesting before this time minimises the impact of harvesting on the wetland (Kotze and Traynor in press).	0	0	0	
To what extent are these rules of law enforced?	Unchanged	Due to the belief of the seven-headed serpent and big storm occurring if harvesting take place outside of harvesting season, this rule is mostly respected amongst the crafter. However if a large order is received outside of harvesting season then crafters who have not accumulated enough raw materials are known to collect. This occurrence is very limited as the material harvested outside of the harvesting season is generally not suitable for weaving.	1	3	4	
Who principally controls the wetland and what rules of law (local, provincial, national, international) are applicable to the enterprise user group?	Additional question	The crafters were of the opinion that the iNkosi principally controls the wetland; however there is was also evidence of self-regulation between the crafters. For example, crafters are not supportive of harvesting taking place before April due to the threat of a big storm and a seven-headed serpent appearing in the wetland.	N/A			
To what degree are cell, telephone, email, fax available to the resource	Removed as addressed in a					

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
users; and to what degree are these facilities necessary?	previous question					
Resources for management						
To what degree is government contributing to the management of resource users with regards to: i) the resource; ii) research; iii) infrastructure; iv) skills / knowledge; v) security; vi) communication?	Unchanged	The government contributed to supporting sustainable use of the wetland through a LandCare project from 2000 to 2004, but following this the government has contributed little to the management of the resource.	2	2	4	
To what degree is local governance, including traditional leaders, contributing to the management of resource users with regards to: i) the resource; ii) infrastructure; iii) skills / knowledge; iv) security; v) communication?	Additional question	The iNkosi is considering the introduction of a charging system whereby harvesters from outside the KTA are charged for collecting material from the wetland.	2	2	4	
Impact of infrastructure on resource levels						
What are the impacts of i) knowledge / skills; ii) infrastructure; iii) security / governance; and vi) communication on the resource?	Unchanged	The traditional knowledge held by the crafters, and local governance supports the scientific knowledge that harvesting should not take place before the end of summer (April). The well maintained road route and craft centre (to a lesser degree) allow the crafters to obtain raw material and distribute their products. This 'good' infrastructure results in material, which is in abundance, being extracted from the wetland. If iNcema was being used, the good access and centre would promote the depletion of these plants. Communication, in the form of cell phones is hindering the success of the enterprise.	2	3	6	iKhwane should remain the preferred choice for craft material. Communication and skills should be improved (see above).
Policy implications						
What policies are applicable to the resource users and what implications do these policies have on the resource users?	Unchanged	Government wants to encourage micro enterprises, especially those which can uplift the rural poor, most notably women who are considered the most disadvantages group.	N/A			

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
		Government provides grants to those who are unemployed, disabled, retired or caring for children.				
To what extent do these policies give i) adequate protection to the resource; ii) give adequate security (i.e. access, availability) of the resource for the resource users?	Unchanged	The above two policies do not give direct protection to the resource, however it is understood that the younger generation is far less interested in craft as they can survive on the money from the government grants. Less crafters in the future may reduce the impact of crafting on the wetland system (which is currently minimal), however if there is no reliance on the health of the system to provide craft material, there is potential for detrimental activities on the wetland to go unnoticed.	2	2	4	
Integrated implementation of developments						
Are there conflicts between government actions and / or government infrastructure?	Unchanged	This question was not applicable at the test site.	N/A			
Monitoring the state of the resource						
To what extent is the state of the resource monitored and who is responsible for this monitoring?	Unchanged	The state of the wetland system is not formally monitored. However the wetland has been the focus of University research projects, and the local conservation department has extension officers in the area who visit the wetland from time to time.	3	2	6	It is recommended that formal monitoring of the wetland system takes place, especially if iNcema, or any other type of plant with limited availability, is used to make products.
Is there evidence, and if so to what extent, are the findings of any monitoring efforts used to evaluate management, and thus influence future actions (adaptive management)?	Unchanged	Although a formal monitoring system is not in place, there is some degree of monitoring of illegal activities though the crafters showing evidence of self regulation, and the iNkosi being aware that there are an increasing number of harvesters visiting the wetland system, and thus implementing a charge to harvest at the site.	2	2	4	
Co-management of built or natural ecosystems						
How adequate is the cooperation between the enterprise resource user group and the government to manage the i) built environment; ii)	Unchanged	There is very limited co-corporation between the craft agency and the government. To date the majority of external assistance has come from the private sector. However it is worth noting that the largest conference bag	2	3	6	Actions should be taken to encourage government to provide greater assistance for the craft agency (e.g. skills training).

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
social / cultural environment; iii) natural environment?		order came from a government department.				
Can the enterprise user group influence upstream users who may influence the ecosystem functioning and therefore the supply levels of services?	Unchanged	This is not directly relevant to the test site, however as mentioned above, the crafters can communicate with the cattle owners to reduce the destruction of craft material in the wetland.	N/A			
Do high transaction costs exclude key stakeholders from the decision making process?	Unchanged	In the past conflict between the crafters and the cattle grazers has required assistance from the iNkosi to resolve the dispute. However, the iNkosi requires payment before he will enter into conflict resolution negotiations between the different parties.	2	2	4	
Capacity and competency to implement policy						
What policies are applicable to public and private infrastructure and to what degree are these policies implemented?	Unchanged	Government seeks to provide the population with access to basic services, which includes access (in the form of roads) and safe drinking water. The government has provided a good local road network and has recently introduced water stand pipes within the community. The road infrastructure has assisted with material collection and product distribution for the crafters. The introduction of stand pipes has reduced the need for women to spend time collecting water, and this in turn has enabled women to spend more time on lucrative activities, such as craft production.	2	2	4	
Inter-government communication						
Is there sufficient communication between different government tiers and departments?	Unchanged	The consensus from the community is that there is insufficient communication between the different government tiers and departments. Although a co-ordinated relationship between the different government tiers and departments could results in the craft agency receiving much needed skills and resources to improve the enterprise, this is unlikely to occur in the short-term.	N/A			
Drought, floods, changes in supply of resource services						

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
What is the nature of severe biophysical impacts on the resource and what is the significance and frequency of these impacts?	Unchanged	Northern KwaZulu-Natal is currently in its 8th year of drought, however the effect of the drought on iKhwane has been gradual and to date is not deemed as significant by the craft agency. Floods in the area occur infrequently, however when they do occur not all of the ikhwane is generally rendered unacceptable for harvesting. Usually re-growth of the iKhwane occurs within a few months in those areas which have been damaged. .	1	3	4	
Disregard for resource fluctuations						
To what degree do the enterprise user group plan for fluctuations and is this planning adequate?	Unchanged	As harvestable material (iKhwane) is available, even during extreme weather conditions, little planning takes place, other than the craft agency stockpiling material, in order to meet the orders which are placed when harvesting is not permitted. Although iKhwane is currently plentiful, in time increased gazing pressures and / or increased frequency of flood event may result in iKhwane not being so readily available. Under these conditions greater planning for fluctuations will be required.	3	2	6	The craft agency should be pro-active against the impacts of increased grazing and flood events on the availability of craft material. The craft agency should raise this issue with the cattle owners before it occurs.
Droughts, floods, wash-aways, destroyed communication						
To what degree do external shocks damage public infrastructure with regards to: knowledge, skills, floods, over exploitation of resource, establishment or non-maintenance of roads, communication?	Unchanged	When flood events have resulted in the road network being inaccessible, the department of transport has conducted the necessary repairs to the road infrastructure.	3	1	4	
To what degree are these external shocks managed / prepared for (i.e. insurance, forward planning)?	Unchanged	It is difficult to gauge to what degree the crafters are prepared for external shocks. It is known that during times of low product demand, the crafters plant garden vegetables; however it is not known if planting occurs when no orders have been placed for sixth months, or whether they are planted at the first indication that orders will not be coming through in the near future. Due to the low literacy level of the crafters and thus unawareness of	3	3	9	The craft agency needs to be educated on the possibility of external shocks, and what preventative methods can be implemented to reduce the impacts of the shocks. Education can either come from government or a private entity.

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
		possible external shocks, it is unlikely that the crafters are prepared for any major external shocks.				
Poverty and affluence – over use and exclusion						
To what extent does poverty, gender and / or affluence influence / affect over use and exclusion of the resource?	'gender' added to question	In Zulu culture, the views of men are valued above those of women. As the craft agency is dominated by women (99% of crafters are women), and the grazing of cattle is controlled by men, the consensus was that the women felt that negotiating separate harvesting and grazing areas was futile.	2	3	6	As the cattle owners may well have a wife or daughter who bring money into the household from the selling of craft products (based on Kotze et al. 2002 who stated that 70% of households were found to use craft plants in the wetland), the craft agency should attempt to negotiate separate grazing and harvesting areas before increased grazing or flood events occur.
Conflict, crime, uncertainty, change in demand						
Are there any internal social and economic forces, such as conflict, which can impact on the demand for wetland services by the enterprise user group?	Question amended and split into two	It was established that there was internal conflict between different members of the craft agency. Some members were not supportive of the appointed treasurer and others felt it was unfair that one particular member was always chosen to communicate with potential clients.	3	3	9	The craft agency requires educating on internal conflict resolution and business management.
Are there any external social and economic forces (e.g. interest rates, crime, competition), which can impact on the demand for wetland services by the enterprise user group?	Second part of original question above	Due to a combination of a lack of market awareness and a rival craft agency having access to the preferred conference bag material, the success of the Mbongolwane craft agency has significantly declined in recent years. Although this decline has resulted in a reduced demand for wetland material, there is concern that if fewer crafters are involved in craft production there will be less reliance on the health of the system. A consequence of this is that there is potential for detrimental wetland activities to go unnoticed.	3	3	9	The craft agency must become more aware or current market demands (e.g. access to internet and attending workshops and conventions), and identify products which are better suited to iKhwane than conference bags.
Have the rules of resource use and benefit sharing been understood and agreed to by all people who have	Unchanged	No. There is no formal understanding of the benefits obtained from the wetland services amongst the different users groups.	3	3	9	The craft agency must educate those that use (cattle owners) and manage (iNkosi) the wetland

Questions	Amendments made to estuarine risk assessment	Results obtained from the test site	A	B	C	Identify actions to mitigate the risk*
rights of use before use commences?						system on the importance of the harvested material.
Increased use pressures						
Are there external social and economic forces (e.g. water provision, housing) creating pressure on the availability of infrastructure which impacts on the enterprises?	Unchanged	Increased unemployment due to the worldwide recession has resulted in the unemployed returning to their rural homes. Increased rural population increases the pressure on services in the rural area. This reversed urbanisation could lead to increased grazing pressures and cultivation in the wetland to meet food demand. These activities are likely to impact on the availability of harvestable craft material.	3	1	3	
Effectiveness of governance						
Does government have capacity / skills to cope with social and economic shocks to the enterprise (resource, access, infrastructure)?	Unchanged	Government departments do have the skills to assist the enterprise to cope with social and economic shocks, however the consensus was that it was unlikely that the government would directly come to the aid of the enterprise, due to its small size. Indirectly the government has assisted with providing social grants to allow those in the community to survive during times of no income. The KTA is not in an economic position to assist the enterprise to cope with economic shocks, however, due to a relatively high regard for traditional leadership within the community, the KTA may be able to provide assistance with social shocks.	1	3	4	

Table 4: Comprehensive list of inland wetland habitats and ecosystem services, and their presence at the test site. * indicate if the habitat / ecosystem service is present at the test site

Wetland habitat	Ecosystem services provided by a wetland	
Open water* Reedbeds* Emergent vegetation >0.8m predominantly in water >0.5 m* Emergent vegetation temporarily in water <0.5 m (sedge & grass)* Substrate– sand, clay, organic matter*	Woven craft* Thatching grass* Medicinal plants* Clay and sand used for building purposes (block, plaster, paint) Clay to make pots and vases Drinking water Domestic use (including clothes washing, cooking, cleaning and bathing)* Commercial or industrial use (e.g. cooling water for an industrial process) Religion / * Cultural traditions (e.g. mourning of a death)*	Tourism (e.g. tour groups, bird watching) Research* Nature conservation Subsistence cultivation farming* Commercial cultivation farming Cattle grazing and drinking* Hunting Fishing

Table 5: Additional questions and scoring introduced into the wetland toolkit in order to assess service demand

Demands	Question type	Question
Local demands	Entry questions	Who from the local community demand this wetland service?
		Has the permanent local community demand increased or decreased over the past 10 years?
	Scoring questions	Current permanent community demand (excluding seasonal variation), 0=no demand, 3=major demand
		Predicted permanent community demand over the next 10 years, 0=no demand, 3=major demand
Other demands	Entry questions	Who visits from outside the community and utilizes the wetland services?
		Has visitor demand increased or decreased over the past 10 years?
	Scoring questions	Current visitor demand (excluding seasonal variation, 0=no demand, 3=major demand
		Predicted visitor demand over the next 10 years, 0=no demand, 3=major demand
	Entry questions	Who from outside the area (at a regional or national scale) is concerned with the wetland services (e.g. government, conservation bodies)?
		Has this regional or national interest increased or decreased over the past 10 years?
	Scoring questions	Current regional / national demand, 0=no demand, 3=major demand
		Predicted regional / national demand over the next 10 years, 0=no demand, 3=major demand

DISCUSSION AND CONCLUSION

In line with the original toolkit (Bowd et al. in prep a), the amended toolkit is primarily based on stakeholder engagement, whereby both quantitative and qualitative information was gathered from the participants. During the workshop the participants were comfortable using their knowledge to assign scores to the different ecosystem services supplied by the wetland. This was despite the fact that most had a fairly low level of formal education and had no prior experience with participating in a similar type of exercise. In addition, the participants engaged freely with other participants in discussing the basis of their scores to reach a consensus view. Although the ecosystem services supply and demand inventory is not the main focus of the toolkit when applying it to an established enterprise, it did contributes to stimulating dialogue between the participants and helped to build a common understanding of the system and its relative importance in supplying a range of different ecosystem services. Thus from this perspective the toolkit was found to be transferable.

A number of amendments to the ecosystem services supply and demand inventory were made or suggested. These included assessing wetland functionality and ecosystem services at a 'wetland' level, instead of at a 'habitat' level. The level at which scoring occurs is entirely site specific, as with determining relevant stakeholders groups. However it should be noted that when conducting the toolkit for an establish enterprise, the services inventory is not the main focus of the exercise (only used to get a shared understand of the wetland system amongst the participants) and that time and effort should be directed towards thoroughly conducting the risk assessment.

A proposed amendment to the services inventory could be to replace the three point scale with a four or five point scale in order to assist with distinguishing intermediate level scores. This amendment to the toolkit is minor and should be determined at a site specific level. However it should be noted that increasing the scale may to increase the time needed to reach score consensus.

The success of transferring the risk assessment is not gauged by the list of mitigation measures which are compiled to improve the resilience of an enterprise, because the risk assessment may well be used to assess an enterprise which cannot be resilient no matter what mitigation measures are implemented. The success of transferring the risk assessment is gauged on whether the risk assessment has extracted sufficient information to gain an accurate understanding of potential risks to the enterprise. Although it is generally hoped that the mitigation measures will result in a more resilient enterprise (provided the enterprise is not negatively impacting on the resource) the main focus of the risk assessment is to highlight potential threats to the enterprise.

Table 3 presents the amendments made to the risk assessment questions, which were relatively few in number (seven amendments to a list of forty-one questions) and can be considered as minor (e.g. the splitting of some questions into two). The original questions contained within risk assessment presented in Bowd et al. (in prep a) was compiled using a matrix which considered all combinations of the four different entities identified by Anderies et al. (2004) which make-up a SES (e.g. impacts of resource users on the resource, impacts of built infrastructure on the resource). This methodical consideration of possible impacts of one entity on another entity provided a degree of assurance that all possible impacts had been considered.

From reviewing the risks presented in Table 3, it can be concluded that the risk assessment provides a comprehensive list of data which not only highlights current and potential risks surrounding the: i) natural resource (wetland); ii) conflict with other resource users (most notably cattle owner); iii) public infrastructure (access roads and local beliefs and traditions); and iv) public infrastructure provides (government departments), but also considers the relationship within and between these different entity (as defined by Anderies et al. 2004), as well as internal and external socioeconomic disturbances (such as changes in market demand and conflict between different members of the craft agency).

The results of the risk assessment identified a number of areas of high risk. Areas regarded as having a high risk were those that when the severity scores (scored out of 3) and the likelihood of occurring

scores (scored out of 3) were multiplied and a score of six or greater was obtained. Where a high risk was indicated, mitigation measures were provided. The risk assessment identified the following as potential risks to the resilience of the enterprise:

- Products, which were made from iNcema, are pursued and cultivation of these plants is not undertaken (cultivation of iNcema has failed on the past);
- Research into products which iKhwane is suitable for is not pursued;
- Communication between the crafters and cattle owners to; i) determine the timing of harvesting and grazing; and ii) demarcate separate harvesting and grazing areas within the wetland does not take place;
- Material is not continued to be collected and stored for use when orders are taken;
- A dedicated craft agency phone, with credit, is not arranged amongst the crafters;
- The crafters are not educated about changes in market demand;
- Literacy classes and small enterprise skills training (including conflict resolution) is not introduced; and
- The crafters are not educated on the possible external shock to the enterprise, and how these can be dealt with.

Through reviewing the results of the risk assessment it can be concluded that the original risk assessment, with slight amendment, is transferable to an established ecosystem-based enterprise. However, although the risk assessment did highlight that there was internal conflict between certain members of the craft agency (unease about the treasurer and resentment towards the client liaison person), the researchers are of the opinion that internal enterprise dynamics are highly complex and an entirely separate risk assessment should be compiled in order to assess the internal risks to the enterprise. It should be noted that type of risk assessment is not needed when using the toolkit to identify potential resilient natural resource-based enterprises, as generally those involved in a potential enterprise have yet to be determined. The researchers believe that assessing the external resilience of an enterprise, which the researchers belief the amended risk assessment does, is equal in importance to assessing the internal resilience of an enterprise. Thus an internal risk assessment is required to be compiled before the external risk assessment, presented in this paper, is fully implementable.

It is recommended that the internal risk assessment should pose questions around: power relations; hierarchical structures; gender dynamic and financial survival strategies. Although the external risk assessment did touch on these issues, far greater questioning is required.

From the above discussion it can be concluded that the toolkit, with slight amendment and which comprises an ecosystem services supply and demand inventory and a risk assessment, is for the most part, transferable for use when assessing the resilience of an established enterprise. The Anderies et al. (2004) framework provided the foundation to the compiling of a risk assessment which took into consideration all possible interactions within and between the different entities and thus ensured that a thorough understanding of the SES was achieved through implementing the toolkit.

Making the toolkit applicable to inland wetlands from estuaries only required the habitats and ecosystem services to be supplemented and / or substituted with a few resource specific habitats and services. This indicates that the toolkit is easily transferable to other natural resources (e.g. forests, grasslands).

In summary, the toolkit presented in this paper further addresses the hiatus between theory and practice, which was a driver for the original Bowd et al. (in prep a) toolkit. This amended toolkit builds on the theory of the Anderies et al. (2004) framework, and provides a practical toolkit which

involves and can be used by a diversity of stakeholders to assess the potential resilience of an established enterprise.

ACKNOWLEDGEMENTS
Dr. Steve Mitchell of the South African Water Research Commission and Mr. Andrew Mather of eThekwini Municipality for their valuable input into the development of this toolkit. The participants of the craft agency workshops for sharing their knowledge. Funding for this project came from the South African Water Research Commission: Estuaries and Economic Empowerment project.

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Appendix E

Draft of paper to be submitted to Water SA

CONNECTING SUPPLY AND DEMAND: A PROCESS FOR STAKEHOLDER LEARNING ABOUT TRADE-OFFS IN SOCIAL-ECOLOGICAL SYSTEMS

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Introduction

As the relative scarcity of ecosystem services (MA 2005) increases attention focuses on sustainable use that is efficient and fair. Ison et al. (2004:6) observed that "it is very useful to view *sustainability* as an emergent property of stakeholder interaction, and not a technical property of the ecosystem." This understanding places negotiation, and collaborative planning around access to and use of ecosystem services as central processes in progress toward sustainable use (Innes 2004). Perrings (2006) commenting on a study by Rodriguez et al. (2006), observed that "the users' own valuation of the resource is wholly dominated by the products it yields" suggesting that individual mental models are context specific and incomplete (Jones et al. 2011). The implication is that interest-based negotiation processes (Innes 2004) have to be directed toward consensus and solutions among actors holding multiple values within the ambit of three broad goals: ecological sustainability; fairness taking present and future generations of humans and other species into account; and of maximising utility or human welfare (Liu et al. 2010).

Landscapes are ecologically and socially heterogeneous and complex, reflecting how production, flow and use of benefits, and the interactions between them, vary over time and space. Because valuation is such a dominant force in shaping user perception, the goals stakeholder's hold reflect their own assumptions, knowledge and understandings about how the system or subsystem is structured and functions. These constrained mental models have to be expanded to accommodate the system views of other stakeholders before it is possible to find solutions that are fair, efficient and direct patterns of use toward sustainability (Brugnach et al. 2008; Bosch et al. 2003; Klimoski & Mohammed 1994). The expanded system view should be spatially-explicit if the assessments required are to expose mismatches between winners and losers when considering trade-offs (Balmford et al. 2008).

Sustainability requires integrated management for 'ecological health' and 'social health'. The former relates to the ability of the ecosystem to sustain the supply services and the latter relates to the contribution sustainable and equitable use of ecosystem services makes to societal wellbeing. Implied in the concepts of ecological and social health is the notion of being able to sustain health under changing circumstances. Resilience as this property is termed, thus ultimately reflects how society adapts its livelihood demands for ecological services that change in time and space in response to how we use them and to other factors such as climate change.

To promote social-ecological health it is necessary to consider both sustaining the supply of services (ecological health) and equity and efficiency in the distribution and use of the sustainable supply of benefits (social health). Maximising social-ecological health under these constraints has much to do with iterative social bargaining processes that are used to make empathetic tradeoffs among competing livelihood benefit streams, particularly under conditions of scarcity. This requires social learning that enables participants to understand and monitor both how choices affect the sustainability of service supply, and how they affect livelihood benefit streams. Deliberative processes among stakeholders are required to enable social learning (McCarthy et al. 2011; Reed et al. 2010) and the co-evolution of socially robust knowledge that is necessary for at least some constructs to be shared so that mental models expand and problems can be reframed in the context of uncertainty (Brugnach et al. 2008; Klimoski and Mohammed 1994; Newell 2001; Plummer 2009; Wenger 2009a, b; Nowotny et al. 2001).

In this paper we present a workshop-based process that is designed to help stakeholders expand their mental models and as they move toward a shared representation of their social-ecological system (Langan-Fox et al. 2001; Anderies et al. 2008). Our premise is that stakeholders are 'experts' holding significant understanding that is largely defined by the context in which they engage ecosystem services but individually they are commonly uninformed, even unaware, of the understandings of others deriving benefit from the same system. The process encourages participants to: appreciate the need for and to develop a larger, more integrated systems view; cater for divergent views and values; recognise and acknowledge interdependence; and be willing to adapt their context (see Bosch et al. 2003). We draw on Newell's research on the theory of interdisciplinarity (2001:15) so that the process is designed to:

- Draw on individual perspectives to define the issues, determine relevant scenarios, develop among participants a working command of relevant concepts; gather individual understanding, study the issues generating shared insights understandings; and
- Integrate insights through construction of a more comprehensive shared perspective by identifying conflicts, using insights to search for common meanings, evaluating individual assumptions, generating a common vocabulary, creating common ground, constructing new understandings and producing and testing a solution.

Principles underpinning the process

The process is based on six principles that are required for stakeholders to be able to contribute to making and supporting informed decisions:

1. Acknowledge that knowledge and understanding are context specific and incomplete
2. Acknowledge social-ecological complexity, uncertainty and the need to accept an adaptive, learning approach to management
3. Acknowledge the variable capacity of the ecosystem to deliver services
4. Acknowledge interdependence of stakeholders with diverse understandings, demands for services, and that demands may not be compatible
5. Be willing to tailor demand to remain within the capacity of the system to supply services
6. Be empathetic and willing to address demands in a manner that considers both efficiency and equity

The process

The interactive learning process has been designed to help stakeholders develop a working command of the relevant concepts that enables them to exchange understandings and learn about the role of ecosystems in their society. It uses ecosystem services to develop the shared insights of the relationships between supply and demand that are necessary for understanding the need for trade-offs when managing for sustainable use. We use an estuary as an illustrative example.

To determine the relationships between supply and demand stakeholders are challenged by questions such as:

- What services can the estuary deliver?
- How good or poor is it at supplying these services?
- Who uses or these services?
- How important are the services in the lives of the users?

Responses vary. Some reflect on personal experiences of supply capabilities and their use of services; others may reflect on regulation or the provision of public infrastructure that enables access to and use of estuary services. The more diverse the stakeholder group, the richer the interactions and learning. Importantly, it is an interactive social learning process that encourages reflection (Biggs et al. 2011; McCarthy et al. 2011) acknowledging and building on the wisdom, knowledge and experiences of all the participants. The primary intention of the first iteration is to create awareness of dynamic interconnectedness and interdependence, expanding and creating overlap among individual mental models. Because of the emphasis we place on learning that leads to emergent shared understandings, the actual scores that are used to indicate levels of supply and demand are less important than the process by which they are determined. With this in mind the first iteration does not require intensive data in order to make an analysis, but it works better if participants have access to local detailed knowledge. Once stakeholders have a grasp of the concepts and share a vocabulary, further iterations can draw more heavily on primary data and technical and scientific understanding and can assess preferences for different scenarios reflecting options for use of ecosystem services and under changing conditions of supply.

The process requires facilitation by a person who understands supply and demand analysis in the context of social-ecological systems and with understanding of the structure and functioning of the system under consideration. It is based on a systems model which is conceptually simple enough for a group of stakeholders from diverse backgrounds to understand, populate, and analyze the outcomes in a one to two day session. Because of the importance placed on the stakeholder knowledge and experience, and appreciation for being spatially explicit, the process starts with a site visit that creates shared awareness among stakeholders of the spatial distribution and extent of the assets, how they are used and by whom.

The model inputs are available data and scores reflecting stakeholder consensus around the supply of and demand for ecosystem services. The scoring system is deliberately simple making it easier for stakeholders holding different views to move away from focusing on detail and toward a consensus score. It is emphasized that scores are ‘current best estimates’ and can be revisited in subsequent iterations and when more detailed analysis may be appropriate. For example, there are three options for habitat state, good, moderate or poor. And for demand stakeholders reflect on whether there are there tens, or hundreds, or

thousands or tens of thousands of users. Furthermore, in the first iteration the model uses a simple list of habitats that are suited to the particular context, and a limited list of ecosystem services to narrow the range of discussion and to ensure the analysis can be completed and outcomes generated within an 8 to 14 hour period. Being able in a short time to construct a more comprehensive, shared perspective in which personal insights are reflected, builds necessary trust for stakeholders to negotiate and have confidence in the outcomes. Typically stakeholders would include: resource users (including recreation users, local residents, businesses with interests associated with the estuary, municipal engineering staff) and those who provide infrastructure whether in the form of policy or physical constructions that affect resource user access to ecosystem services.

An example

We illustrate the process by drawing on its application at the Mpenjati Estuary on the East coast of South Africa (*aerial photograph to source*). It is located in a rural setting with the sixty hectare Mpenjati Nature Reserve that caters for day visitors. It comprises a system of interlinking wetlands, grasslands and dune forests. The most popular activities are birding, fishing, swimming, and hiking. The Ipithi trail on the south bank is 1.2 km long and offers visitors the opportunity of sighting blue, red and grey duiker and bushbuck. The Yengele trail on the north bank is 1,8 km long and is routed through one of the largest dune forests on the KwaZulu-Natal South Coast. The forest is home to forest antelope and a host of bird species, as well as a breeding pair of Fish Eagle. Observation platforms on both trails provide breathtaking views of the lagoon, wetland system and the coast. The lagoon is ideal for canoeing, windsurfing, fishing and swimming.

Step 1: Bounding the system and sharing personal understandings of the SES

Dialogue during the on-site session is directed at making supply and demand spatially explicit in the minds of stakeholders. Because both supply of and demand for ecosystem services are scale dependent, stakeholders are encouraged to exchange understandings about the spatial dimensions of the system, the associated assets (habitat and infrastructure), their condition and the services that are being or can be accessed. For an estuary questions that are used to prompt deliberation and interaction are:

- What are the boundaries of the estuary ecosystem?
- What are the assets, the estuary habitats, that provide ecosystem services and how good are they at providing these?
- Who uses or has an interest in using the ecosystem services and where do they come from? What are the boundaries of the social system?
- How big is the demand and can the demand be satisfied?
- How is access and use regulated?
- Are there conflicts around access to and use of ecosystem services and if so what are the causal factors?

Step 2: Analyzing supply and demand

Assessing functionality

Functionality is a measure of the capacity of the ecosystem to deliver services. This is determined by both size and condition. The larger a habitat within an estuary and the better its condition or health, the more functional it is at producing ecosystem services. Functionality is also determined by external influences reflecting the landscape context. In the case of an estuary for example, its 'connectedness' to the inshore marine environment or to upstream rivers may exert strong influence over functionality whilst degraded terrestrial habitats might have low connectedness. Estimates of functionality for each habitat are thus the product of size, condition and connectedness. In the Mpenjati example, connectedness was considered to be less important than size and condition and so the score was weighted at 10% of the other two in the estimation of functionality.

Participants discuss and:

- Identify and agree on the habitat types for the ecosystem under consideration and list these in the spreadsheet (Table 1)
- Score on a four point scale (1 to 25% = 1, 26 to 50% = 2, 51 to 75% = 3, 76 to 100% = 4) and record in the spreadsheet the condition of each habitat
- Estimate from maps or aerial photos and agree on the area occupied by each habitat and insert the score as hectares of habitat on the spreadsheet
- Agree on the degree (poor = 1, moderate = 2, good = 3, excellent = 4) of connectedness in the landscape the landscape context by considering connectedness of the estuary to the landscape and other estuaries

This functionality score becomes the driver of the services supply level.

Identifying services supplied by habitats

Participants are introduced to the concept of ecosystem services as being services that are generated by ecological processes in nature which enhance human wellbeing and are directly used by people. Possible ecosystem services are identified and agreement is reached on those to be used in the assessment (Table 2).

Determining the relative potential of habitat to deliver services

This exercise determines the relative potential of individual habitats to deliver discrete services so that the contribution each makes to the total services available can be assessed. Such knowledge is helpful when deciding which habitat and associated services offer the best economic or welfare opportunities. Because the present state of a habitat (as recorded when determining functionality) may be degraded, it is not necessarily a good indicator of the inherent potential for a habitat in good condition to deliver services. Participants are required to envisage the services each habitat could deliver if it was in a 'near natural' condition and score these on a scale of no supply (0), low (2), moderate (3) and high (4) (see Table 2) . Assessment requires scientific and technical expertise and experience. Reaching consensus is challenging because of the speculative nature of the process and discussion can be robust. Success depends on constructive engagement by scientists, government officials and people with local knowledge. It is important to stress the iterative nature of the overall process; scores can be changed in subsequent iterations to test the sensitivity of the outcomes to changes in contested scores.

Determining the present service supply level

As the functionality of a habitat declines the less able it is to deliver services to its potential. The present service supply level is thus estimated as the product of the scores for functionality and potential to deliver for each service. When these scores for each ecosystem service are summed across habitats, it becomes possible to determine the service levels for the whole system (the estuary in this case). Ranking ecosystem services in order of their present levels of supply provides insight into their potential for contributing to economic development and welfare (Table 3).

Demand for ecosystem services

In the Mpenjati Estuary study demand for services was assessed from the perspective of four different user groups defined as: Local users (living around and upstream of the estuary who may be frequent users); Flow-related users (those whose use of the adjacent coastal waters is dependent on estuary services); District users (residents, businesses and government in the district and who use services intermittently); and Provincial and National users (those who live further afield and access ecosystem services infrequently). The process ranked each of the user groups according to the number of users, and then by their level of dependence (Tables 6a – d). The number of users for each discrete service was estimated by drawing available population data, local government census data, on the ground observations, assessments using Google Earth, and local knowledge. Because demand is affected by the availability and affordability of accessing the same service elsewhere, we also estimated the relative dependence of each user group on the services supplied by the estuary. Relative dependence was scored as high (3), medium (2) or low (1) (Tables 6a – d).

Whereas the discussion on supply capabilities was largely informed by the scientists, users who had local insights into use patterns and local dependencies provided insights for assessment of demand.

Comparing supply and demand

Achieving social-ecological health requires that demand is managed to accord with the services that the ecosystem can supply. Being able to compare supply and demand (Table 5) informs discussions regarding the identification and selection of options for use and management. For example, where there is a high demand for services with low levels of supply, ecological health can become compromised if demand is not carefully managed. However, where services are supplied at a high level but with little demand there may be opportunities to enhance social well-being. Because supply capability sets limits to use of ecosystem services, it is helpful to use it to rank the services (Table 5).

The comparison of supply and demand focuses discussion on and the limits to options for use. In instances where it exposes demand as a threat to sustainable use, it may not be possible to achieve consensus on the management implications. Because the process makes assumptions explicit, it is possible to go back and check their validity.

Discussion and conclusions

Our intention in developing this approach has been to enable stakeholders with mental models shaped by their own experiences and expectations of a social-ecological system to share these with others holding different mental models. And, in the process to learn and come to appreciate mental models that may not accord with their own so that they are better prepared to move toward a shared representation of the system. What they derive is a

representation that reflects the mix of knowledge, experience and wisdom within the group. Importantly, it is a representation that emerges as participants develop a shared vocabulary around concepts and portrayals of how the system is structured and functions.

The process is designed to enable participants to 'learn to share' their understandings. Although it is important that the outcomes reflect reality, the learning is more important than how precise the outcomes are. It is more important that participants debate their understandings than the accuracy of the scores. As participants become more familiar with concepts, vocabulary and the structure and functioning of social ecological systems future iterations will yield better representations of the system.

As with all representations of complex systems the outputs reflect the assumptions made by the group as it works through the process. These are discussed and are reflected in the scores that are entered into the tables. Because they are explicit, if an output is contested it is possible to go back and check on the reasonableness of the assumptions. It this way the process is strongly supportive of adaptive management and particularly triple loop learning.

Society is increasingly exercising its right to influence the choice of options for the use of ecosystem services and the way in which management supports these choices. And so, as Ison (2004) suggests, sustainability is an emergent property of stakeholder interaction. The process we have developed focuses and structures these interactions. Although it acknowledges complexity it does not allow this to inhibit learning across disciplinary and experiential boundaries. It allows for progressive engagement of complexity according to need and the pace of learning. This provides a platform for ongoing interaction among stakeholders as they adapt use to accord with changes in the supply and demand for ecosystem services. This shared interest and negotiation is the foundation for a community of practice out of which sustainability can emerge.

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Table 1. Functionality of the habitats (the ecological assets) of the Mpenjati estuary. Functionality is determined as the product of habitat condition, size and connectedness. Large habitats in good condition that are strongly connected have high scores.

ECOLOGICAL ASSETS	Reedbeds and Incema	Open water	Nearshore ocean	Sandy beach	Floodplain woodland	Shallow subtidal / Sandbanks	Stream/river	Coastal forest	Dune vegetation	Coastal grasslands
CONDITION – score relative to its potential	3	2	4	3	1	3	3	4	4	3
SIZE – area in ha (rivers in km)	4	18	63	13	2	5	5	60	3	31
CONNECTEDNESS Score – 0 to 4	4	2	4	4	2	4	3	2	4	1
OVERALL FUNCTIONALITY	17.3	42.7	353.9	54.1	2.7	19.3	17.6	290.3	15.7	102.3

Table 2. Assessment of the capacity of identified habitats in the Mpenjati Estuary to deliver ecosystem services. Scores are determined on the assumption that habitat condition accords with what is considered to be a 'near natural' condition.

Ecosystem services	Reedbeds and Incema	Open water	Nearshore ocean	Sandy beach	Floodplain woodland	Shallow subtidal / Sandbanks	Stream/ river	Coastal forest	Dune vegetation	Coastal grasslands
Angling	0	3	3	0	0	3	2	0	0	0
Bait harvesting	0	3	2	0	0	3	0	0	0	0
Birding	3	3	2	2	3	3	3	3	1	3
Carbon sequestration	2	1	1	0	2	1	2	3	1	2
Canoeing	0	3	2	0	0	2	1	0	0	0
Cultural heritage / medicinals	3	2	2	3	3	1	3	3	1	3
Disease control	3	3	2	0	1	3	2	1	1	1
Fibres	3	0	0	0	3	0	2	3	1	3
Flood and storm surge attenuation	3	2	1	1	3	2	1	2	3	2
Food – fish, bushmeat	1	3	3	0	1	1	2	2	0	2
General recreation	1	1	0	3	3	0	2	2	1	2
Knowledge gen. and learning sites	3	3	2	3	3	3	3	3	3	3
Soil / sand stability	3	1	2	0	3	0	1	3	2	3
Natural Heritage	3	3	3	3	3	3	3	3	3	3
Nursery for fish/crustacean species	3	3	1	0	0	3	1	0	0	0
Pest control (alien species)	2	0	0	0	1	1	1	3	1	3
Sailing / kite boarding	0	3	3	1	0	1	0	0	0	0
Sediment supply to beaches	0	2	2	2	1	3	3	0	1	0
Settlement/accommodation/ conf.	0	0	0	0	2	0	0	2	0	3
Aquaculture	0	3	0	0	0	0	0	0	0	0
Swimming	0	3	3	1	0	3	3	0	0	0
Visual amenity	3	3	3	3	3	3	3	3	3	3
Waste assimilation	3	3	1	0	1	2	1	2	1	2
Waste dilution	1	2	3	0	0	1	1	0	0	0
Wind damage control	1	0	0	0	3	0	0	3	2	1
Palaeontology heritage	0	0	3	0	0	0	0	0	0	0
Sand and stone mining	1	3	0	0	3	3	3	0	0	0

Table 3. Ecosystem services in the Mpenjati Estuary ranked in order of their present supply, even if they are not utilised. Values are determined as the sums of products of scores for functionality and potential for each service across all habitats. Services at the top of the table indicate relatively high levels of supply, or of resource use opportunities, whilst those at the bottom of the table suggest lower levels of supply and less opportunity.

Ecosystem Services	Total supply score
Natural Heritage	2 747
Visual amenity	2 747
Knowledge generation and learning sites	2 394
Birding	2 308
Cultural heritage / medicinals	2 281
Food – fish, bushmeat	2 049
Soil / sand stability	2 037
Carbon sequestration	1 582
Flood and storm surge attenuation	1 442
Waste assimilation	1 393
Disease control	1 392
Swimming	1 355
Fibres	1 288
Angling	1 283
Pest control (alien species)	1 267
Sailing / kite boarding	1 263
Waste dilution	1 201
General recreation	1 066
Palaeontology heritage	1 062
Sediment supply to beaches	1 030
Wind damage control	1 030
Bait harvesting	894
Settlement/ accommodation/ conference	893
Canoeing	892
Nursery for fish/crustacean species	609
Sand and stone mining	264
Aquaculture	128

Table. 4a, b, c, d. Numbers of users in four categories and their dependency on ecosystem services supplied by the Mpenjati Estuary

Table 4a: The role of ecosystem services at the local level.

Ecosystem services	Number of users	Dependence on service
Natural Heritage – Mpenjati conserves the local community's natural heritage for their current and future use, and is quite unique in hosting a wide range of terrestrial, marine, estuarine and freshwater habitats at one site.	30 000	3
Sand and stone mining – the river estuary interface provides an easily accessible source of sand and stone for the community.	5 000	2
General recreation – the floodplains provide an attractive picnicking and general recreation facility for the local community.	2 500	3
Knowledge generation and learning sites – the nature reserve provides an educational facility for local school children and other interest groups (trees, etc.).	2 500	3
Soil / sand stability – Fringing estuarine vegetation and the associated forests and grassland ensure soil stability for surrounding landowners.	2 500	3
Swimming – the estuary and nearshore ocean provide good swimming opportunities.	2 500	3
Pest control (alien species) – intact ecosystems limit the spread of alien plant species into neighbouring properties.	2 000	2
Angling – the estuary, mouth and ocean are good angling areas.	1 500	3
Food – fish and bushmeat are harvested from the system for food by local households.	1 000	3
Birding – the variety of natural habitat types offer a small group of local residents good birding opportunities.	500	3
Cultural heritage / medicinals – local community ancestors are buried in the area.	500	3
Wind damage control – homesteads adjacent to the nature reserve are protected from the wind by the robust vegetation cover.	400	2
Flood and storm surge attenuation – property owners immediately adjacent the reserve are protected to some degree by the intact ecosystem systems of Mpenjati.	120	3
Settlement/ accommodation/ conference – the local topography provide a suitable space for limited settlement infrastructure.	120	3
Visual amenity – property owners adjacent to the reserve enjoy excellent views over the reserve.	120	3

Table 4 b: The role of ecosystem services for downstream users.

Ecosystem services	Number of users	Dependence on service
Disease control – the estuary plays an important role cleaning up the river water (and associated pollution) before being discharged on the adjacent Trafalgar and Palm swimming Beach beaches.	100 000	1
Sediment supply to beaches – the estuary is a conduit for sand supply to Trafalgar and Palm Beach swimming beaches.	100 000	1
Flood and storm surge attenuation – beach and estuary users benefit by having the local built and natural environment protected (or less frequently damaged) by storm flows and surges.	10 000	2
Soil / sand stability – beach and estuary users benefit by having the local built and natural environment protected from erosion.	10 000	2
Waste assimilation – beach and estuary users benefit by excessive nutrients captured and stored – improving recreation water quality.	10 000	1
Waste dilution – beach and estuary users benefit by having excessive nutrients diluted – improving recreation water quality.	10 000	1

Table 4c: The role of ecosystem services in the district municipality

Ecosystem services	Number of users	Dependence on service
Natural Heritage – Mpenjati conserves the local municipality's natural heritage for their current and future use, and is quite unique in hosting a wide range of protected terrestrial, marine, estuarine and freshwater habitats at one site.	250 000	3
Waste assimilation – the municipality and associated rate payers benefit by discharging treated waste water into the estuary – reducing waste water treatment costs as the estuary assimilates the waste.	25 000	3
Waste dilution – the municipality and associated rate payers benefit by discharging treated waste water into the estuary – reducing waste water treatment costs – as the estuary dilutes the waste.	25 000	3
Cultural heritage / medicinal plants – a fraction of the municipality relates culturally to the nature reserve.	5 000	2
Flood and storm surge attenuation – municipal residents visiting the nature reserve benefit from less frequent flood and storm surge damage.	5 000	2
Soil / sand stability – municipal residents visiting the nature reserve benefit from a stable floodplain and intact recreation facilities.	5 000	2
Knowledge generation and learning sites – municipal residents visit the nature reserve for learning purposes.	5 000	2
Swimming – municipal residents visit the nature reserve for recreation.	3 000	2
General recreation – municipal residents visit the nature reserve for recreation.	3 000	2
Angling – municipal residents visit the nature reserve for recreation.	1 500	2
Sailing / kite boarding – municipal residents visit the nature reserve for recreation.	500	1
Canoeing – municipal residents visit the nature reserve for recreation.	300	3
Birding – municipal residents visit the nature reserve for recreation.	100	2

Table 4d: The provincial and national role of ecosystem services.

Ecosystem services	Number of users	Dependence on service
Natural Heritage – Mpenjati is one of the few temporary open estuaries protected in RSA, and is also linked to a marine protected area, thereby generating a more robust package of natural assets.	50 000 000	3
Knowledge generation and learning sites – the learning and research associated with Mpenjati has provincial and national implications for estuary management.	50 000 000	2
Visual amenity – the national road users benefit by being supplied with an attractive natural vista when crossing the estuary on an otherwise largely transformed coast.	2 000 000	1
Nursery for fish/crustacean species – regional fishermen benefit by having the estuary bolster restocking of certain angling fish species.	80 000	2
Angling – national residents visit the area for recreation.	10 000	1
Swimming – national residents visit the area for recreation.	2 500	2
General recreation – national residents visit the area for recreation.	2 500	2
Palaeontology heritage – national residents visit the area for recreation.	500	2
Birding – national residents visit the area for recreation.	400	1

Table 5. A comparison of ecosystem services supply and demand, and implications for management for the Mpenjati Estuary. The list is ranked by supply capability

Ecosystem Services	Total supply score	Total number beneficiaries	Average dependency	Implications for management emerging for the discussion process
Natural Heritage	2 747	50 280 000	3.0	National importance warrants an elevated investment into management for RSA residents.
Visual amenity	2 747	2 000 120	2.0	Infrastructure development in and adjacent to reserve and estuary needs to add value to visual amenity of the site. Overgrown natural vegetation adjacent to the national road could also impact on this service.
Knowledge generation and learning sites	2 394	50 007 500	2.3	Manage information generation, storage and distribution, promoting national benefits. More education facilities could be developed to enhance learning potential.
Birding	2 308	1 000	2.0	An underutilised opportunity, which supports the key land use objective of the site – conservation. Guiding businesses could be developed in association with land claim community but success would depend on effective regional linkages and marketing.
Cultural heritage / medicinals	2 281	5 500	2.5	An underutilised opportunity but which would need sensitive exploitation given the presence of burial sites. Medicinal species should not be harvested in the nature reserve, but seeds / cuttings would be suited to sustainable harvesting.
Food – fish, bushmeat	2 049	1 000	3.0	Harvesting has the potential to impact negative on other service users. Caution needs to be applied in permitting harvesting. Unprotected areas may need special attention, given the possible knock–on impacts of harvesting in the system.
Soil / sand stability	2 037	17 500	2.3	Ensure vegetation cover maintained in areas with a high propensity to erode. Focussed restoration of habitats outside of the protected area may be necessary. Be prepared to deal with erosive processes associated with floods, storm surge and vehicle traffic (terrestrial and water based). Consider the location of infrastructure. Alien plant clearing would be to be carefully managed to reduce erosion possibilities.
Carbon sequestration	1 582	-	#DIV/0!	Consider marketing the carbon storage facilities of the coastal forests.
Flood and storm surge attenuation	1 442	15 120	2.3	Ensure protective vegetation is robust.
Waste assimilation	1 393	35 000	2.0	Careful management (regulation of standards, monitoring, risk management, disaster preparedness, and prosecution of offenders) of the waste water works discharge is critical, as this has the potential to run down the condition of habitats and reduce service supply levels for most of the other services. Promote watershed management as the estuary will be the recipient of either good or bad land use practices. A strong system driver.
Disease control	1 392	100 000	1.0	Careful management (regulation of standards, monitoring, risk management, disaster preparedness, and prosecution of offenders) of the waste water works discharge is critical, as this has the potential to run down the condition of habitats and reduce service supply levels for most of the other services. Promote watershed management as the estuary will be the recipient of either good or bad land use practices. A strong system driver.
Swimming	1 355	8 000	2.3	Monitoring of water quality is critical.
Fibres	1 288	-	#DIV/0!	Alien plants upstream of the nature reserve could be a source of fibre.
Angling	1 283	13 000	2.0	Harvesting has the potential to impact negative on other service users. Caution needs to be applied in permitting harvesting. Unprotected areas may need special attention, given the possible knock–on impacts of harvesting in the system.

Ecosystem Services	Total supply score	Total number beneficiaries	Average dependency	Implications for management emerging for the discussion process
				Consider the possibility of guided fly-fishing (tag-and-release) as potential job creation mechanism.
Pest control (alien species)	1 267	2 000	2.0	Alien plants in the nature reserve and upstream of the nature reserve should be a management priority.
Sailing / kite boarding	1 263	500	1.0	Monitoring of water quality is critical. Possible impacts on nesting birds may require seasonal zoning of limited disturbance.
Waste dilution	1 201	35 000	2.0	Careful management (regulation of standards, monitoring, risk management, disaster preparedness, and prosecution of offenders) of the waste water works discharge is critical, as this has the potential to run down the condition of habitats and reduce service supply levels for most of the other services. Promote watershed management as the estuary will be the recipient of either good or bad land use practices. A strong system driver.
General recreation	1 066	8 000	2.3	The small size of the area means careful management of intrusive recreation activities is necessary.
Palaeontology heritage	1 062	500	2.0	More education facilities could be developed to enhance learning potential.
Sediment supply to beaches	1 030	100 000	1.0	Ensure that natural sediment movement processes are sustained.
Wind damage control	1 030	400	2.0	Sustain the vegetation cover of the dune forest vegetation to ensure that wind blows are prevented.
Bait harvesting	894	-	#DIV/0!	Harvesting has the potential to impact negative on other service users. Caution needs to be applied in permitting harvesting. Unprotected areas may need special attention, given the possible knock–on impacts of harvesting in the system. As this is a small system, this may not be a suitable activity.
Settlement/ accommodation/ conference	893	120	3.0	As this is a local, district, provincial and national site of conservation importance, adjacent and internal infrastructure development should add value to the services supplied and not detract from it. Town planning should be informed by the limited services supplied in this location.
Canoeing	892	300	3.0	This has the potential to be a business opportunity for local communities and land claimants if marketed appropriately.
Nursery for fish/crustacean species	609	80 000	2.0	As this is a critical service in relatively short supply, it may be necessary to promote the development of nurseries, such as the establishment of shallow protected areas adjacent to the estuary edges, particularly upstream.
Sand and stone mining	264	5 000	2.0	Mining has the potential to impact negative on other service users. Caution needs to be applied in permitting mining. No mining should take place within the nature reserve. Seasonal and equipment specific rules may need to guide sand mining to ensure it does not generate poor water quality and remove all sand inputs into the estuary.
Aquaculture	128	-	#DIV/0!	There is limited potential for aquaculture upstream. Due to the small size and discharges from the waste water works, this service would be severely constrained. However, the possibility of an engineered indigenous estuary fish nursery, as a public works programme should be considered, using less intrusive infrastructure.