

STRATEGIC REVIEW OF RIVER RESEARCH

Water Research Commission Project K5/1198



FINAL REPORT

Project team:

**C.M. Breen (Project Leader), D. Cox, C. Dickens, H. MacKay,
M. Mander, D.J. Roux, A. Turton and E. van Wyk**

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**‘Surprise is essential to high performance.
All learning is preceded by ignorance,
followed by surprise. It is surprise that
develops energy and motivation’**

David Napoli in Whiteley, 1995

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The future is unknown. At best we can use knowledge and wisdom to envisage what the future may hold and then prepare to meet it. How we do this has much to do with co-evolution of ideas, and it is difficult to trace the paths by which these ideas are constructed and shaped. The ideas that have found expression here have their roots in discussion with many colleagues. I am most grateful to all my colleagues from whom I have been privileged to learn. They, and especially the contributors to this review are, however, not responsible for the interpretation I have given in the Executive Summary and in Part 1, Overview.

I am particularly grateful to Kevin Rogers and Mark Dent who were not able to contribute directly to this review, but who have had a very considerable impact on my understanding of the context in which research is conducted.

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Charles M. Breen

EXECUTIVE SUMMARY

This project had its origins in growing appreciation of the need for research on river systems to contribute more immediately and directly to improved management of river systems. Research is perceived to be a service that leverages change in the way in which river systems (the resource) are managed. Research should improve our capacity to act in ways that direct behaviour towards sustainable use. This requires us to simultaneously address four issues: **perceptions** of the **state of the resource**, the **behaviour** that determines state, and the **regulatory environment**. Research should present ‘seamless’ interpretations as this accords better with how society experiences the real world.

If we are to improve leverage of change then research design, implementation and communication should address ‘outcomes’ (not only outputs) more explicitly than has been the case. An high level interorganisational entity, a ‘Centre of Competence’ is suggested as a way of enhancing our ‘fitness to respond’ through improved direction of research endeavor and, where appropriate, actively leveraging change.

Language currently applied in research and management is not supportive of leveraging change. This is because society, by and large, perceives rivers as a resource providing goods and services and through the use of which individuals experience benefits and costs, whilst scientists commonly refer to ecological state. It is suggested that the river system can be regarded as a production system. The Environmental Reserve is the allocation of water to sustain the river production system so that society can, in perpetuity, draw on the goods and services it produces. If water abstracted for use in production is equated with water left in the river for production, there would be less cause for confusion and misrepresentation for the Reserve.

The shift in emphasis for conversing about ecosystems and their state, to conversing about goods and services (not all of which need be monetised) and their state, draws attention to rights of use. Clearly for sustainable use there needs to be clarity over rights of use and the authority regimes that attend such rights. Whilst the matter of rights for use of water is clear, that for the goods and services produced by rivers is less clear. This is particularly so in sectors of rivers in traditional rural areas where, at least in the past, common property regimes prevailed. Two strategic research needs emerge: we need to understand how to design and implement public-private compacts that promote sustainable use of river systems. One suggestion is that these might take the form of ‘Covenants of Mutual Obligation’. The second suggestion is that we need to understand how to use the issues of rights of access to goods and services, distribution of costs and benefits and the Covenants of Mutual Obligation to deepen understanding and practice of democracy. It emerges that we need to be able to enhance cohesion, improve demarcation, establish legitimacy and increase the resilience of communities so that they can express themselves effectively and appropriately in managing the use of river systems. Such a process of founding democracy around the use of river systems would promote efforts to achieve dynamic equity in resource use.

A state of dynamic equity is perceived as essential across all scales from local to regional. This is particularly relevant in South Africa because it shares so many river basins with other countries. It is clear that we do not yet have in place a system that enables us to interpret the propagation of impacts and their consequences across scales. We need to be

able to establish scenarios depicting how options at various physical and social scales are likely to be expressed in terms of river health and human welfare.

The key strategic research issues that have emerged from the study are:

- Establishment of an interorganisational entity (Centre of Competence in River Research and Management) that maintains our fitness to respond to issues pertinent to river system management.
- Strengthen our ability to leverage change consequent upon research fundings by shifting emphasis of research to outcomes and by connecting researchers and managers effectively.
- Strengthening of democracy in support of dynamic equity in apportioning costs and benefits deriving from the use of river systems and the adjoining land.
- Effective public-private compacts that empower civil society to promote sustainable use of river resources.
- A system for analysing and assessing the propagation of impacts and their consequences across scales whereby scenarios can be generated for decision-making.

Recommendations

1. Establish a national 'Centre of Competence' for river management that acts as a broker of knowledge and experience. This Centre should bring together strategic thinkers and managers at senior level to ensure we have the required 'fitness to respond' to the challenges of river management.
2. Revise research organisations and management so as to strengthen collaboration between researchers, government and stakeholders, emphasising attainment of outcomes by leveraging change.
3. Initiate a comprehensive research and development programme directed at strengthening democracy in decision making around use of river resources.
4. Initiate a comprehensive research and development programme directed at establishing public – private compacts that empower civil society to continuously promote sustainable use of river resources.
5. Develop and institutionalise strategic analysis and decision making for river systems that enable integration across physical, social and economic scales.

PART I: OVERVIEW by C. M. Breen

CONCEPTS AND PRINCIPLES

Importance of context

This project had its origins in growing appreciation for the context in which research is conducted. Whilst considerable progress has been made in advancing understanding of the functioning of aquatic ecosystems and their component parts, it is increasingly evident that these systems need to be understood in a socio-economic and political context. This is because we view our world largely in terms of goods and services useful to us¹. In the end it will not matter how well we understand ecosystems if we are not able to connect this understanding meaningfully with society.

Of all the forces shaping our global system, there is only one over which we have direct influence, and that is human behaviour. Unless our understanding of environmental change is linked to behavioural change it will rightly be disregarded by society. Since the rate of human impact on aquatic systems has increased exponentially, there is a sense of urgency in our need to link information generation, knowledge and behaviour.

Research is not an end in itself. It is a social service. As such it must be informed and shaped by societal perceptions, and in turn it must represent a force of change where such perceptions are shown to be founded on ignorance or misunderstanding. Research must leverage change in perceptions in order to effect changes in behaviour. Government agencies and organised civil society are perceived to be the fulcrums for leverage of change. As such they should be partners in the research process, and not be the target or market for research findings. Only if they are partners can we foresee the situation where research builds a 'fitness to respond' to emerging challenges (see Jones, 2002).

Strategic adaptive research

Research is by nature adaptive. Although researchers commonly claim that their research is strategic, design and communication seldom address this explicitly. A consequence is that research that appears to hold great promise for strategic change seldom delivers to these expectations, and disillusionment, frustration and conflict arise. Since the intention of research on natural resources is to inform human behaviour, directing it towards sustainable use of resources, failure to address strategic issues is clearly of serious consequence. Indeed one can scarcely imagine research providing a quality social service if strategic issues are not addressed explicitly and with commitment. This is all the more important given increasing public expectations for involvement in decision-making.

Strategic adaptive **researchers** are characterised by:

- their partnerships with agents who leverage change so that they inform and are informed by emerging strategic issues;

¹ Not all goods and services have to be valued in monetary terms. Some, such as sense of place and spiritual revival, have value that must be acknowledged even if not quantified in monetary terms.

- their capacity to address strategic issues explicitly in their research endeavours;
- their partnerships with researchers who together address the complexity of the issue under consideration;
- flexibility that enables them to adapt over time scales that reflect imperatives of emerging strategic issues; and
- their desire to contribute to the co-evolution of concepts, principles and practices directing use of the resource.

If we accept a central role for strategic adaptive research as a lever for behavioural change, then we must develop and sustain our capacity to conduct strategic research.

Driving forces

As a social service, research must be responsive to perceived and felt needs of society. These are shaped by perceptions of the supply of goods and services and the distribution of costs and benefits accruing from the use of the resource system. In other words, perceptions of the state of the system are the driving force that directs behaviour in ways that bring about change considered desirable. Policy and legislation are used to direct and regulate behaviour in accordance with what society perceives to be appropriate. If research is to provide a ‘one stop’ social service then it must **simultaneously** consider these four issues; namely **perceptions** of the **state of the system**, the **behaviour** that directly or indirectly brings about that state, and the appropriateness of the **regulatory instruments**.

This is not intended to imply that all of these must be addressed with equal emphasis in any particular project or programme. Rather, it is intended that the implications for all the sectors should be considered explicitly presenting a ‘**seamless**’ interpretation for society that accords better with how people experience the world. This will also encourage researchers and those who leverage change, to appreciate and deal with the inherent complexity of the social-ecological system.

Complexity is compounded by the globalisation of society. Natural resource management issues elicit powerful responses across the range of scales from local to global. In this way, for example, global conventions (e.g. Convention on Biodiversity 1992) and regional protocols (e.g. SADC Revised Shared Watercourse System Protocol 2001) act as driving forces shaping perceptions, policies and behaviour at local scale. Scale, and connectedness across scales need to be considered in the design and implementation of strategic research and of the diffusion of new knowledge. However convenient and comfortable it may be to envisage small compartments, the reality is that factors ‘external’ to the compartment may well be of greater import than those within the compartment. Rivers, by their nature, create connectivity around life support systems and we must learn to work with the consequent complexity.

Emerging paradigms

The complexity of ecosystems has challenged researchers for many years yet we perceive it necessary to add further complexity by requiring explicit interaction with the societal system; and we, at least in southern Africa, must meet the challenge with limited resources.

Systems thinking, which has been applied in ecology and other disciplines for more than fifty years, offers the opportunity to envision the linkages and promote communication in a common language between the river and societal systems, and to engage constructively their inherent complexities. But this is not sufficient. The complexity is of such a nature that trans-disciplinary engagement is commonly required both within and between the systems. Strong strategic alliances provide the mechanism for achieving this. What is required is adoption of a 'mental modeling' or 'mind mapping' (Senge, 1990; Senge et al., 1999) approach as this will provide a neutral interface between the domains of ecosystems and society.

It is evident that the success of strategic adaptive research is contingent upon an 'organisational environment' that fosters collaboration and learning. Whereas in the past it may have seemed sufficient to allocate a grant and leave the researcher(s) to get on with it, now it is understood that a nurturing environment is necessary for good performance. The role of the 'research administrator' is changing. Administration must be separated from the leadership role necessary to build and sustain strategic alliances and to foster the social service process that is research. This must also be underpinned by an 'organisational culture' that fosters the creative tension and behaviour that leads to the productive relationships on which research can be built (Senge, 1990). Boxes 1 and 2 provide further insight into these issues.

Incentives and disincentives are powerful forces directing human endeavour and behaviour. For too long the incentives for researchers and research managers have been measured by products (reports, papers etc). These are **outputs** of research and hardly reflect the intended **outcomes** of research. Society does not fund research for outputs; it does so for outcomes. If research is indeed intended to influence societal behaviour then we should be concentrating far more on what has been **learned** and how this may be used to influence the behaviour of both researchers and those who promote application of new understanding in practice. The manner in which learning (through research) leveraged change in perceptions leading to fundamental changes in the water law, and the manner in which research findings leveraged change in the Kruger National Park (Rogers et al., 2000) are excellent examples. What is needed, however, is for these linkages and leverages to be addressed more explicitly and more consistently than has been the case. This requires us to be more disciplined in our approach to planning strategic research and in leveraging change. Since these occur sequentially, at least to some degree, there has to be strong commitment to continuity. It is irresponsible to leave research planning to researchers alone. Specific provision must be made to ensure research is planned and conducted to deliver outcomes in addition to outputs.

Box 1: This illustrates the dilemma facing managers – do they want performance or control. The structures, processes and behaviours required for performance differ from those required for control. Source: Napoli in Whiteley, 1995.

Control focussed organisations

- Organisation pyramids value control above all else. Organisations are inward looking. Predictability is valued.
- Whole departments are created for control purposes.
- To lose control is to lose everything.
- As long as we are in control who cares what else is happening?
- External controls are emphasised.
- There are rules (which are flexible).
- 'No surprises' leads to the illusion of control.
- People avoid individual responsibility.
- Performance assessment is from above to someone.
- We feel our survival is in the hands of others.

Performance-focussed organisations

- Focus is on the customer and organisations are outward looking. Improvements are always being sought. Responsiveness is valued.
- There is reduced or eliminated dependence on inspection.
- To give control is to get control.
- Focus is on service and contribution to the whole.
- Self control is emphasised.
- There are guidelines (which allow flexibility).
- Surprise is essential to high performance. All learning is preceded by ignorance, followed by surprise. It is surprise that develops energy and motivation.
- People act as if it is their business. They don't blame the boss, system or the product.
- It is appreciated that in reality we know it is not possible to accurately plan and predict. The individual seeks assessment from customers and participants in the process.
- Our survival is in our hands.

Implications

Distinction needs to be drawn between the intentions of strategic research and those of a research project or programme. Research projects and programmes must contribute to the greater intentions of strategic research. The environment in which strategic research is nurtured and conducted is a critical determinant of performance measured by both outputs and outcomes. Strategic research on issues identified below, is unlikely to achieve its intentions if it is practised in an environment that does not enable researchers and those who leverage change in behaviour to operate jointly and severally with common cause.

Box 2. Properties of leaders. Source: Top 10 Watershed Lessons, EPA, 1997.

- Reflect values of the community.
- Good communicators.
- Ability to bring about change.
- Ability to set things in motion.
- Committed to the course.
- Know how to engage, respect and empower others.
- Find new or leverage existing resources.

"A Great Leader is One Whose Followers say:
'We did it ourselves'." Lao-tzu

STRATEGIC RESEARCH ISSUES

The intention of research is to build a 'fitness to respond' amongst researchers and those proximal to researchers who leverage change in behaviour. To do this it is necessary to be able to identify and prioritise those issues for which a 'fitness to respond' should be built in anticipation of need in the future. This distinguishes strategic research from tactical research that addresses an immediate problem. Anticipating the challenges that we will face in the future lies at the heart of strategic research. This is not an 'event' to be conducted every three or five years. It is a continuous process driven by leadership referred to earlier.

The process adopted in this project led to identification of strategic fields of research. Reports were commissioned to expose the strategic issues in these fields. It is expected that these fields would provide direction for discussion amongst those who leverage change in behaviour (government and civil society organisations), researchers and research administrators leading, in due course, to calls for expressions of research interest in particular issues, and ultimately to contracted research projects and/or programmes. The reports received are incorporated as appendices. What follows is the project leader's interpretation of these submissions shaped strongly by personal perspectives. As such the views expressed may not be held by colleagues who have participated in this process.

River research and the promotion of learning organisations

It is evident that history has bequeathed research organisations and research operational systems that are no longer appropriate. The intention of research is to anticipate, build and sustain a ‘fitness to respond’ to challenges before they arise. Research is only one link in the chain of ‘fitness to respond’; those who act on knowledge to pre-empt and deal with challenges are another. The research and implementation operational systems need to be dynamically connected so that **together** they build the ‘fitness to respond’ by continuously expanding their joint capacity to learn. This exposes the central role for new a organisational **structure** (Box 3) and a new organisational **philosophy** (Box 4).

The structure must be interorganisational, and the philosophy must be one that embraces commitment, change and learning. In essence, the new institution needs to progress from a collection of organisations to an association of knowledge based capabilities that are used to develop the required ‘fitness to respond’ and to leverage change in the service of society.

This may sound simple, but it is not. The envisaged change is fundamental because it involves a shift from managing research projects to managing for the outcomes of research projects, particularly the diffusion and application of knowledge. Personal change is essential, and whilst individuals may not resist change, they do resist being changed (Senge, 1990). New approaches to setting priorities, analysing findings and providing rewards will be required. It will not happen without leadership (Box 2).

Box 3: The need for multistakeholder Centers of Competence as brokers of knowledge and experience.

‘So where does our fuzzy society look for the new tools it needs to manage what it doesn’t know? “well, not at a once-a-year conference, that’s for sure,” Zimmerli says. He sees multistakeholder “centers of competence” such as Witten/Herdecke’s own German Center of Competence for Sustainable Economics – as one vital instrument, acting as brokers of knowledge and experience.’

Ribbans 2001 quoting Zimmerli

Box 4: Teams, playing the game are required in the quest for sustainability.

“The quest requires constant attention from companies, politicians, academics and civil society to explore the know-how, the know-what and the don’t-know-what.” The missing philosophy will not be found in ivory towers: “Its down to all these players to define the rules, to invent the game by playing it,” he says.

Ribbans 2001 quoting Zimmerli

Why should we commit to changing the way we are operating? As service providers for society we are accountable for timeously delivering outcomes that address the challenges, and for efficient and effective expenditure of public funds. Reports emanating from

several recent research projects and committees (Coordinating Committee for Water Ecosystem Research CCWER) on river systems draw attention to problems with efficiency and effectiveness. It would be irresponsible to pursue a 'business as usual' approach.

Strategic research priorities.

The report by Roux and van Wyk in **Part II** provides further insight and background to the identification of, and rationale for the identified priorities.

- Goal
An interorganisational entity exists that continuously maintains our fitness to respond to issues pertinent for river system management.
It does this by demonstrating:
 - commitment to outcomes-based strategic research;
 - commitment to servicing the needs of society through leveraging change;
 - embracing change and learning; and
 - providing a nurturing environment for the advancement of knowledge through research and application.
- Research priorities
To be able to establish such an entity it will be necessary to develop the following:
 - An analysis of how change in behaviour is leveraged on the basis of findings of strategic research, and how outcomes can be measured and evaluated.
 - A conceptual institutional framework that illustrates how co-operative governance for river systems will work.
 - Characterisation of an interface that would promote relationships and the flow of knowledge between river research (knowledge supply) and river management (knowledge demand) within a co-operative governance system.
 - A philosophical analysis of the concept of learning organisations in the context of co-operative governance for river systems.
 - Inter-organisational learning/knowledge networks.
 - A critical assessment of the extent to which current research is promoting continuous learning for co-operative governance of river systems.
 - Research briefs and notional budgets indicating priority research required to promote continuous learning for co-operative governance. An example of such a research theme would be: to understand the changing role of science in society and its relevance in the water institution.

River research and the distribution of costs and benefits

South African legislation makes provision for an allocation of water, the Environmental Reserve. The term is misleading. A fundamental principle underlying the law is that the river system is to be interpreted as a resource. The implication of this is that society regards the river system as a producer of goods and services that are valued by society. In this sense we are not expected to envisage that the intentions of abstracting water from the river and retaining water in the river are different. They are **both** expected to produce goods and services desired and treasured by society (Box 5). So the intentions of ‘reserving water for the environment’ are not to ‘protect the environment’, rather they are to protect the goods and services that rivers bring to society. This is achieved by providing water of appropriate quality and quantity to ensure proper functioning (i.e. protecting the environment). Protecting the environment is a means to an end; it is not the end.

We could, perhaps, restate the ‘Environmental Reserve’ as the ‘River Resource Reserve’. The abstracted water might be termed the ‘Abstracted Water Resource Reserve’ since it is reserved through issuance of licenses for use. The ‘Environmental Reserve’ is really just another license for use. If this approach was adopted it would convey the intentions of society and the law more consistently and accurately.

Box 5: Oliver Wendell Holmes quoted in Natural Heritage Institute, Berkley, California (undated)

‘A river is more than an amenity it is a treasure. It offers a necessity of life that must be rationed amongst those who have power over it.’

Rivers are ‘production units’ in much the same way as an irrigated pasture or an industry using water abstracted from the river. The Environmental Reserve is the water supplied to support the river production unit. An industry would not draw water from a river for a process unless it had a good idea of the goods and/or services it was to produce, of the market for those goods and services and of the production processes. Applying the same notions to the river production unit, we would say that it is necessary for us to establish:

- the demand for goods and services;
- the distribution of these goods and services;
- how these are valued and treasured;
- the distribution of costs and benefits associated with use of these goods and services;
- the capacity of the river system to produce the goods and services; and
- the requirements for water in order to sustain the production process.

Only once we have a grasp of this would we be able to intelligently consider impacts of flow modification. Importantly we would be able to communicate in a common paradigm across user sectors and between river and distant water users.

It would follow from the above arguments that the impacts of flow modification should be determined in respect of the goods and services that the river is able to produce, and their distribution and use in time and space. In simple terms we need to be able to assess the impacts on the river goods and services production processes, on the distribution of the

products of those processes, and on the benefits and costs associated with this distribution. Whilst it is so that the 'ecosystem' is the production system and its processes produce the products, we have typically, with some notable exceptions, defined the products very loosely. Most commonly we define them in ecological terms that are, at best, poorly related to most citizens perceptions of what the river delivers to them. At worst they are perceived to be unrelated and elitist. It seems desirable to:

- be able to relate ecosystem processes to goods and services more explicitly than we are currently able (willing?) to do;
- be able to establish the effects of flow modification on the nature and levels of the products available from a river system;
- be able to establish the effects of flow modification on access to and distribution of the products available from a river system;
- be able to establish the distribution of costs and benefits consequent upon flow modification; and
- be able to pass reasoned commentary on matters of sustainability of use, equity of access and use, and efficiency of use.

River systems are arguably the most complex natural systems. We are, therefore, tempted to adopt simplistic (reductionist) approaches. It seems improbable that we can successfully achieve what appears to be necessary unless we are able to work with the inherent complexity. Rivers are production systems. We cannot change that. So, we have no option but to learn to deal with them as complex production systems, not only as ecosystems; and we have to deal with what may also turn out to be complex distribution systems. Systems thinking is not a new discipline. It is, however, demonstrating considerable potential in widely differing systems. Most importantly, it offers a common philosophical basis and language to bridge boundaries between different systems e.g. the river production system, the goods and services distribution system and the costs and benefits distribution system.

Organisation and tenure

The notion that river systems might be regarded as 'production units' delivering goods and services valued by society directs us to reflect upon how access to use of such goods and services is regulated. This is particularly pertinent in those situations where rivers are an integral part of life support systems.

The vulnerability of communities dependent upon the goods and services of river systems for survival, is strongly reflected in their rights to secure, long-term access to these, the benefits they derive from them, and their responsibilities related to their rights. Tenure is, therefore, a central issue in water resources management in general, and of river flow modification in particular. Rights confer authority and responsibility, both of which exert influence when assessing the impacts of flow regulation and of mitigation and compensation.

Rights require regimes of authority. Whilst these are commonly well defined and established in the developed and private sectors, this is less so in rural community situations, at least in Africa. The scales of these authority regimes in respect of natural

resources is particularly influenced by the nature of the resource over which rights are exercised, as is clearly evident for example in river fisheries and flood plain agriculture.

In the past common property authority regimes predominated in rural African resource management. As traditional authorities weakened under the influence of western dogmas, there has been a shift to open access that is typified by the absence of an effective authority regime. The result is the absence of formal and recognised agreements with agreed rights and responsibilities. Collaborative management, which is essential for promoting equity, efficiency and sustainability in the use of river goods and services, is impossible under such conditions. Very importantly, it also provides the basis for practical expressions of democracy. Anarchy prevails in resource use where there is no collaborative management founded on clearly established rights of use. Once started, anarchy spreads as individuals assume for themselves more and more rights for resources.

The authority, rights and responsibilities ‘vacuum’ that exists in many rural situations clearly confounds attempts to adequately consider the needs of rural communities in considerations of flow modification and of compensation for the consequences thereof. It also confounds attempts to promote accountability for the stewardship of use of river resources. Re-establishing civil authority regimes with clearly defined and agreed rights and responsibilities is a necessary pre-requisite for achieving the intentions of integrated water resources management. It is also a vehicle for deepening democracy within marginalised sectors of society. What is required is for users of river resources to organise themselves so as to provide the credible authority? Barrow and Murphree (2001) have suggested four characteristics:

- Cohesion. This refers to a sense of common identity and interest which serves to bring people together for collaborative action. Cohesion determines social boundaries and determines membership;
- Demarcation. This sets the boundaries of jurisdiction for the collective regime. It is commonly based on spatial criteria;
- Legitimacy. This is required for its process and leadership, and relates to power and authority; and
- Resilience. This refers to the ability to accommodate change in affiliation, boundaries and sources of legitimacy.

Distribution of costs and benefits

South African policy and legislation directs us to seek equity in the use of goods and services from river systems and in the sharing of costs and benefits deriving therefrom. Since rivers are highly variable in time and space, so too is the availability of and demands for goods and services; and consequently so too is the distribution of costs and benefits. We envisage what MacKay (Part II) calls **dynamic equity** which shifts in response to changes in any part of the social-ecological system.

It is difficult to envisage sustaining dynamic equity where supply and demand for goods and services is poorly defined; where tenure over resources (not only land and water) is not or is only partly established; and where some users at least (perhaps even a majority) have

no authority regime that empowers them. It is also difficult, if not impossible, to envisage successful attainment of co-operative governance around the use of river and estuary resources unless these matters are addressed.

The goods and services of rivers and estuaries are accessible only from adjoining land. Those who hold tenure over the land are able to exert control over access to and use of river system resources. Allocating a right to fish means little if access to the opportunity to fish is denied. Any consideration of dynamic equity must acknowledge that the riverine and adjoining land systems are so connected as to be inseparable. It must also acknowledge that the greater opportunities to benefit from economic growth associated with river systems stem from investment in infrastructure and services that are land-based and not river-based. In a development context the rivers and estuaries add value to land-based operations and, consequently, if poor rural societies are to benefit meaningfully from 'their' parts of river systems, they must have rights and authority regimes that empower them in respect of the use of adjoining land.

The reports by MacKay and Cox and Mander in **Part II** provide further insight and background to identification of and rationale for identified priorities.
Strategic research priorities.

- Goal
Democracy is strengthened and deepened through attainment of dynamic equity in apportioning benefits and costs deriving from the use of river systems and the adjoining land.
This will be achieved by:
 - empowering presently marginalised sectors by addressing issues of tenure;
 - a robust process of reaching consensus amongst stakeholders on multiple issues related to resource use and the distribution of costs and benefits associated with resource use;
 - procedures and formats for capturing, communicating and using information and knowledge which will best serve the process of consensus-seeking;
 - capacity amongst all stakeholder groups to participate in the consensus-seeking process;
 - a strong policy context to provide guidance and a mandate to implementing agencies in the distribution of costs and benefits; and
 - governance structures that can accommodate a process of consensus-seeking amongst stakeholders, and through which consensus decisions on distribution of costs and benefits can be implemented.
- Research priorities.
 - Develop tenure regimes that promote democratic participation and opportunities for disempowered groups.
 - Identification of specific goods and services and their use by different socio-economic groups.
 - Quantification of the value of goods and services.
 - Development principles, criteria, indicators and tools.
 - Processes for distributing costs and benefits.
 - Policy and regulatory procedures.

River research and sustainable use of goods and services

Vastly differing time scales are involved in the production of goods and services deriving from river systems. Some processes (services) that deliver products (goods) operate over thousands and millions of years to generate a product (e.g. oil and genes). By contrast the regeneration times of other resources, fish for example, may be measured in years and of algae in days. From a human use perspective, we can only envisage sustainable use of those resources that have regeneration times that accord with human life spans. If each generation is able to continue to use the resource, then we are journeying towards sustainability (see Dickens in Part II).

Sustainable use requires that we understand the ‘production system’, that we manage use of the products (goods and services) and that we manage the distribution of the benefits and costs. Failure in any of these will lead to unsustainable use.

Society sees in river systems a range of useful goods and services. Since these hold value, and what individuals value varies so widely, the distribution of benefit is a potential source of conflict in society. And, since not all uses of goods and services are compatible, use brings with it benefits for some and costs for others. The distribution of costs is also a potential source of conflict. We cannot envisage striving to achieve sustainable use unless there is equity in access to opportunity to use and benefit from goods and services, and equity in the distribution of costs borne through use of goods and services,

The processes that have shaped ecosystems (the producers of goods and services) and their functioning, are highly variable in space and time. This informs us that variability is a prerequisite for promoting sustainability of these production systems. We conclude that the availability of goods and services and the distribution of costs and benefits will vary in time and space, and hence the imperative of striving for a dynamic state of equity underpinned by a robust institutionalised process for reaching consensus (see MacKay, Part II). This cannot occur in the absence of knowledge (‘the capacity for effective action’, Senge et al., 1999, pg.421). In the context of sustainable use, ‘the capacity for effective action’ hinges on understanding and acknowledging the range of values stakeholders attach to river systems; the dynamic relationship between the ecosystem (the production unit), the goods and services and their value and use, so that ‘availability’ can be projected, enabling strategic adaptive management for dynamic equity.

We cannot presently envisage all probable goods and services that may be inherent in the complexity of ecosystems. Sustainable use therefore requires us to also maintain the ‘health’ of ecosystems for delivery of as yet undetermined goods and services to society. The national River Health Programme makes an important contribution in this regard.

Sustainable use of resources, such as river systems, that are essential for survival of so many people, cannot be achieved until there are clearly defined rights and authority regimes that are able to sustain a condition of dynamic equity. At the present time these are unambiguous in some instances (e.g. Water User Associations) but totally ambiguous in others (e.g. Subsistence users in rural communities). Such authority regimes need to develop the ‘capacity to act’, founded in knowledge achieved through an understanding of

and appreciation for the complex social economic and environmental nature of river systems.

Goal

Users together promote a state of dynamic equity in the distribution of costs and benefits deriving from the sustainable use of river systems at scales appropriate to their use of the resource.

This will be achieved by:

- establishing appropriate authority regimes;
- establishing rights of use; and
- developing the capacity to act in the promotion of dynamic equity based on sustainable use.
- Research priorities (Dickens, Part II)
 - Review intentions and application of legislation.
 - Integration of ecological, social and economic issues to create dynamic equity.
 - Review the concept of goods and services and its relationship with sustainable development.
 - Consider how to build intrinsic values into sustainable use.
 - Relate ecosystem change to sustainable use.
 - Identify priorities for addressing sustainable use of river systems.

River research and the protection of river systems

The Water Research Commission has recently received a report on river rehabilitation prepared by Dr Mandy Uys. This report provides a comprehensive review of rehabilitation and has formed the basis for a proposal that is currently in preparation. The intention here is to develop further the context in which river protection is practiced with a view to promoting the sustainability of technical solutions.

The term protection implies action directed to sustain a preferred state of the system²; and rehabilitation implies action directed to reinstate a preferred (not necessarily the original) condition. With few exceptions it is not practical to define the preferred condition as 'natural'. In most situations society is striving to sustain a preferred condition in transformed river systems, or parts thereof. In these instances particularly, it is evident that protection is a continuous process. It is not an event. Likewise, whilst rehabilitation may have some properties of an 'event' in that it may occur over a relatively short period, sustaining the rehabilitated, co-evolving preferred state is also a process.

The challenge for protection lies in sustaining an open-ended process. Government and its agencies, particularly the Catchment Management Agencies, contribute to this by ensuring a supportive institutional setting and thereby the availability and supply of water of

² The preferred state or condition of the system is to be interpreted as a dynamic, co-evolving state or condition reflecting the interplay between biophysical, social and economic preferences.

appropriate quality in perpetuity. But, along the hundreds of thousands of kilometers of river edge in South Africa, many thousands of people interact daily with river systems, making decisions that severally and jointly determine the extent to which the preferred condition is sustained. The behaviour of every one of these individuals needs to be directed towards promotion of the shared perception of preferred condition. Individuals need to be held accountable for their actions.

Whilst one can argue that legislation makes provision for censure, a number of factors weaken our resolve for censure:

- in many instances there is no shared view on the preferred state, or it is poorly articulated and censure is sectorally applied (e.g. restrictions on fishing and little else);
- in instances where there is a 'shared view', it is unclear who shares the vision because demarcation of the 'community of users' is fuzzy;
- in many instances there is little cohesion within the 'community of users', and the community easily fractures around contentious issues, particularly if leadership is weak;
- the 'community of users' has no legitimacy. Thus it strongly reflects the sense of disempowerment in the absence of tenure, and failure to devolve responsibility. Consequently there is no accountability; and
- where the 'community of users' has little cohesion, is poorly demarcated and has no legitimacy, then it has no resilience in its ability to deal with change.

It would be hard, if not impossible, to mobilise and sustain mobilisation of civil society in support of protection of river systems and their resources in the absence of a 'sense of ownership'. Basically we have to return **rivers** to civil society so that they can be held accountable for sustainable use within the context of national policies and legislation. A precondition for supporting the required sense of ownership is congruence between the spatial demarcation of the 'community of users' and the spatial demarcation of the section of river over which tenure is granted. What is envisaged is essentially public-private compacts in which rights, responsibilities and authority over the use of the section of river and its resources are granted for a defined period. Clearly these sectors could be aggregated to accord with larger scale concepts such as 'Heritage Rivers' (Thomas, pers. comm.³). Hooper (2000) has suggested a mechanism whereby this could happen (Box 6). He refers to 'Covenants of Mutual Obligation', and whilst he refers specifically to water rights, the concept is equally applicable to rights to use of a section of river system and its 'basket' of goods and services. He also suggests several critical tasks to implement covenants of mutual obligation (Box 7).

³ Gregory Thomas, Natural Heritage Institute, Berkley, California

Box 6: Elements of 'Covenants of Mutual Obligation' for river system management.
Adapted from Hooper, 2000.

- Clear identification and specification of rights.
- A vision statement of the desired future for the river sector and adjoining land.
- Identification of cost-sharing arrangements to share management expenses
- Clear specification of works and targeted actions, and who is responsible for each
- Contracts between government departments, industry organisations, the river user groups and catchment management organisations to undertake these actions
- External review process to audit outcomes

Box 7: Critical tasks to implement Covenants of Mutual Obligation.
(Source: Hooper, 2000).

- Building and maintaining '*strong leadership*' of the 'engaged' communities.
 - Ensuring membership of catchment management organisations is on a *skills basis*, and not a representative basis.
 - *Clarifying, strengthening and finding the role of Local Government* in catchment management.
 - *Developing trust* between stakeholder groups to agree on each other's mutual obligations; ensuring a *sustained funding base*.
 - Designing a *clearer definition of property rights*.
 - Creating *financial and risk averse* opportunities for landowners, to adopt sustainable land and river management practices.
- Using support tools such as *interactive catchment information systems*

South African legislation makes provision for co-management (National Water Act No. 36 of 1998; National Environmental Management Act No. 107 of 1998 and White Paper on Sustainable Coastal Development in South Africa, 2000). Considerable progress has been made with co-management in Water Users Associations. But so far there has been little progress where the resource is the river system (or a part thereof) as defined in the National Water Act. The Department of Environmental Affairs and Tourism (2000) has published a discussion document titled Environmental Management Cooperation Agreements: a guide for their design and use. This is a useful basis from which to initiate co-management. The Division of Marine Coastal Management is endeavouring to establish 'Co-operation Agreements' but it is not yet clear the extent to which these will be the elements expounded in the Covenants of Mutual Obligation as envisaged by Hooper (2000) (Box 6).

Experience of community based natural resource management, particularly in respect of wildlife (Hulme and Murphree, 2001), encourages us to appreciate the universality of the principle that participation in, and accountability for, management of use of resources is closely linked to apportioning of rights of use and of authority over use. It is, therefore, difficult to envisage successful community based management of river systems if these issues are not integral to the approach adopted. Since large sums of money are currently being expended on rehabilitation of wetlands and sectors of river systems through the Working for Water Programme, there is some urgency to develop ways of sustaining the rehabilitated state.

Strategic research directions

- **Goal**
Effective public-private compacts exist in which civil society is empowered to promote sustainable use of the river resource in accordance with national policy and legislation, and is accountable for its actions.
- **Research priorities**
To be able to establish such partnerships it will be necessary to:
 - define the properties of a public-private partnership;
 - describe and legitimise the processes required to establish and sustain such partnerships; and
 - establish and support partnerships to promote learning by doing. Opportunities already exist in the Working for Water Programme and in the Coast Care Programme.

Hydropolitics and river systems

As a scarce and essential resource, access to water will increasingly hold potential for conflict. Recent studies (Turton, **Part II** of this report) suggest that notwithstanding the potential for conflict, in southern Africa particularly the emphasis on conflict between states in a shared river basin is too narrow. Two new elements are considered essential for widening the concept and practice of hydropolitics.

Before taking the discussion further it is useful to draw distinction between water that ‘knows no boundaries’ in terms of its origins as precipitation and its destinations as it drains from the land, and those resources associated with water in rivers that are fixed in space. The focus in the previous section ‘Distribution of costs and benefits’ addressed the latter. Here we take a broader view particularly of water, even though some aquatic resources such as fish and waterfowl also ‘know no boundaries’. Lessons learned from study of the hydropolitics of water will inform us about the ‘hydropolitics’ of migratory resources associated with river systems.

Turton defines research in hydropolitics as study of the authoritative allocation of values in society with respect to water. Since values are personal and these are aggregated to be reflected at different levels, it is evident that scale, from individual through international to global is an important consideration. Values are founded on use of the goods and services (e.g. economic value) and also on less tangible matters such as morality and ethics. So, hydropolitical studies must also take account of the diverse factors that combine to construct value over the range of scales. Conflict is a consequence of our failure to effectively manage differing perceptions of value, including potential or future value, so that ‘dynamic equity’ (see previous section) can be sustained across the scales.

Africa in general, but South Africa in particular, has a heavy reliance on shared river basins. Approximately 60% of the country is located within international river basins, namely the Orange, Limpopo, Incomati and Maputo, all of which are strategically important. This importance lies not only in the urgency to deal constructively with

establishing dynamic equity, but also in the lessons to be learned that may have much wider application in Africa and beyond.

Application of the dimensions of scale and range in systemic analysis of research needs reveals three 'clusters' that serve as a starting point for hydropolitical research.

Economic cluster.

This consists of a conglomeration of issue-areas that primarily have economic impact. There are six key issue-areas:

- Food security and the need for national self-sufficiency;
- Water for the sustenance and generation of economic activity;
- Inter-basin transfer linking basins, states and political economies;
- Sectoral allocation as water scarcity increases;
- Virtual water where products requiring substantial water for their production are imported rather than produced nationally; and
- Sustainable development because of both the essential requirements for water and its role in the economy.

Legal/Institutional Cluster

This cluster of issue-areas has a predominantly institutional focus. It includes legal issues because institutions are based on rules and agreements. Issues identified are:

- International law;
- River Basin Organisations;
- Catchment Management Agencies; and
- Water Demand Management.

Social/cultural cluster

The focus of this cluster is primarily society. Ecological issues that are linked closely with social issues have been addressed earlier. Issues are:

- Poverty that plays out at all levels. This is addressed mainly in the context of tenure and access to opportunities associated with rivers and adjacent land;
- HIV/AIDS. The primary relationship with river systems is indirect through population change and demand for goods and services;
- Gender. This is closely linked with the water sector via the Dublin Principles, but it is difficult to determine a primary focal point for research; and
- Ecological issues have become increasingly socially relevant as outlined earlier in the report.

It is evident from these clusters and the associated research agenda, that research and leverage of research findings into behavioural change requires that we develop an organisational and procedural approach to operate across scales and the range of issues that demand attention.

CONCLUSIONS AND KEY RESEARCH ISSUES

Society has expectations of research. If it is to continue to support research, these expectations have to be addressed explicitly, more especially if research findings are to lever changes in behaviour towards sustainable use. Radical changes are envisaged for both the organisation of research and the way in which it is conducted. It is concluded that research must be oriented more explicitly to outcomes in addition to outputs which dominates the present paradigm. This requires a much closer interface with those who leverage change consequent upon research findings.

Four key research issues have emerged:

- Establishment of an interorganisational entity (Centre of Competence in River Research and Management) that maintains our fitness to respond to issues pertinent to river system management.
- Strengthening of democracy in support of dynamic equity in apportioning costs and benefits deriving from the use of river systems and the adjoining land.
- Effective public-private compacts that empower civil society to promote sustainable use of river resources.
- A system for analysing and assessing the propagation of impacts and their consequences across scales whereby scenarios can be generated for decision-making.

RECOMMENDATIONS

1. Establish a national 'Centre of Competence' for river management that acts as a broker of knowledge and experience. This Centre should bring together strategic thinkers and managers at senior level to ensure we have the required 'fitness to respond' to the challenges of river management.
2. Revise research organisations and management so as to strengthen collaboration between researchers, government and stakeholders, emphasising attainment of outcomes by leveraging change.
3. Initiate a comprehensive research and development programme directed at strengthening democracy in decision making around use of river resources.
4. Initiate a comprehensive research and development programme directed at establishing public – private compacts that empower civil society to continuously promote sustainable use of river resources.
5. Develop and institutionalise strategic analysis and decision making for river systems that enables integration across physical, social and economic scales.

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PART II: SUBMISSIONS

A Strategic Analysis for River Systems Research in South Africa

By Dirk Roux and Ernita van Wyk

November 2001

Research brief 1: Promotion of learning organisations for effective river management.

Aim of research brief: Define research needs for promoting a culture of continuous learning and adaptation/improvement in the co-operative governance system for river management.

Target group: Researchers and research funders in the first instance, and then stakeholders and regulating authorities.

Motivation

The South African National Water Policy (DWAF, 1997) sets out a vision which is far-reaching, making provision for sophisticated policy tools to enable co-operative, sustainable and equitable management of water resources. The National Water Act (Act 36 of 1998) and the Water Services Act (Act 108 of 1997) comprise the legal means that give effect to the National Water Policy. Strategies are now being developed for the implementation of the policy.

The vision for water management in South Africa is considered internationally to be progressive and ambitious. Achieving this vision will require dramatic changes in the way we conduct water resource management – we will need new institutions, new concepts, processes and products, and new mindsets. Above all, we will need new and innovative ways of leveraging the limited available knowledge, skills and financial resources.

Since the new vision is unprecedented regarding organisational strategy and structure, collaboration, relationship management, style of leadership, stakeholder engagement and technological capabilities, it will essentially have to evolve into operation through ongoing learning and adaptation. Successful implementation of the vision is clearly dependant on effective organisational learning and an ability to translate new knowledge into new and improved ways of doing. The theoretical concepts that are of particular relevance here are:

- Learning organisations
- Knowledge management
- Continuous improvement
- Knowledge & research networks
- Strategic Adaptive Management (SAM)

Understanding the roles and incorporation of the above concepts within the co-operative governance system for water resources will significantly promote the effectiveness and efficiency of organisational behaviour that supports river management in South Africa.

We know that organizations that will excel in years to come will be those that understand how to **continuously expand their capacity to learn** (Senge, 1990). In order to provide for a sustainable and thriving society that benefits from healthy rivers, we will need to know how to build the sorts of organizations that have the appropriate skills (such as learning capabilities) to not just cope with rapid and continuous change in the river management domain, but also to create and sustain change.

Learning and change processes are inseparable. Learning changes people and change requires learning and learning is achieved when we gain and apply new knowledge and skills. We recognize that river management requires change and therefore change initiatives (mechanisms that drive and sustain change), but we do not know how to proceed, what is needed to sustain change or the sort of research that will support the desired changes. To understand the role of research, we will first need to understand the nature of change, the connection between concepts such as change, learning and knowledge, and what the implications are for organizations that want to participate meaningfully in integrated river management.

The objective of this component of the strategic analysis for river systems research in South Africa is to describe, in broad terms, the research needs for promoting and sustaining organizational learning in the cooperative governance system for river management’.

Broad research priorities

1. A conceptual institutional framework that illustrates how co-operative governance for river systems will work.
2. Characterisation of an interface that would promote relationships and the flow of knowledge between river research (knowledge supply) and river management (knowledge demand) within a co-operative governance system.
3. A philosophical analysis of the concept of learning organisations in the context of co-operative governance for river systems.
4. Inter-organizational learning/knowledge networks
5. A critical assessment of the extent to which current research is promoting continuous learning for co-operative governance of river systems.
6. Research briefs and notional budgets indicating priority research required to promote continuous learning for co-operative governance. An example of such a research theme would be: To understand the changing role of science in society and its relevance in the water institution.

1. A conceptual institutional framework that illustrates how co-operative governance for river systems will work:

It is recognised that the challenges laid out in the National Water Policy cannot be achieved with the resources of only DWAF. This is a challenge for the nation, and both public and private sector should actively participate in shaping the future of river management. The vision requires true devolution of authority, responsibility and accountability. While the DWAF must learn to give some, stakeholders in the agricultural, industrial, mining and community sectors must learn to take some responsibility. The nature of the links and relationships between the multiple organisations that form part of the co-operative governance system needs to be defined.

2. Characterisation of an interface that would promote relationships and the flow of knowledge between river scientists (knowledge supply) and river managers (knowledge demand) within a co-operative governance system.

The planning, development and implementation of appropriate technological capabilities are prerequisites for accomplishing strategic and operational objectives related to water resources management. Having a continual supply of appropriate knowledge and technology is strongly dependant on the deliberate coordination (to bring into proper relation) of R&D and associated application and operational functions (conceptualise-design-establish-operate cycle). In order to ensure the required coordination and integration between these two technology compartments, the creation of knowledge and its conversion into technology in the innovation cycle should ideally be initiated by real operational needs with end-user involvement all along the way. At the same time, the applicers of knowledge/technology should allow their actions and strategies to be influenced, in an ongoing and pro-active manner, by the results of R&D activities.

Both the scientific community at large and managers of water resources are inspired by the vision presented in the water policy and are desperately keen to see that their knowledge contribute to the implementation of the policy. However, at present there appears to be insufficient communication, unhealthy conflict and significant misalignment between researchers and managers, and the synergy between these domains is less than optimal. In fact, it is common to observe misunderstanding, friction and even animosity between researchers and managers of water resources.

Misalignment and friction can hardly be afforded in this time of severe challenges. Instead, the creative and synergistic combination of knowledge across research and manager domains will be required to effectively address the multiple challenges posed by implementing the water policy. It is realised that an effective creation-application interface could enhance:

- Researcher-alignment with, and anticipation of, market needs or end-user requirements
- The probability of successful transfer and implementation of research outputs
- Faster development of new products (knowledge and technology) and more effective exploitation of existing knowledge
- Effective utilisation of R&D investment

Misunderstanding between scientists and managers involved with rivers is nothing new. This phenomenon has, for example, been documented in Australia (Cullen, 1990) and the United States (Walters, 1998). These authors have looked at the sources of misunderstanding and even suggested tactics for helping overcome these misunderstandings. Their solutions have mostly been based on ecosystem perspectives. It may be necessary to learn from disciplines outside the domain of environmental sciences, in order to benefit from advances in the fields of relationship management, knowledge management, and technology and innovation management.

3. A philosophical analysis of the concept of learning organisations in the context of co-operative governance for river systems.

What is a learning organization?

"Organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to learn together" (Senge, 1994).

Successful, learning organizations typically focus on 5 key components of their activities and thinking (Senge, 1990):

- Systems thinking
- Personal mastery
- Mental models
- Shared vision
- Team learning

In order to know how to best support the development of learning organizations for cooperative river management, research should develop an understanding the concepts and processes that drive the development of learning organizations. We need to extend this understanding to discover the meaning of these concepts within the contexts of individual and organizational learning and of cooperative management for sustainable river systems. Thirdly, we need to understand the role of research in supporting and sustaining these processes. In addition, we need to prioritise and harmonise research efforts to provide new knowledge that is relevant and that will have effective impact on the change processes.

For research to contribute meaningfully to organizational learning, the research community needs to build a shared understanding of the concepts and processes underpinning learning organizations. Shared understanding will help research to engage, in a coordinated, unified fashion, the change strategies that promote the development of learning organizations.

Grasping Concepts

We need to define concepts in and around learning organizations, such as learning (types and levels of learning, learning culture - see Farago and Skyrme, 1995), knowledge generation and sharing, and transformation. We also need to share an understanding of

these concepts within and between the research and management domains and to extend this understanding to be relevant within the context of river research and management.

Shared understanding of processes

We need to understand the processes that make up the concepts above, (as well as the obstacles that tend to hijack these processes, Senge *et al.*, 2000) and to build mental models around how the concepts relate to one another and what they mean within the context of cooperative governance for river management.

For example, we need to understand the relationship between learning and knowledge management. People learn as they gain new knowledge - this learning is advanced when people share and apply that knowledge and are exposed to the responses resulting from knowledge sharing and application. We need to also understand these relationships and how these processes can be made operational in an organizational environment.

Designing a change strategy

Progress from current to a desired state (i.e. effective learning organizations) will require a strategy for change. A change strategy must be based on an understanding of the processes that reinforce and sustain change/growth, an understanding of the processes that impede/limit change and an understanding of the interplay between the catalysing and the limiting processes. We know for example that a deficiency in basic learning capabilities represents a fundamental limitation to sustaining change (Senge *et al.*, 2000) and that the interaction between limitations and learning opportunities generate the creative tension needed to drive change.

It is these sorts of challenges that research should address within the context of river management and that will help to build change strategies for building learning organizations.

Supporting Research

We need to understand what and how research can support the processes that continuously optimise organizational learning within the river management context.

Research must generate and communicate new knowledge to inform organizations, with the aim that the recipient organization should modify its own agendas and processes as a result of the actions and outcomes rooted in new learning (Cullen *et al.*, 2001). Information and knowledge management therefore forms one of the key management processes of learning organizations (Farago and Skyrme, 1995).

We need to understand clearly how research (knowledge generation and diffusion) can best support change and learning in organizations that form part of the cooperative river management system. For example, most capacities for action that are important to organizations are collective, i.e. knowledge is shared. [Sharing knowledge is what happens when people have an interest in helping one another develop new capacities for action; it is about creating learning processes (Senge, 1990)]. Understanding how research can

support collective learning would therefore be one component of a research strategy for supporting the development of learning organizations.

Also, if research is going to support change, it must itself constitute a process of continuous change and shift in focus as change is anticipated. The research community should be continuously vigilant that research initiatives themselves are vehicles for change.

Inter-organizational learning through knowledge networks

The ability of an organisation to create, learn and exploit different types of knowledge is strongly dependant on research collaboration and knowledge networks. In a water institution, people must have the flexibility to freely work across organisational boundaries. In essence, the institution needs to progress from a collection of organisations to a collection of knowledge-based capabilities.

A united water institution implies that many people work together across conventional boundaries for a common purpose. For such an institutional architecture to be effective, it must allow for multiple leaders, many voluntary links and many interacting levels. The networked organisation is the foremost form of collaboration that conforms to these architectural requirements. Other names that have been used include holonic enterprise, virtual corporation and knowledge network.

The value of knowledge networks (or networked organisations) in facilitating learning and internalising knowledge that would otherwise reside outside the organisation, are well documented (Savage, 1996; Skyrme, 1999). These networks constitute a specific form of collaboration, and as with other forms of collaboration it has advantages, limitations and enabling criteria.

For the water management institution of South Africa, it is necessary to develop a model for collaboration that would address:

- How to move beyond the extreme fragmentation that currently exists in this sector.
 - How to maintain accountability in an environment characterised by devolution of powers and participation that is more inclusive.
 - How to support the focusing and coordination of multiple cross-functional task teams.
 - How to build into the very structure of the institution the capacity for continual learning and for translating new knowledge into improved ways of doing.
4. A critical assessment of the extent to which current research is promoting continuous learning for co-operative governance of river systems.

We need to describe a set of characteristics that typifies the type of research (in terms of research content and processes) that effectively supports the development of learning organizations. Past and existing research projects can then be assessed against these requirements and gaps identified. We will need to explore ways of approaching this exercise.

However, the following could be used to guide the gathering of information around past and current river research initiatives in relation to building learning organizations:

- **Clients:** which target group was the research aimed at? Who was the funder of the research?
- **Diffusion:** What methods were used to influence the target groups?
- **Impact:** What changes in mindset and behaviour are evident from the research? How widely was the technology adopted and incorporated into day-to-day operations? Where does the expertise reside currently – in tools and skills, or as knowledge, part of people's know-how? What have been the research impact achievements in relation to impact objectives for supporting learning organizations?
- **Objective and nature of the research.** Can we draw a link between the objectives and type of particular research project and features of research projects that tend to promote the development of learning organizations?
- **Duration of research.** Given that developing learning organizations and relationship building (collaboration) is a long-term (continuous) change process, can we establish a relationship between research programme duration and the programme's contribution to building learning organizations?

Research briefs and notional budgets indicating priority research required to promote continuous learning for co-operative governance.

Do we know how to decide what is priority research for supporting the development of learning organizations?

GENERAL

Learning organisations

The learning organisation has its origins in companies like Shell, where Arie de Geus described learning as the only sustainable competitive advantage. The learning organisation is seen as a response to an increasingly unpredictable and dynamic work environment. With the pace of change ever quickening, the need to develop mechanisms for continuous learning and innovation is greater than ever. Here are some definitions by key writers:

"The essence of organisational learning is the organization's ability to use the amazing mental capacity of all its members to create the kind of processes that will improve its own" (Dixon, 1994).

"A Learning Company is an organization that facilitates the learning of all its members and continually transforms itself" (Pedler et al., 1991).

"Organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to learn together" (Senge, 1994).

"Learning organizations are those that have in place systems, mechanisms and processes, that are used to continually enhance their capabilities and those who work with it or for it, to achieve sustainable objectives - for themselves and the communities in which they participate" (Farago and Skyrme, 1995).

The important points to note about the latter definition are that learning organisations:

- Are adaptive to their external environment
- Continually enhance their capability to change/adapt
- Develop collective as well as individual learning
- Use the results of learning to achieve better results

Some of the most common obstacles to becoming a learning organization are:

- Operational/fire fighting preoccupation - not creating time to sit back and think strategically
- Too focused on systems and process (e.g. ISO9000) to exclusion of other factors (bureaucratic vs. thinking)
- Reluctance to train (or invest in training), other than for obvious immediate needs
- Too many hidden personal agendas
- Too top-down driven, over tight supervision = lack of real empowerment

The concepts of the *learning organisations* and *knowledge management* are increasingly seen as two sides of the same coin - as you learn you gain knowledge which you apply and

learn more. Collective (i.e. team and organizational) learning requires skills for sharing information and knowledge, particularly implicit knowledge, assumptions and beliefs that are traditionally "beneath the surface". Key skills here are:

- Communication, especially across organisational boundaries
- Listening and observing
- Mentoring and supporting colleagues
- Taking a holistic perspective - seeing the team and organisation as a whole
- Coping with challenge and uncertainty

A learning organization is not about 'more training'. While training does help develop certain types of skill, a learning organisation involves the development of higher levels of knowledge and skill. Four types of factors are important in facilitating this development (Farago and Skyrme, 1995):

- **Learning Culture** - an organizational climate that nurtures learning. There is a strong similarity with those characteristics associated with innovation.
- **Processes** - processes that encourage interaction across boundaries. These are infrastructure, development and management processes, as opposed to business operational processes (the typical focus of many BPR initiatives).
- **Tools and Techniques** - methods that aid individual and group learning, such as creativity and problem solving techniques.
- **Skills and Motivation** - to learn and adapt.

Here are some additional points on the first three of these.

- **A Learning Culture**

- Future, external orientation - these organisations develop understanding of their environment; senior teams take time out to think about the future. Widespread use of external sources and advisors e.g. customers on planning teams.
- Free exchange and flow of information - systems are in place to ensure that expertise is available where it is needed; individuals network extensively, crossing organisational boundaries to develop their knowledge and expertise.
- Commitment to learning, personal development - support from top management; people at all levels encouraged to learn regularly; learning is rewarded. Time to think and learn (understanding, exploring, reflecting, developing)
- Valuing people - ideas, creativity and "imaginative capabilities" are stimulated, made use of and developed. Diversity is recognised as a strength. Views can be challenged.
- Climate of openness and trust - individuals are encouraged to develop ideas, to speak out, to challenge actions.
- Learning from experience - learning from mistakes is often more powerful than learning from success. Failure is tolerated, provided lessons are learnt ("learning from fast failure" – Peters and Austin, 1985).

Key Management Processes

- Strategic and Scenario Planning - approaches to planning that go beyond the numbers, encourage challenging assumptions, thinking 'outside of the box'. They also allocate a proportion of resources for experimentation.
 - Competitor Analysis - as part of a process of continuous monitoring and analysis of all key factor in the external environment, including technology and political factors. A coherent competitor analysis process that gathers information from multiple sources, sifts, analyses, refines, adds value and redistributes is evidence that the appropriate mechanisms are in place.
 - Information and Knowledge Management - using techniques to identify, audit, value (cost/benefit), develop and exploit information as a resource; use of collaboration processes and groupware e.g. Lotus Notes, First Class to categorise and share expertise.
 - Capability Planning - profiling both qualitatively and quantitatively the competencies of the organisation. Profiling these on a matrix can be helpful to planning adjustment:
 - Team and Organisation development - the use of facilitators to help groups with work, job and organisation design and team development - reinforcing values, developing vision, cohesiveness and a climate of stretching goals, sharing and support
 - Performance Measurement - finding appropriate measures and indicators of performance; ones that provide a 'balanced scorecard' and encourage investment in learning
 - Reward and Recognition Systems - processes and systems that recognize acquisition of new skills, teamwork as well as individual effort, celebrate successes and accomplishments, and encourages continuous personal development.
- *Tools and Techniques*
- Inquiry - interviewing, seeking information
 - Creativity - brainstorming, associating ideas
 - Making sense of situations - organising information and thoughts
 - Making choices - deciding courses of action
 - Observing outcomes - recording, observation
 - Reframing knowledge - embedding new knowledge into mental models, memorizing

Below are some key questions which could be translated into research proposals under some or all of the above headings: Understanding concepts, processes, strategies and research support.

What constitutes a learning organization?

We need to describe what we mean by learning (the learning process, the institutional milieu for learning, etc.) and the sort of human behaviours and cultures characterize learning organizations.

How does an organization know that it is learning effectively? Both as individuals and groups? i.e., we need to find appropriate ways of measuring whether appropriate learning is (i.e. move away from formal descriptions of work and learning and start to report on practice).

What are the obstacles to being or becoming a learning organization?

What drives the sort of behaviours that keep these obstacles in place? What is the role of appropriate (and inappropriate) reward systems?

What drives the behaviours that sustain the momentum of effective learning? For example what sorts of things promote a willingness to change, or attitude to risk?

What motivates people to be receptive to new knowledge and information? How can we create appropriate reward systems to encourage these behaviours?

What would be diagnostic indicators of these behavioural drivers?

Can we characterize the current situation in WRM institutions (e.g. DWAF and supporting research organizations) in terms of being a learning organization?

If we know and understand this and we know to what sort of organization we would like them to be, we may be able to devise a strategy for change.

How can research activities and projects be aligned to serve the creation and maintenance of learning organizations?

What would be the practical steps to initiate change, especially change in thinking and behaviour, and in particular when this means changing large bureaucratic-type organizations?

How can an organization cater for a diversity of personal or preferred learning strategies?

How can researchers better understand the context within which resource managers operate, since the knowledge provided and learning must be relevant within this context.

What is the role of changing credibility of science? What do scientists need to do to ensure continued trust in the knowledge generated by research? What drives the development of mistrust in knowledge generated by research?

Through what mechanisms do resource managers seek knowledge and through what mechanisms is knowledge provided by research? How can the mechanisms of seeking and provision be improved and how can knowledge channels between knowledge generators/providers and recipients be better aligned?

How do (and should) knowledge recipients translate new knowledge into action?

How can the research community be encouraged to buy into a broad research strategy? Researchers or organizations focus on their own research and it may not be aligned with strategic needs. Thus, what the research community needs to develop is a sense, or culture, of community good. How can this be achieved?

How can researchers go about understanding the intended recipients' (managers') needs, context and existing knowledge base to which new knowledge provided should be relevant? How should researchers go about understanding the recipients' current beliefs and values that drive their perceptions of what needs to be done and what sort of knowledge supports the required decisions and actions?

How should research best be communicated so as to promote the change in thinking and behaviour it intends to?

How should key management processes (such as knowledge management) in the learning organization be approached? (see Farago and Skyrme, 1995)

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River Research and the Distribution of Costs and Benefits

By Heather MacKay

1. Approaches to valuing ecosystems and ecosystem goods and services

There are two main kinds of approaches to valuing ecosystems and the goods and services provided by ecosystems. In the first, the human or social system is seen as separate, to a large degree, from the ecosystem. Ecosystem functions and processes result in the production, as output, of certain goods and services, which in turn act as input to various processes and production functions in the social system. This approach is more commonly observed in social systems which are more urbanised or more technologically developed. Since the operational currency of these social systems tends to be monetary, this approach lends itself to the application of typical resource economics tools, through which ecosystem goods and services can be valued in monetary terms as inputs to production functions. These tools attempt to express the costs and benefits of changes in ecosystem goods and services in a single bottom line.

In the second kind of approach, humans are seen as a component of the ecosystem, its functions and processes. The boundaries between the ecological and social system are much less clear, and the interactions more complex and stronger. Typically, such a closely integrated ecological-social system is observed in subsistence economies or less technologically developed societies. It may be much more difficult to ascribe monetary values to ecosystem goods and services because it is more difficult to separate ecological components from social components of the system, and because the working currency of such a system may not be primarily monetary. Often it is not possible to express costs and benefits in a single bottom line, but rather simultaneously in multiple currencies or criteria.

In South Africa, we have both developed and subsistence economies present, often in close geographical proximity to each other and relying on the same ecosystems for a supply of goods and services. However, as more globalisation of economies occurs at regional, national and local scales, we are seeing more injection of monetary currencies into local subsistence systems, and the links and feedback loops between social and ecological components of subsistence systems are becoming loosened. Though recognising the move towards more monetised local economies, we need to develop a range of tools for determining and valuing the goods and services provided by ecosystems, which reflect the range of social systems present in South Africa, and which can co-evolve with our evolving society.

2. Tools for determining the value of ecosystem goods and services

Goods and services provided by water resources range from the highly tangible (such as water available for abstraction and offstream commercial use) to the non-tangible (such as

the “sense of place” on which the decision not to mine the St. Lucia dune system was based). Likewise the values of goods and services can be:

- Quantitative, and measurable in terms of a monetary currency;
- Qualitative, being able to be described but not necessarily quantified in monetary terms, though can be ranked relative to the perceived value of other goods and services;
- Abstract, which includes such difficult-to-describe values such as sense of place, intrinsic value and existence value.

Generally, in the field of valuation of ecosystem goods and services, the effort is made to express all the values, from quantitative through to abstract, in monetary terms or in terms of a single quantitative currency. In order to do this, techniques are used which rely mostly on asking or observing people’s willingness to pay for a particular good or service, usually their willingness to pay to prevent loss of the good or service.

For the tangible goods and services, if a market exists in which the good or service is freely traded, then a price can be established which is a fairly accurate indication of the value to people. However, there are few truly free markets for the trade of goods and services provided by water resources, since prices and availability tend to be artificially manipulated. For example, water tariffs are established at a national or regional level, and although there is some allowance made for regional availability of water, the use of cross-subsidies and the prevalence of inter-basin transfers distorts the price of water significantly in relation to its actual value. Although the National Water Act allows for limited trading of water use licenses, including those for abstraction as well as discharge, in practice it is unlikely that free markets in water will ever develop fully in South Africa.

Sometimes, the price of an alternative can be established and used as a surrogate for the value of the original good or service. For example, healthy aquatic ecosystems are able to assimilate some biodegradable wastes. The cost of the equivalent treatment by a sewage treatment plant is fairly straightforward to establish, and can be assumed to be equal to the value of the water treatment service which would be lost if the aquatic ecosystem were to be destroyed. The determination of the cost of alternatives is probably the approach which has more potential for application in South Africa.

For the less tangible goods and services, such as recreational value, aesthetic value or heritage value, surveys can be conducted to ascertain people’s willingness to pay. People may be asked how much they would be willing to pay to ensure that a particular water resource, say a wetland, continued to exist. This can be used as an indicator of the value of the water resource, but such methods are notoriously inaccurate, particularly if people are questioned directly on their preferences. It is somewhat more accurate to observe what people actually do and infer values from their revealed behavioural preferences, rather than to rely on what they say. However, a significant problem with application of such methods in South Africa is the wide range in socio-economic groupings, which leads to large variances in perceived values. The willingness of a person to pay for an ecosystem good or service is much greater in an affluent group than in a poor group. In addition, the value of the monetary currency itself varies: a rand in Johannesburg, for example, which is a society where almost all commodities are traded in monetary terms, has a very different value to a rand in the rural areas of the Northern province, where the economy may be a mix of subsistence and formal.

A valuation method which is specific to the determination of recreational value is the travel cost method. Although it has some technical difficulties associated with it (including the inability to deal with multiple-destination journeys) it is also probably not appropriate for South African conditions unless applied strictly within a single socio-economic group.

Given the range of conditions which exist in South Africa, in socio-economic terms, in biophysical terms and in cultural terms, methods which rely on relative ranking of preferences may be more useful in valuing ecosystem goods and services. Techniques such as multi-criteria decision analysis do not absolutely require the expression of all values in a single currency, and are probably more appropriate for our situation.

Overall, there is a tendency in the field of resource economics, including the economic valuation of ecosystem goods and services, to take a strictly utilitarian approach, incorporating in the valuation exercise only those goods and services which are perceived to be of direct cost/benefit to humans. There is a danger with this approach that critical aspects of ecosystem functions, and the place of ecosystem components within the larger global perspective, can be overlooked. In addition, more recent writing in the field of political science (for example Cobb, 2000) and deep ecology is urging us to look wider, and consider as part of our world those ecosystems and ecosystem components which do not have direct or close links with human existence, or which may not, within our current understanding, appear to be essential for supporting human existence. The current research trajectory in the field of resource economics may not be able to encompass this wider view, and there may be merit in stimulating debate at a more philosophical level in South Africa before we define our research agenda in too much detail.

3. Tools for distributing the costs and benefits associated with ecosystem goods and services

Changes in patterns of water resource use, or changes in land use patterns which affect water resources, can demonstrate many intended benefits to a range of stakeholders, but may also result in unintended, often unforeseen, costs, usually environmental. Environmental costs may be passed on to a group or groups of stakeholders in the form of added economic costs. As indicated above, it is necessary to have the fullest possible picture of all potential costs and benefits associated with a course of action or policy, in order to make the best decision. However, another essential aspect of the decision is to address the equitable distribution of costs and benefits amongst stakeholders.

Equity in distribution of costs and benefits tends to be dynamic: at any one time, equity can be seen as a multi-dimensional tension between

- quantitative, monetised costs and benefits vs. non-quantifiable costs and benefits;
- present and future generations, especially in the allocation of costs to future generations in return for benefits to the current generation;
- different groups of stakeholders, perhaps distributing costs to one group against benefits to another previously disadvantaged group;
- different geographic scales, such as local, regional, national and global.

Equity is something which needs to be optimised, depending on social, economic and ecological factors, different time scales of interest and different geographic scales of

interest. As such, we will constantly find ourselves in a process of defining and redefining what we consider to be an equitable distribution of the costs and benefits of use of ecosystem goods and services, as changes occur in social-ecological systems, and as more information and knowledge comes to light. This means that the process by which agreement is reached on the distribution of costs and benefits is far more important than the actual distribution at any particular point in time. This is in line with current trends in systems thinking, which has shifted from a focus on optimisation of well-defined systems with clear objectives, to a focus on systemic processes of learning and adapting in complex systems with ill-defined or changing objectives (Hodge et al. 1999).

In order to support this search for a dynamic equity which can shift in response to changes in any part of the social-ecological system, it is necessary to have in place

- a robust process of reaching consensus amongst stakeholders on multiple issues related to resource use and the distribution of costs and benefits associated with resource use;
- procedures and formats for capturing, communicating and using information and knowledge which will best serve the process of consensus-seeking;
- capacity amongst all stakeholder groups to participate in the consensus-seeking process;
- a strong policy context to provide guidance and a mandate to implementing agencies in the distribution of costs and benefits;
- governance structures which can accommodate a process of consensus-seeking amongst stakeholders, and through which consensus decisions on distribution of costs and benefits can be implemented.

3.1. Process for reaching consensus on distribution of costs and benefits

The process for reaching consensus on the distribution of costs and benefits associated with resource use is of necessity a multi-stakeholder, multi-issue process. It must include legitimate representation of all stakeholders who may benefit from or in some way pay for the use of the resource, and must allow us to balance the values of stakeholder groupings at local, regional, national and global scales, as well as taking into account the possible values of future generations. Such a process must enable stakeholders to consider and weigh up abstract, qualitative and quantitative values of a resource and the associated costs and benefits of resource use. It must also be a process in which there is trust and confidence, since stakeholders must come together again in the future to review and possibly adapt the agreed distribution of costs and benefits as the point of equity shifts. Lastly, it must be a transparent process to ensure accountability and responsibility for implementation of consensus decisions.

To be successful, a multi-stakeholder, multi-issue process requires careful, expert management, which can often be usefully supported by various technologies. There is a considerable body of knowledge available to us from the field of negotiation theory and public administration (e.g. Susskind & Cruikshank, 1987; Susskind, 1994), which could usefully be applied within the water sector in South Africa to decision making on distribution of the costs and benefits of water resource use. However, this knowledge is not generally accessed by local water sector professionals who may be responsible for designing and managing consensus-seeking processes. There is a need to review this knowledge and consider ways to transfer both the knowledge and appropriate skills to relevant practitioners in the water sector.

There is a range of technologies which can support consensus-seeking processes, from participatory appraisal methods to multi-criteria decision making tools, and including scenario-generating tools. Most of these technologies have been adequately researched and applied in South Africa in various natural resource allocation processes. Multi-criteria decision making approaches show the most promise for supporting the search for equitable distribution of costs and benefits of resource use, since they allow stakeholders to build and compare scenarios involving quantitative and qualitative values, and to express different preferences for different aspects of a particular decision or course of action. Rather than additional research in this field, what is needed now is guidance on which tools are appropriate for which situations and issues, and transfer of these technologies to practitioners in the water sector. The development of a “toolkit” which also provides case studies and worked examples should be considered.

3.2. Informing the process

The consensus-seeking process must be supported by good information and knowledge which is easily accessible and understandable by all stakeholders in the process, and in which all stakeholders have confidence. Implementation of consensus decisions must also be informed on an ongoing basis by measurement indicators which clearly reflect the consequences of these decisions, so that review of decisions and adjustment of actions can be most efficient and best tailored to suit the situation.

The sustainability literature promotes the use of pressure-state-response indicators, by which are measured

- the driving forces or pressures on an ecological system;
- the resulting state of the ecosystem, and
- the response of the social system to this ecosystem state.

In South Africa, we have tended to focus on measurement of pressures on aquatic ecosystems, including natural driving forces such as climate, hydrology and geochemistry, as well as anthropogenic impacts such as land use, effluent discharges and water abstraction. We have only recently, through the development and implementation of aquatic biomonitoring programmes, begun to measure the resulting state of aquatic ecosystems in ways which allow us to better link cause and effect. We have little history of measurement of the flow of goods and services associated with a particular ecosystem state, and almost no experience in development and implementation of measurement tools which can indicate to us the response of social systems to the flow or change in flow of ecosystem goods and services.

3.3. Building capacity to participate in the process

People need to appreciate and understand the range of ecosystem goods and services which water resources provide, and to begin thinking about these goods and services in terms of their relative values, as well as asking the critical questions about distribution of value and of costs and benefits. This is not necessarily the responsibility of a research organisation such as the Water Research Commission. The most effective way to get the message across

is likely to be through incorporating the goods and services issues into all decision making processes related to water resources management, thus raising the awareness not only of government agency and CMA staff, but also of stakeholders and the general public. The publication and dissemination of case studies, and their use in training courses and graduate teaching programmes will also establish the ideas more firmly in people's minds. The production of a set of "blue accounts" for water resources in South Africa may be useful for demonstration purposes – this would be similar to the production of "green national accounts", in which the value of natural capital and its utilisation, the costs of damage to resources and the benefits of use, are reflected on a balance sheet.

3.4. Governance structures to support the process

In future, institutions with responsibility for governance and management of water resources will need to be designed to accommodate the process of continual adaptation to a shifting equity in the utilisation and distribution of goods and services. Institutions will need to be flexible and able to respond quickly to changes in socio-economic values and perceptions as well as in ecosystems, since both will influence the value of goods and services, the costs and benefits associated with changes in these goods and services, and perceptions about where the point of equity lies in distribution of costs and benefits.

Much of the new thinking about adaptive organisations, and the development of virtual organisations and networks for management of water resources, is relevant here, and reference should be made to the strategic review of research related to establishment and functioning of such institutions.

4. Research briefs

4.1. Identification of specific goods and services and their use by different socio-economic groups

The generic suite of goods and services provided by water resources has been fairly well described in recent and current research (Mander, pers. comm.). However, South Africa has a highly non-homogenous population, with widely varying socio-economic groupings, superimposed on often strongly regionalised cultural groupings and traditions. There is a need to undertake research based on social profiling (which in itself is not very politically correct), in order to generate more understanding of how different socio-economic groups in different regions, linked to different kinds of water resources (e.g. in arid zones, coastal zones or in high rainfall zones), perceive, utilise and value the goods and services provided by water resources, and what substitutes may exist or be available for particular goods and services. This would provide a knowledge base from which information could quickly be drawn regarding the significance and importance of specific goods and services, allowing for initial assessments at scoping level to be made of the likely socio-economic impact of policy, water resources management or water allocation decisions.

Quantification of the value of goods and services

Two pieces of information are needed to determine the value of a good or service, as per the relationship:

$$\text{value} = \text{quantity} \times \text{price}$$

For South African conditions, it remains very difficult to obtain accurate quantitative estimates of the value of specific goods and services provided by water resources, and even more so to predict changes in the flow and quality of goods and services, since accurate estimates of quantity or price are not usually readily available, and must be guessed, inferred or extrapolated from other studies.

Most ecosystem models are aimed at understanding internal links and processes within and between various components of ecosystems. There is a need to develop aquatic ecosystem models which have as their objectives quantification of the outputs of an ecosystem, in terms of specific goods and services. This would provide us with the capability to quantify and predict changes in the flow of goods and services associated with changes in ecosystem state.

The other key research area is in determination of local prices for specific goods and services. Because of the large variability in socio-economic status and regional economies, there is a need to develop reliable, quantitative information on the regional prices of a generic set of goods and services, which can serve as input to economic cost-benefit models for water resources planning.

Development of measurement tools and indicators

The development of measurement tools is perhaps the area where most research is required in the medium term. We need indicators in three categories, viz.:

- those which can allow us to predict quantitatively the changes in quality and quantity of various ecosystem goods and services associated with changes in ecosystem state, and to monitor trends in the quantity and quality of these goods and services as a result of changes in ecosystem state;
- those which allow us to identify and quantify trends in the flow of specific ecosystem goods and services to specific socio-economic or stakeholder groups; to identify how the associated costs and benefits, both monetary and non-monetary, are distributed at any point in time; to assess the state of the resource capital which provides the goods and services i.e. whether increasing, decreasing or steady, and to allow judgement of whether a scenario or decision will lead to sustainable use of a resource;
- those which allow us to predict and assess trends in the well-being (economic, social, health, etc) of target stakeholder groups as a result of decisions regarding the distribution of ecosystem goods and services and their associated costs and benefits.

Processes for distributing costs and benefits

There is a need to review the theory and practice of managing multi-stakeholder, multi-issue negotiations, which are the kind of processes within which decisions are made about the distribution of costs and benefits of changes in the flow of goods and services associated with water resources. The objective of such a review would be to make

information and knowledge available to water sector professionals regarding how to design, establish and manage the most appropriate processes for the specific purpose of reaching consensus decisions about the equitable distribution of costs and benefits related to use of water resources.

There is also a need to provide a “toolkit” or easy reference guide to the various supporting technologies such as multi-criteria decision making, cost-benefit analysis, scenario generation and testing, what-if analysis and systems models, which can be used to inform processes for negotiating about the distribution of costs and benefits.

Policy and regulatory procedures

This may not be strictly a research need, but there is very limited understanding within government and regulatory agencies of the use of a goods-and-services approach to decision making, and still less understanding of how determination of the value of ecosystem goods and services can be used to support decision making on the distribution of costs and benefits. Although the current policy and legislative environment is in principle supportive of the use of such approaches and tools, there has been little development of thinking at an operational level, and if the research outlined above is to be taken up and applied in the future, there is a need to influence the development of policy and regulatory procedures which can support the incorporation of these ideas into allocation and planning decisions.

Some effort needs to go into raising the awareness of policy makers and policy implementers regarding the goods and services approach, valuation of goods and services, economic instruments and processes for distributing costs and benefits, such as “green taxes”. This may best be achieved through the production of a series of informative but non-technical brochures, possibly supplemented by a series of seminars and internet-based information, and a comparative international review of policy and regulatory options for water resources management which are based on a goods and services approach. Stimulation of national debate on this issue can only enhance the level of understanding at the policy level as well as the stakeholder level.

Notional budgets

It is not possible to recommend actual rand amounts which should be invested in research into this area, but Table 1 indicates recommended proportional allocation of the research investment into the whole area of goods and services and distribution of the costs and benefits of water resource use.

Table 1

Research theme	Recommended % of total research investment related to goods and services / costs and benefits approaches
SOCIO-ECONOMIC PROFILING OF USE AND VALUE OF GOODS AND SERVICES	10
Development of models which quantify ecosystem outputs in terms of goods and services	25
Determination of local prices for a generic set of goods and services	10
DEVELOPMENT OF MEASUREMENT TOOLS AND INDICATORS	35
Processes and supporting technologies for distribution of costs and benefits	10
Stimulation and development of policy and regulatory environment	10

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River Research and the Distribution of Costs and Benefits

By David Cox and Myles Mander

Institute of Natural Resources

1. BACKGROUND

The National Water Act, No 36 of 1998 (NWA) requires that the future management of water resources in South Africa is based on the principles of equity and sustainability. Society values river systems according to the goods and services supplied by river systems and the costs and benefits they derive from the use of these. To manage water resources in an equitable manner, it is therefore necessary to understand how much of a good or service a river system can supply, and the demand for that good or service by different water user groups. If one is then able to quantify the costs and benefits associated with the use of these goods i.e. the value, it will become evident which user groups may be benefiting at the expense of other groups, and how water resources may be distributed in a more equitable manner.

The Reserve Determination, or water allocation process requires the participation of representatives from all water user groups. Central to the effectiveness of such a process, is the provision of knowledge and understanding in a form that will allow water users to understand how the existing allocation of water resources may not meet the 'equity' requirement, and secondly, to analyse how changes in the allocation of the resources in a catchment will affect the provision of goods and services, along with the costs and benefits derived from the altered allocation.

This aim of this document is to identify research needs for promoting the equitable distribution of costs and benefits accruing from the use of goods and services provided by river systems. The focus of the analysis will be on:

- An evaluation of approaches to determining the value of goods and services and the distribution of costs and benefits at various scales.
- An evaluation of systems for continuously promoting equitable distribution of costs and benefits.
- An assessment of the extent to which current research is informing decision making around the equitable distribution of costs and benefits.
- A summary of research requirement for addressing limitations identified during the critical evaluation of the

2. VALUING GOODS AND SERVICES

The costs and benefits derived by water user groups are generally expressed in financial terms e.g. the profits of a white water rafting company, or sale of an irrigated crop. In addition, it has long been acknowledged that in order to make informed decisions regarding the utilisation of natural resources, it is important to be able to value them in financial terms. Having a monetary value for a natural resource and the goods and services

it provides, allows one to weigh up the financial costs (decrease in the value of a service provided by a river system e.g. waste assimilation), with the benefits arising from allocating more water to a certain use e.g. irrigation (for which the benefits are profits from increased agricultural yields). Without a monetary value for the river system service, it is difficult to allocate the system good or service adequate weight within the decision making process. This situation often results in the degradation of the natural resource at the expense of development, i.e. the principle of sustainability is not met.

The discipline of Resource Economics (RE) has developed in response to the need to derive values for natural resources that will inform decision making. Within this discipline, numerous techniques and methodologies aimed at providing realistic and accurate monetary value for natural resources, have emerged.

The use of RE as a tool in facilitating the participation of water user groups in the decision making process around the allocation of water resources involves three steps.

- The collection of sufficient amounts of the specific data within a catchment to quantify the goods and services being supplied by a system.
- Calculation of the value of the costs and benefits for the goods and services provided by the river system in its current state. This exercise will provide a summary of the costs and benefits being derived by different users through the existing distribution of goods and services. This will highlight any inequalities in the status quo.
- The application of the values within a decision making situation designed to determine an equitable distribution of the water in a system. This process will involve water users, managers, scientists and responsible government bodies. By analysing the values attached to the existing distribution of goods and services and illustrating how changes in the allocation of water will affect these, users will be able to understand the likely trade-offs of different resource allocation scenarios. Provision of knowledge and understanding in these terms will inform the decision making process in a manner which may facilitate the equitable distribution of goods and services provided by river systems.

In a recent study, Mander *et al* (2001) investigated the effectiveness of incorporating economic considerations into the allocation, quantification and management of the environmental reserve in the Crocodile River catchment in Mpumalanga. This research importantly highlighted limitations that currently hinder the effective use of RE as a tool for assisting in the determination of the reserve.

2.1 Establishing the Supply of and Demand for Goods and Services

The collection of data required to establish the level of goods and services being provided by the Crocodile River system proved to be a resource intensive undertaking, and consequently an expensive one. There are considerable limitations in data availability as information is often not collected or stored in a form which allows for easy collection or analysis. This necessitated a change in certain methodologies originally proposed by Mander *et al* (2001) for establishing the quantity of goods and services being provided by the Crocodile river system. In some cases, significant primary data collection was required e.g. the collection of data on recreational fishing in the upper Crocodile River catchment. Reliance on a wide range of different people and organisations for information further hampered efforts to obtain and consolidate

the data. The intensive effort and associated costs required to make such assessments is likely to constrain the widespread application of resource economics for these purposes.

In addition, a number of the ecosystem services proved to be complex, requiring considerable primary research to establish predictable relationships between river functionality and the quantity and quality of ecosystem goods and services supplied e.g. there are a variety of factors and complex relationships which influence the maintenance of bank stability in a river system. As these vary along the river gradient and not all of the relationships are completely understood, it was not possible to value this and a number of other goods and services which are subject to similar limitations.

The study was however successful in identifying key goods and services for which data required to value them does currently exist. In order to further develop the use of RE as a decision support tool in the management of River Resources it is necessary that the following research takes place:

- *There is a refinement of the methodologies proposed and adopted by Mander et al (2000) for valuing certain key goods and services. It is therefore necessary to develop methodologies that are replicable, across catchments.*
- *The methodologies will need to be based on information which will exist for each catchment and a research focus should therefore be:*
 - *the type, volume and form of data needed to be collected to apply the methodologies discussed above across catchments, and*
 - *how this information can be stored and accessed so that it is readily available for application, and*
 - *what organisation should be responsible for consolidating data for a catchment and facilitating the distribution of the data e.g. catchment management agency (CMA).*

2.2 Valuation of River System Goods and Services

Where sufficient data was collected, Mander *et al* (2001) were able to analyse and calculate 'order of magnitude estimates' for seven of the ten goods and services that were originally proposed for valuation. By estimating the values of river ecosystem services, one is able to identify:

- The relative values of different river ecosystem goods and services supplied,
- The magnitude of values,
- The distribution of the benefits between various sectors in society,
- The location of the user groups (or demands), and
- The river reaches where demand is significant.

Importantly, the results showed that river ecosystem goods and services are key role players in local and regional economies. It was also shown that the value of several services are sufficient to warrant specific consideration in the RDM process and would also be critical in directing catchment management activities.

It was also apparent that the RE tools and techniques required to value goods and services exist. With the collection of appropriate data, it is therefore possible to calculate values for the goods and services provided by a river system. The usefulness of these values in informing a decision making process varies depending on the scale

at which they are applied. At a macro level they are useful for illustrative purposes e.g. how ‘unequal’ the existing distribution of costs and benefits associated with the use of goods and services within a catchment may be. The level of confidence associated with the results is a product of the inputs i.e. the quality and quantity of data – the better the data the fewer assumptions that need to be made and the more accurate the values obtained are. Consequently, the more accurate the data and resulting values, the higher the scale at which they can effectively be applied. Whereas the values obtained by Mander *et al* (2000) may be useful for informing national water accounts upon which the development of the national water strategy are based, or at a catchment level, more accurate figures are probably necessary for the values to prove realistic at a tributary or reach level. In addition to the spatial scale at which values may be applicable, it is also necessary to consider the level of reserve determination undertaken for the catchment, tributary etc. As these range from a preliminary to an intermediate and full reserve determination, it is necessary to investigate what accuracy of the ecosystem service value is required to prove useful at these different levels.

In summary, the resource economic tools required to value river system goods and services exist. The usefulness of the values derived from the process is therefore dependant on the quality and scale of the data used as the inputs. As the Reserve Determination process is currently still developing, future research regarding the use of resource economics as a tool for assisting the process should investigate:

- *What accuracy for the values obtained can be considered useful in informing decision making at different*
 - *spatial scales i.e. national water strategy, versus catchment, or reach level or*
 - *scales related to the level of reserve determination i.e. preliminary, intermediate or full*

The final step in arriving at an equitable distribution of costs and benefits derived from goods and services provided by a river system, is to apply results in a decision making framework.

2.3 Decision Making Process

As described in the introduction, the reserve determination process involves the interaction between different users groups, responsible authorities and water management bodies to arrive at an equitable and sustainable allocation of water resources in a catchment. Mander *et al* (2001) propose that this may be achieved using a Multi-criteria Decision Analysis (MCDA). This tool would involve evaluating how the value (costs and benefits) associated with different goods and services will change under different resource (water) allocation scenarios. By illustrating how changes in the allocation of water resources will affect the costs and benefits derived from the use of goods and services in the catchment, the various role players will be able to understand the implications for their well being. By understanding, how certain users may have been getting an unequal share of the resources in the past, users who may previously have been benefiting greatly, may be more willing to agree to a decrease in the benefits they derive from the catchments resources.

The application of values within a MCDA can not take place unless it is possible to establish how the provision of goods and services will change with changes in the

different allocation scenarios i.e. management classes. Current and traditional river research focuses on understanding how different components of river systems function e.g. riparian vegetation, aquatic invertebrates and to a degree how changes in one affects the other - this allows scientists to identify and qualify the state of a river system in ecological terms. They are however, unable to convert this understanding into what the ecological status means for the supply of the river system goods and services e.g. if the riparian vegetation is considered to be of 'B' class status, what is its value to rural populations which rely on this vegetation for craft work and building materials. As shown by Mander *et al* (2000), it is possible to establish broad values for the different services. If ecologists then provide an assessment of the status of the various riverine habitats and functions, one is able to establish a value of the goods and services provided by the river in its current state.

The main shortcoming of current understanding is when one tries to calculate changes in the socio-economic status of water users resulting from a change in the ecological status. Because scientists and ecologists are unable, or unwilling, to say how changes in the ecological state will affect the costs and benefits to various user groups because of changes in the amount of goods and services supplied by the system, it is impossible to use the values within a decision making framework i.e. it is not possible to see how an increase in the allocation to one user e.g. agriculture, will affect another user e.g. water dependent recreational initiatives within a catchment, and by how much they will be affected i.e. the size of the decrease in the benefits derived by say, a white water rafting enterprise from increased abstraction by agriculture for irrigation.

A further limitation is in the understanding of how changes in different components of river systems affect other components and in turn how this impacts on user groups. Mander *et al* (2001) established that disease related to water borne pests and pathogens resulted in costs to the Crocodile catchment of R5.5 million per annum associated with treatment and approximately R11 million per annum in terms of lost productivity to households. Although it is understood that decreased flows increase the habitat for vectors of such diseases e.g. snails, it is not known by how much flows should be increased to reduce the incidence of such disease and thereby reduce the costs borne by society.

Research is currently undertaken within single disciplines e.g. scientific, social and economic. Despite researchers working in a similar spatial sphere, the focus of and way in which the results of each project are presented have no bearing or use for other disciplines. As the volume and quality of the water resources, and the resulting goods and services supplied are a product of what economic, social and land-use takes place in the catchment, it is naïve to undertake research with a singular focus.

If there is to be any progress in meeting the 'equity' principle required by the NWA, then it is vital that future research:

- *Investigate how the ecological state of a river system relates to the provision of key goods and services i.e. how changes in the management class affect the costs and benefits derived from the use of the river system goods and services. This is critical to utilising results within a decision making framework – without such understanding the implications of different resource allocation scenarios can not be illustrated.*

- *Results need to be collected in a form which facilitates their analysis within resource economic methodologies and application within decision making frameworks i.e. the focus of scientific results should change in order that they may be used to value key goods and services.*
- *Further research needs to be conducted to establish whether the key goods and services identified by Mander et al (2001) represent all probable water user groups that may be encountered in South Africa. Where the interests of certain user groups can not be represented the effectiveness of utilising the values in a decision making process will be reduced.*
- *Research must be integrated, both within disciplines e.g science and between e.g. social, economic and science in order that the outcomes of each allow for useful analysis within a catchment that produces useful understanding and results that inform decision making regarding the allocation of water resources.*
- *Broad values that have been established should be tested within a MCDA in order to assess its effectiveness at arriving at an equitable and sustainable distribution of resources in a test catchment. This will also establish whether water user groups support the use of RE within such a process – without their support and confidence in values, the usefulness of the values will be limited.*
- *The applicability of specialist ‘wisdom’ at different scales needs to be investigated. Where the costs implications of gathering data are preclusive, specialist understanding may be sufficient to make broad qualifications that will assist decision making at a particular level – whether this is acceptable and the level at which it may be applicable needs to be tested.*

3. CONCLUSION

Water users perceive the state of a river system in the context of the costs and benefits arising from the use of the goods and services provided by the system. Since users differ in the value they attach to particular goods and services, the reserve determination process will inevitably involve a conflict of interests and an interactive decision making process will be required to overcome such situations. Traditional rivers research has focussed on understanding how river systems function, and defined the state of rivers in terms of their ecological integrity or management class. Unless there is a change in the focus of rivers research which enables scientists to show how changes in functionality or management class, affect the provision of goods and services, water users will not be able to effectively participate in the reserve determination process, as required by law.

Resource economics has been shown to be a useful tool in converting scientific understanding to financial terms which may be understood and used to inform the decision making process. In order to refine the use of RE in meeting the ‘equity’ principle, it is necessary that the research recommendations outlined in this document are undertaken.

River Research and Sustainable Use of Goods and Services

By Chris Dickens

A framework for directing R&D

Umgeni Water

“People usually learn the hard way. There was an ignorant man who had a hen. She used to lay one egg every day. One day he was in need of more than one egg and thought that why should he not take out all the eggs; he cut open the body and found none. Perhaps the greed of man will result in poverty in due course.”

Indian philosopher Shantanand Saraswati

Background:

In response to the document “A Strategic Analysis for River Systems Research in South Africa” compiled by Prof. C. Breen, below is an attempt to stimulate new vision into the research needs relating to the sustainable use of goods and services supplied by rivers (and other aquatic resources). In his document, Prof. Breen introduces a change to the traditional perception of the state of an aquatic resource, suggesting that the primary assessment should be based on the provision of goods and services, which are the main drivers behind society’s appreciation of a resource. Only after such an assessment has been done, then the results would be translated into ecological terms to allow for the systematic management of the resource.

Research Brief:

Key question – what research are we doing and what do we need to do to be able to effectively promote wise use and protection of the supplies of goods and services deriving from river systems?

Aim - River systems are protected through the effective implementation of strategic adaptive management of the sustainable use of goods and services.

Introduction:

The above aim includes three main areas that need to be investigated:

1. is the provision of goods and services a valid measure for aquatic resource management?
2. how may aquatic resources be used sustainably?
3. how may strategic adaptive management be used to manage and protect a resource?

In order to understand these aims, it is necessary to first examine the principles behind them.

Principles:

► The key principle underlying the sustainable use of natural resources centres on the state of mind of users. Wisdom in the management of resources is imperative, otherwise as suggested in the quotation at the top of this page, *“Perhaps the greed of man will result in poverty in due course”*.

► A second principle is that Natural Law will operate irrespective of opinion, as *nature herself writes the rulebook*. As managers of the resource, to be successful we need to understand and listen to the language of Natural Law. Transgression will inevitably lead to failure. If legislation and societal laws do not concur with Natural Law, then failure is inevitable.

► Nature will always move to restore a balance. Any imbalance created by poor management of resources, will inevitably be restored by Nature. But, the time frame of this restoration, and the process of restoration itself, is unlikely to be to the liking of Mankind.

Principles for the sustainable use of resources

Definition – Sustainability is the “capacity for indefinite continuance”. Sustainable Development is “the journey that society must necessarily take towards a state of sustainability” (Everard, 1999).

Everard continues to describe the paradigm shift that society must go through in order to accept Sustainable Development. He describes how current society views the flow of resources in a linear way, which he terms *mine – use – dispose*, which encourages us to make use of resources and then to fix the problems afterwards. He suggests a change to a cyclic view, accepting that the earth is a closed system where everything has to be recycled. He (and the organisation The Natural Step) describes four conditions necessary to ensure sustainability. These are:

1. Substances from the Earth’s crust must not systematically increase in nature.
2. Substances produced by society must not systematically increase in nature.
3. The physical basis for the productivity and diversity of nature must not be systematically diminished.
4. There needs to be fair and efficient use of resources with respect to meeting human needs.

► Key principle – where we make use of resources that cannot be regenerated (e.g. oil or loss of species) we must do so with the understanding that they will not be available in the future, and we must be willing and able to live and prosper without them in the future. But, in doing so, we put sustainability at risk.

► Key principle - if resources can be regenerated, then we must live within the constraints of those regeneration rates. This needs to be measured.

► Key principle – it is imperative that sustainable development includes the three limbs of environmental, social and economic sustainability.

► Key principle – if the distribution and access to resources is uneven, instability will follow.

Principles of Goods and Services from Aquatic Resources

► In economic terms, aquatic resources, subjected to human desires and modified by labour, produce wealth. (*Wealth may be defined as land modified by labour so as to fit it for the gratification of human desire – Maclaren*).

► There is congruence between the *health* of an aquatic resource and the provision of goods and services. Take note of this definition of the word *health*.

Health – soundness of body; that condition in which its functions are duly discharged. Spiritual, moral or mental soundness. Well being, safety. Root = whole condition.

Shorter Oxford Dictionary on Historical Principles

Clearly, according to this description, a healthy aquatic resource will be one that is continuing to discharge its functions (including the provision of goods and services). A loss of health will be associated with a loss of the provision of goods and services.

Principles of strategic adaptive management

► This is the process (some would say obvious) of continual monitoring of the results of management and adaptation of the process to ensure continuous improvement towards the desired outcome. In order to accomplish this, systems need to be in place that are well directed but sufficiently flexible to ensure freedom to respond.

Research Needs:

Following on from the above, several research needs are identifiable. These include:

1. Document all of the parts of the legislation, especially the Water Act, that require development to be sustainable. Is this legislation being taken seriously? What procedures are in place to ensure this? Are there currently laws in place which go against sustainable development? Does the Government issue subsidies and sponsor other activities that go against sustainable development?
2. It is said by the IUCN (2000) and also contained in the Biodiversity Convention, that sustainable development must encapsulate an ecosystems approach. How best can ecological objectives be integrated with social and economic issues? How does this relate to the suggestion that an assessment of sustainability should be done through the measurement of the provision of goods and services? The relationship between utilization of resources, goods and services and ecological health needs to be clarified.
3. Goods and services – is this a valid way to measure sustainable development or is this just an easy sell? What are the goods and services provided by aquatic resources in South Africa? How much are they worth? How would sustainable development be monitored according to goods and services? Is there a chance that sustainability may be transgressed while maintaining adequate goods and services, e.g. some valid goods and services may allow total ecological destruction – is this acceptable (e.g. using a river as a sewer)?
4. Is it acceptable to evaluate the environment according to accounting principles? What would be the acceptable time horizon for this? Should we apply a precautionary principle? Is there place for consideration of the intrinsic value of the resource?
5. Are we living within the carrying capacity of the environment? Are the concentrations of substances, natural and man-made, systematically

increasing in the environment? To what extent is the quantity of biological systems being reduced?
6. According to Valli Moosa (Minister of Environment and Tourism 2001) “..as we approach the World Summit, it is poverty and inequality which are the greatest threats to sustainable development, and that in order to tackle them seriously we will have to review terms of trade, investment and debt relief”. Are these the greatest threats? What are the priorities for addressing sustainable development?
7. What constitutes a sustainably utilised aquatic resource? a. How many species may be lost? b. To what extent may ecological processes be acceptably altered? c. What about the quantity of habitat and the quantity of biomass? Is that given a fair consideration? d. Increasing development may be associated with increasing risk of unsustainable development. Is there a threshold risk and how may it be defined? e. How should risk of unsustainable development be apportioned in the country? What are the risks associated with managing all resources towards a threshold, thus reducing the “headspace” for unforeseen changes. f. According to the IUCN, conservation is an important aspect of sustainable development. This includes the “intrinsic” value of a river. Is this being adequately catered for?

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Report on the Hydropolitical Dimension

By Anthony Turton

African Water Issues Research Unit (AWIRU)

University of Pretoria

URL: <http://www.up.ac.za/academic/libarts/polsci/awiru>

Awiru@postino.up.ac.za

Art@icon.co.za

Introduction

The Coordinating Committee for Water Ecosystem Research (CCWER) at the Water Research Commission (WRC) is currently developing a strategic research framework for river management. This framework is an attempt to generate a multidisciplinary approach to the overall problem of managing river systems in a more holistic and sustainable manner. Given the fact that the emerging new international discourse on water management is based on the notion of Integrated Water Resources Management (IWRM), new impetus has been given to the attempt to generate a more strategic-level approach to research. In the case of South Africa, there is a heavy reliance on shared river basins, with approximately 60% of the country being in international river basins. This fact makes the hydropolitical dimension relevant to the generation of an integrated research agenda.

Statement of the Problem

The fundamental research problem that is being reviewed is to determine what the state of knowledge is at present regarding the hydropolitical dimension of IWRM in the context of South(ern) African river basins.

Approach and Methodology

The approach that was adopted was based on two current research initiatives underway at the African Water Issues Research Unit (AWIRU). These are as follows:

- The first initiative is centered on a current study of the four international river basins in South Africa. These are the Orange, Limpopo, Incomati and Maputo, all of which are strategically important. Given the fact that these basins cover approximately 60% of the surface area of South Africa makes them representative of the sort of problems that need to be addressed in future multidisciplinary research. Added to this is the fact that these rivers are shared with various riparian states including Namibia, Botswana, Zimbabwe, Mozambique, Swaziland and Lesotho, so they also represent a wide variety of the type of problems that can occur in managing international rivers as an integrated hydrological and ecological entity. In addition to this the Okavango River Basin is also currently part of an AWIRU-based study, so it has also been included. As such, it is felt that these five river basins are adequately representative of the broader problematique of river basin management.

- The second initiative is based on research for a book that AWIRU will be publishing in 2002. The central concern of this particular book, which is entitled "Hydropolitics in the Developing World: A Southern African Perspective" is to generate an integrated hydropolitical research agenda that is valid for Southern Africa as a whole. As such it is felt that this project can add considerable value to the current WRC CCWER initiative.

The methodology that was used was thus based on these two initiatives. The starting point was to take the knowledge that had emerged from the book project, as that had already managed to distil out a number of key issues. Using these as a point of departure, six key areas were isolated. These are as follows:

- Politics and rivers
- Social issues and rivers
- Conflict and rivers
- Economics and rivers
- IWRM and rivers
- Institutions and rivers

Using these generic issues as a search term, a literature review was done of the WRC Waterlit Database using the four international rivers found in South Africa - Orange, Limpopo, Incomati and Maputo - as well as the Okavango River Basin. This was supported by a parallel literature review that was conducted via the library at the University of Pretoria. The results of this literature review were then taken to indicate the state of the art in the field of hydropolitics and rivers. This enabled the generation of a strategic research framework for consideration by the CCWER at the WRC.

Results

The results from the research project can be reported as follows:

Appendix "A" is a copy of the opening chapter in the book entitled "Hydropolitics in the Developing World: A Southern African Perspective". This book has been edited by Anthony Turton and is going to be published in 2002. The opening chapter is entitled "Hydropolitics: The Concept and its Limitations" and it deals with some of the basic conceptual problems. Central to this is the fact that existing literature is biased in favour of river basins that lie in areas of high conflict. This creates the impression that river basin management is automatically linked with conflict or the potential for conflict. As such the existing literature is largely unhelpful for South Africa as these conditions are not the key drivers in the river basins under review. Appendix "A" conducts a literature review drawn mostly from the political sciences and political geography, focussing on river basins other than those found in South Africa. This reveals the existence of four main themes:

- Water and conflict
- Water and the environment with conflict as an element
- Water and crisis within either the water sector or in the broader environmental setting

- Water and socio-cultural issues

Appendix "B" is the concluding chapter of the book entitled "Hydropolitics in the Developing World: A Southern African Perspective". It is entitled "The Expanded Concept of Hydropolitics: Towards a New Research Agenda for Southern Africa" and it isolates three clusters that should (could) become the foundation of hydropolitical research in the context of river basins in Southern Africa. These three clusters are as follows:

- The Economic Cluster consists of a conglomeration of issue-areas that have primarily an economic impact. The focus of research needs is mainly at the strategic level of analysis. Within this cluster there are six key issue-areas:
 - Food security
 - Water for the economy
 - Inter-Basin Transfers (IBTs)
 - Sectoral allocation of water in closed (closing) river basins
 - Virtual Water as an element of sustainable river basin management
 - Sustainable development

Emerging from this analysis, a proposed strategic-level research agenda would embrace the issues listed in Table 1.

Table 1. Economic Cluster showing Scale and Range of Issues.							
SCALE	RANGE						
	FS	ECON	IBT	SAW	VW	SD	OTHER
International		Yes		Yes	Yes	Yes	?
Regional	Yes	Yes	Yes	Yes	Yes	Yes	?
National	Main	Main	Yes	Main	Main	Main	?
Basin	Yes	Yes	Main	Yes	Yes	Yes	?
Provincial	Yes	Yes	Yes	Yes		Yes	?
City	Yes	Yes	Yes	Yes		Yes	?
Community	Yes	Yes	Yes	Yes		Yes	?
Family	Yes	Yes				Yes	?
Individual	Yes	Yes				Yes	?

- The Legal/Institutional Cluster consists of a conglomeration of issue-areas that have primarily an institutional focus. Due to the fact that institutions are largely based on agreements and bureaucratic rules, the two key components of this cluster are law and institutions. Within this cluster there are six key issue-areas:
 - International Law
 - The SADC Protocol on Shared Water Course Systems and its Amendment
 - Institutions and institutional models
 - River Basin Organizations (RBOs) as a specific form of institution
 - Catchment Management Agencies (CMAs) as a specific form of institution
 - Water Demand Management (WDM) as an institutional response

Emerging from this analysis, a proposed strategic-level research agenda would embrace the issues listed in Table 2.

Table 2. Legal / Institutional Cluster showing Scale and Range of Issues.							
SCALE	RANGE						
	IL	SP	INST	RBO	CMA	WDM	OTHER
International	Main		Yes				?
Regional	Yes	Main	Yes	Yes			?
National	Yes	Yes	Yes	Yes	Yes	Yes	?
Basin	Yes	Yes	Yes	Main	Main	Main	?
Provincial			Yes	Yes	Yes	Yes	?
City			Yes	Yes	Yes	Yes	?
Community			Yes	Yes	Yes	Yes	?
Family						Yes	?
Individual						Yes	?

- The Social Cluster consists of a conglomeration of issue-areas that have primarily a social focus. Linked with this are ecological issues, which are another important area of research interest. Given the fact that ecological issues are a potential conflict driver, they have been included in the Social Cluster. Within this cluster there are four key issue-areas:
 - Poverty and its relationship to river management
 - HIV/AIDS and its relationship to river management
 - Gender and river management
 - Ecological issues and their relationship to river management, specifically as potential conflict drivers

Emerging from this analysis, a proposed strategic-level research agenda would embrace the issues listed in Table 3.

Table 3. Social Cluster showing Scale and Range of Issues.					
SCALE	RANGE				
	POV	HIV	GEND	ECOL	OTHER
International	Yes	Yes	Yes	Yes	?
Regional	Yes	Yes	Yes	Yes	?
National	Yes	Yes	Yes	Yes	?
Basin	Yes	Yes	Yes	Yes	?
Provincial	Yes	Yes	Yes	Yes	?
City	Yes	Yes	Yes	Yes	?
Community	Yes	Yes	Yes	Yes	?
Family	Yes	Yes	Yes	Yes	?
Individual	Yes	Yes	Yes	Yes	?

The literature review for IWRM with South(ern) Africa as a specific focus, or from which an appropriate lesson can be learned that could be applicable to South(ern) Africa is listed in Appendix "C" that was compiled by Ms. Gloria Moleta (Research Assistant at AWIRU). This bibliography contains 82 entries and reveals that there is generally a dearth of knowledge about the actual problems that are being experienced in the implementation of IWRM, particularly regarding institutional development.

The literature for Institutional Models is listed by Ms. Gloria Moleta in Appendix "D". This is a small bibliography containing a mere 7 entries, indicating the general dearth of knowledge on the institutional aspects of river management. This fact is supported by the findings listed in Tables 4 - 8.

The literature review for the Orange River Basin is listed by Ms. Gloria Moleta in Appendix "E". This literature is small, containing 15 entries as shown in Table 4. It is evident from this that institutional aspects have not been well documented. This is significant given the overall economic importance of this specific river basin, coupled with the fact that it is the first South African basin to establish a basin-wide authority (ORACOM) in keeping with the SADC Protocol on Shared Watercourse Systems. Research is needed to support this institutional development, as well as to enable the transfer of knowledge to other river basins where basin-wide authorities are not yet in existence.

Table 4: Analysis of the Orange River Basin Bibliography	
Generic Subject	Number of Entries
Orange River Basin and Conflict	4
Orange River Basin and Social Issues	1
Orange River Basin and Politics	2
Orange River Basin and Economics	2
IWRM	6
TOTAL	15

The literature review for the Limpopo River Basin is listed by Ms. Gloria Moleta in Appendix "F". This literature is more comprehensive than that of the Orange River Basin but is still small, containing 41 entries as shown in Table 5. It is evident from this that institutional aspects have not been well documented.

Table 5: Analysis of the Limpopo River Basin Bibliography	
Generic Subject	Number of Entries
Limpopo River Basin and Conflict	7
Limpopo River Basin and Social Issues	5
Limpopo River Basin and Politics	5
Limpopo River Basin and Economics	9
IWRM	16
TOTAL	42

The literature review for the Incomati River Basin is listed by Ms. Gloria Moleta in Appendix "G". This literature is similar to that of the Limpopo River Basin with some duplications, containing 45 entries as shown in Table 6. It is significant that institutional issues are listed in this bibliography, whereas they tend to be absent from other bibliographies.

Table 6: Analysis of the Incomati River Basin Bibliography	
Generic Subject	Number of Entries
Incomati River Basin and Conflict	5
Incomati River Basin and Social Issues	4

Incomati River Basin and Politics	7
Incomati River Basin and Economics	8
IWRM	9
Institutions	6
Cooperation	6
TOTAL	45

The literature review for the Maputo River Basin is listed by Ms. Gloria Moleta in Appendix "H". This includes literature that is not directly on the Maputo River Basin as a topic, but that contains lessons that are relevant to the management of that basin. This literature contains 23 entries as shown in Table 7.

Table 7: Analysis of the Maputo River Basin Bibliography	
Generic Subject	Number of Entries
Maputo River Basin and Conflict	Nil
Maputo River Basin and Social Issues	6
Maputo River Basin and Politics	8
Maputo River Basin and Economics	5
IWRM	4
Institutions	Nil
TOTAL	23

The literature review for the Okavango River Basin is listed by Ms. Gloria Moleta in Appendix "I". This literature contains 69 entries as shown in Table 8. Significantly this literature contains nothing on institutions other than the foundation documents for the establishment of OKACOM. This is relevant given the conflict potential that exists within the river basin, along with the need for institutional development to mitigate that conflict. This reveals a large gap in the research field as knowledge of institutional processes is relevant in all of the river basins in South(ern) Africa.

Table 8: Analysis of the Okavango River Basin Bibliography	
Generic Subject	Number of Entries
Okavango River Basin and Conflict	11
Okavango River Basin and Social Issues	21
Okavango River Basin and Politics	15
Okavango River Basin and Economics	21
Institutions	1
TOTAL	69

Recommendations

It is recommended from a hydropolitical perspective that the CCWER consider adopting the research framework that is presented in Appendix "B" and Tables 1 - 3 as this is the most comprehensive and well researched to date.

The additional work that is presented in Tables 4 - 8 shows the dearth of literature on institutional aspects, but given the relative lack of sophistication in the methodology used for this particular assessment, it is not recommended that any hard conclusion be drawn

from this work. The analysis in Tables 4 - 8 should be seen as supporting the analysis presented in Appendix "B" and Tables 1 - 3, which should be regarded as being the most conclusive.

Conclusion

The two strands of research that have been represented here have made a contribution to the development of a more integrated research framework that can be considered by the WRC CCWER. This framework is particularly suited to the study of river basins from a hydropolitical perspective. Research that focuses on institutional aspects is a high priority, but other issue-areas such as poverty and economic aspects are also important in the context of post-Apartheid South African water resources development.

APPENDIX "A"

HYDROPOLITICS: THE CONCEPT AND ITS LIMITATIONS

Introduction

The study of hydropolitics is a relatively new discipline. As with any new endeavor, there is a lot of fuzziness around the edges of concepts, which in most cases are poorly formulated and invariably used indiscriminately in the literature. This creates confusion and adds little to the overall development of the discipline. It is the contention of the author that hydropolitics is emerging as a specific discipline, largely as the result of the increased awareness that water-related issues are important, possibly due to a growing North-driven environmental consciousness, so for this reason, we need to start focussing on the development of conceptual clarity. As scholars and researchers work on water-related issues, they quickly realize that water is a multi-facetted resource. The cliché that life is impossible without water is in fact true and this makes water extremely valuable. What is even more pertinent is the fact that the human species has inhabited every conceivable ecological niche on the planet, probably in an unsustainable fashion, and this is the fundamental driving force of hydropolitics as more people compete for, and rely on, declining water resource-bases. Because water is scarce, and because it is essential for life, health and welfare, it is contested and therefore political. For this reason, studies on water invariably start to touch on the many different facets of life, making such studies highly suited to multidisciplinary. Yet multidisciplinary is not really being fostered in our Universities and professional environments. Herein lies the dilemma - as specialists in one given field start working on water by embracing other disciplinary methodologies and epistemologies - we start to see the emergence of a new language register that is both necessary but also confusing to the uninitiated.

Hydropolitics: A Brief Literature Review

Hydropolitics, as it is currently being written about in the majority of the literature, seems to have certain biases that this book seeks to challenge. A detailed analysis of the literature reveals that there are four main elements that seem to be present. Each of these impacts on

the literature as a form of bias, giving that specific genre of writing a distinctive pattern or context.

The first bias inherent in the current literature is that of water and conflict. A glance at the burgeoning literature in this regard is instructive (Allan, 1994; 1996a; 1998; 1999; Amery, 1997; Anderson, 1988; Ashton, 2000; Baskin, 1993; Boronkay & Abbott, 1997; Brooks, 1994; Bulloch & Darwish, 1993; Choucri, 1986; Choucri & North, 1975; 1989; Cleaver, 1994; Corell & Swain, 1995; Diehl & Gleditsch, 2001; Duna, 1998; Elhance, 1997; Falkenmark, 1986; 1989; 1994a; Frey, 1993a; 1993b; Gleick, 1990a; 1990b; 1992a; 1992b; 1992c; 1993a; 1993b; 1994a; 1994b; Gruen, 1992; Güner, 1997; Gustafsson, 1985; Haftendorn, 2000; Hirji & Grey, 1998; Homer-Dixon, 1999; Hudson, 1996; Hultin, 1995; Isaac & Zarour, 1993; Isaac & Shuval, 1994; Isaac, 1995; Kinzer, 1999; Kliot, 1994; Libiszewski, 1995; Lindholm, 1995; Lonergan, 1991; Lowi, 1990; 1992; 1993a; 1993b; Medzini, 1996; Meissner, 1999; 2001; Morris, 1997; Nachmani, 1997; Naff, 1990a; 1990b; 1994; Naff & Matson, 1984; Neff, 1994; Nijim, 1990; Öjendal, 1995; Ohlsson, 1992; 1995; Pearce, 1991; Plant, 1995; Sadat, 1985; Salman & de Chazournes, 1998; Salmi, 1997; Samaddar, 1997; Schiff 1993a; 1993b; Schulz, 1995; Shuval, 1992; 1993; Shuval & Isaac, 1993; Starr, 1991; Starr & Stoll, 1988; Swain, 1993; Swatuk, 1996; Tamimi, 1991; Trottier, 1999; Turton, 1999a; 2000a; 2000b; 2000c; 2001a; 2001b; Turton *et al.*, 2000a; Verghese, 1997; Vines, 1996; Waterbury, 1979; Weatherbee, 1997; Whittington & Haynes, 1985; Widstrand, 1980; Wolf, 1995; 1998; Wolf & Ross, 1992). This literature mostly has the state or components of the state as the unit of analysis, or focuses on conflict and cooperation within the framework of the state. There are some notable exceptions to this tendency. Swatuk & Vale (2000) challenge the notion of state centrism in a refreshing but not-yet-mainstream approach. Allan, (2000:233) criticizes prevailing International Relations theorists for failing to consider the dampening effect of the trade in water rich products - what he calls 'Virtual Water' (Allan, 1998) - that has been responsible for preventing the once confidently prophesized water wars (Bulloch & Darwish, 1993; Gruen, 1992; Starr, 1991) from occurring.

The second body of literature is growing rapidly and seeks to place water within a broader environmental setting. As such, water is seen as being a component of the environment, with a variety of conflict drivers inherent therein. In this context, the scholars concerned see environmental goods as being scarce resources, which in turn are contested. There is also a strong North/South component to this literature with elements of what may best be described as reflexivity (Giddens, 1990) to it. A glance at this literature is therefore also equally instructive (Allan, 1996b; Allan & Karshenas, 1996; Bächler, 1993; 1994; Biswas, 1978; 1983; Böge, 1992; Bottrall, 1978; Burton & Chiza, 1997; Coetzee & Cooper, 1991; Dessler, 1994; Ekins, 1993; Falkenmark, 1994a; 1994b; 1995a; 1995b; 1995c; Gleick, 1991; Homer-Dixon, 1990; 1991; 1994a; 1994b; 1996; 2000; Homer-Dixon *et al.*, 1993; Homer-Dixon & Percival, 1996; 1998; Isaac & Twite, 1994; Leiss, 1974; Libiszewski, 1992; Lonergan & Kavanagh, 1991; Myers, 1987; 1989; 1991; 1992; 1993a; 1993b; Ohlsson, 1998; 1999; Okidi, 1992; Percival & Homer-Dixon, 1995; 1998; Porter, 1990; Renner 1989; 1991; Renner *et al.*, (undated); Rubenson, 1991; Sachs, 1993; Smil, 1992; Suhrke, 1992; 1993; Suliman, 1992; Tinker & Timberlake, 1985; Turton, 2000d; Warburg, 1995; Westing, 1986; 1988; 1991). Significantly, within this literature, new drivers and actors are identified. It should also be noted that some of the authors have straddled the first and second bodies of literature. Most obvious amongst these are Allan, Falkenmark, Lonergan and Turton.

The third main focal area of hydropolitical writing aims at drawing attention to the element of crisis within the water sector (or in its' broader environmental setting), and as a result seeks to politicize, and possibly even to securitize, the management of water (Turton, 2001d). Elements of this can be understood (Turton, 2001c) when one uses the expanded concept of security as suggested by Buzan (1991; 1994) and Buzan *et al.*, (1998). A glance at this literature consequently shows a different pattern of interest (Bächler & Spillman, 1995; Clarke, 1991; Falkenmark & Lindh, 1993; Falkenmark & Lundqvist, 1995; Gleick, 1992d; 1993c; Gruen, 1992; Huss-Ashmore & Katz, 1989; Jaradat, 1993; Kolars, 1993; Lundqvist, 1998; Pearce, 1992; Postel, 1993; 1999; Redclift, 1994; Saeijs & van Berkel, 1997; Schiffler, 1997; Sexton, 1992; Turton & Warner, 2000; World Bank, 1989; Yamskov, 1989).

There is also a fourth category of literature that seeks to explore the social and cultural components of water and water-related issues, and as such tends to examine water in a more abstract and less empirically defined sense. While this literature is probably quite big, a few selected examples serve to represent the tendency (Académie de L'eau, 2000; Bennett, 1974; Buil & Bergua, 1998; Fereres & Ceña, 1997; Franks *et al.*, 1997; Ghimire & Pimbert, 1997; Goldblatt, 1996; Goldsmith & Hildyard, 1986; Guyer & Richards, 1996; Harvey, 1993; Lichtenthäler, 1996; 1999; 2000; Lichtenthäler & Turton, 1999; Lowi & Rothman, 1993; Ohlsson, 1998; Ohlsson & Turton, 1999; Redclift, 1985; Rogers *et al.*, 1998; Turton, 1999b; Turton & Ohlsson, 1999; Turton *et al.*, 2000b; 2000c; 2001; Warner & Turton, 2000; Widstrand, 1978; Yamskov, 1994).

Conceptual Clarity: Definitions and Issues of Scale and Range

So where does this leave us? Clearly water is complex and as a result one would expect hydropolitics to reflect this complexity, yet one of the problems we are finding is the lack of clear definitions of concepts. For example, one of the few definitions of hydropolitics is provided by Elhance (1997:218), who noted that it is the systematic analysis of interstate conflict and cooperation regarding international water resources. If one unpacks this definition, it becomes evident that hydropolitics is about the following:

- Conflict and cooperation.
- Involving states as the main actors.
- Taking place in shared international river basins.

Yet a glance at the above-mentioned literature will show that this state-centric focus on conflict and conflict mitigation in shared international basins is not the only focal point of hydropolitical interest. If this is so, then clearly the definition must be flawed or inadequate. Meissner (1999:4-5) has also tried to develop a definition of hydropolitics. He says that the study of hydropolitics is the systematic investigation with respect to the interaction between states, non-state actors and a host of other participants, like individuals within and outside the state, regarding the authoritative allocation and/or use of international and national water resources. If one unpacks this definition, it becomes evident that hydropolitics is about the following:

- An investigation into the interaction between state and non-state actors.

- This includes individuals and other participants both within and outside of the state.
- It is about the authoritative allocation or use of water.
- The water in question can be both international and national in its origin thereby implying sovereignty over that water.

Whereas Elhance's (1997) definition is very narrow and precise (thereby not covering all forms of political interaction over water), it seems as if Meissner's (1999) definition is somewhat wider but also fuzzier. Significantly, both imply sovereign control over water in some form. In the opinion of the author, both are helpful but neither hit the nail on the proverbial head. Clearly some of the literature falls into either of these two definitions, but there is no single definition that covers all hydropolitical analysis. It may therefore be instructive to get back to some first principle basics. David Easton (1965:21) defined politics as the authoritative allocation of values in society. If one unpacks this definition, the following becomes apparent:

- Politics is a process that is dynamic and ongoing.
- Central to this process is the allocation of values via laws and policies.
- This implies decision-making of some kind.
- Decision-making favors some over others.
- This implies an element of contestation as no universal set of values exists.
- These values are being applied in an authoritative manner.
- This implies contestation over the legitimacy of the authority concerned.
- This also means that some are favoured whereas others are not, so who gets what, when, where and how becomes relevant.

While Easton's (1965) definition is not universally accepted in the political science literature, it is certainly widely acknowledged and is consequently a good starting point. The value of Easton's (1965) definition is that it is simple, clear cut and easy to understand. It is also the contention of the author that Easton's (1965) definition embraces the essential elements of political dynamics, making it highly suited to hydropolitics. Seen in this way, hydropolitics is the authoritative allocation of values in society with respect to water. This definition builds on the time-proven fundamental principles of politics that were developed by Easton in 1965 and makes them relevant to water. One of the central purposes of this book is to develop this definition a little further.

Taking this as our point of departure, this book seeks to develop the discipline of hydropolitics in a manner that is beneficial to a wide range of role-players. This range includes scholars, researchers, water resource managers, water service providers, political decision-makers, Non Governmental Organizations (NGOs), aid agencies, development institutions, engineers, environmentalists, human rights activists etc. In fact the range is almost infinitely wide. If this is the broad goal, then there are two specific objectives that this book has:

- Firstly, it is an attempt to gain intellectual clarity on what hydropolitics is about. To this end a definition has been offered in which hydropolitics is the authoritative allocation of values in society with respect to water. This will hopefully enable us to

develop the discipline further by embracing a wider range of issues than simply conflict in shared international river basins.

- Secondly, this definition implies a number of things, two of which are of cardinal importance and in need of further research:
 - Central to any understanding of hydropolitics is the issue of scale, ranging from the individual, to the household, village, city, social, provincial, national and international level with a number of undefined levels in between. In short, the writer and consumer of hydropolitical literature should always be acutely aware of the issue of scale, best depicted as a vertical axis within any given study.
 - Another critical element in the understanding of hydropolitics is the range of issues that are covered. These can best be understood as a horizontal dimension to the discipline of hydropolitics. In reality the range is infinitely wide, including issues such as conflict and its mitigation, states and non-state actors, water service delivery, water for food, the social value of water, the political value of water, the psychological value of water, Water Demand Management (WDM), water as a target of aggression, water as an instrument of peace; water and gender, water and ecosystems and water as a critical element of sustainable development.

Layout of the Book

What this book seeks to achieve, is a widening of the concept of hydropolitics by developing the issues of scale and range in a systematic manner. As such, the book is divided into five sections. The first introduces the issues of scale and range, along with a simple new definition of hydropolitics.

The second section deals with theoretical dimensions of hydropolitics and discusses the notions of scale and range in more detail. This is not exhaustive and is also not purely theoretical, but the chapters that have been selected are predominantly of a theoretical nature even if they do deal with case studies as well. The chapter by Tony Allan exposes the reader to one of the central issues of scale, namely the shift in mindset from the river basin level where water scarcities occur, to the global trade in cereals where the politically silent remedies for water deficits can be found. This opens up a range of strategically relevant issues such as the political acceptability of an increased dependence on food imports. This is important in Southern Africa where the recently independent states tend to guard their newfound sovereignty with considerable zeal, but where this is being challenged by water deficit which in turn means a shift in policy from national self-sufficiency in food production to food security. The chapter by the author and Richard Meissner introduces the concept of a hydro-social contract that forms the basis of all institutional development in the water sector. Significantly, the hydro-social contract changes over time, implying that institutions need to change as well. The hydro-social contract also introduces issues of sustainability and the second order social resources needed to achieve this, the holy grail of policy-makers in developing countries. The chapter by Philippus Wester and Jeroen Warner is a provocative challenge to the emerging dominant discourse that says river basins should be managed as integral units via one River

Basin Organization (RBO). Anders Jägerskog's chapter looks at regime theory as an underlying component of cooperation in shared international river basins.

The third section focuses exclusively on the role of law in the water sector and builds a little more on the notions of scale and range. Gabriel Eckstein unpacks the development of the Convention on the Law of the Non-Navigational Uses of International Watercourses, as this is relevant to most modern water-sharing agreements between states. As such it deals mainly with the international scale. Sackey Akweenda builds on this by delving into some of the historical precedents of international law, focusing specifically on what has come to be known as the Helsinki Rules. Phera Ramoeli gives an insight into the history and status of the SADC Protocol on Shared Watercourse Systems. This uses the Helsinki Rules and is the basis for regional cooperation in Southern Africa. As such it takes the issue of scale down to the regional level. Robin Stein then goes to the national scale and illustrates how some key water sector reforms have occurred in Namibia, South Africa and Zambia. Stein's chapter also deals with range in the sense that water law is a remedy for the historical inequity that is endemic to Southern Africa.

The fourth section is designed to take the reader through some of the scale and range issues in more detail. The chapter by Barbara Schreiner, Barbara van Koppen and Tshepo Khumbane opens up a number of key issues that are relevant to Southern Africa. Central to this at the range level is the gender and poverty issue, but this is also situated in terms of scale as an interaction between the grass-roots level and the national level of decision-making. This specific chapter also touches on other key range-related issues such as resource capture, land reform, household-level economic security, the Dublin Principles that see water as being an economic good, law as a remedy and institutional development. David Molden and Doug Merrey discuss the issue of scale in more detail, spanning the individual farmer's field to the entire river basin. Within this discussion, issues of range also become evident such as institutional development as a function of scale. Implicit within this is also the issue of linkage to Virtual Water trade as a strategic remedy for local water scarcity as discussed by Tony Allan in Section Two. Piet Heyns deals with the strategically important but environmentally controversial issue of inter-basin transfers (IBTs) of water. This has a scale dimension in the sense that it impacts at different levels of society, but it also represents an element of range because it opens up other issues such as ecological integrity versus development, rights versus needs and national sovereignty and state vulnerability caused by water deficit. Roland Henwood and Nicci Funke deal with the management of water in shared international river basins from a political science perspective by exploring the linkage between foreign policy and international relations. Most shared international water is managed by engineers through technical commissions, but they are actually engaged in international relations at the same time, probably without being fully aware of it. This issue is relevant to both range and scale and has hardly been explored in the literature. As such it is highly relevant to Southern Africa given the large number of shared river basins found there. Peter Ashton and Ben Haasbroek focus on water demand management (WDM) as a central issue. This is then expanded on by Klaudia Schachtschneider who looks at WDM in the tourist industry of Namibia, thereby focussing on an aspect of hydropolitics that has received little attention in the mainstream literature, but that will become increasingly important to Southern Africa in future. Peter Ashton and Vasna Ramasar do the first known exploration of water and HIV/AIDS from a strategic perspective. As such this is offered as a new example of the range of hydropolitics writing because HIV/AIDS is such an important issue in Southern Africa, that the water-

related ramifications deserve better research coverage in future. The HIV/AIDS issue also has an important element of scale to it that needs to be explored further.

The fifth section offers a conclusion to the book, and suggests a research framework that is applicable to Southern Africa (and possibly other developing regions of the world) using the definition of hydropolitics offered in the introduction, and taking into consideration the elements of scale and range.

Conclusion

This book is not trying to be the final word on hydropolitics. Quite the opposite is true. Hydropolitics as it is currently being written about in the mainstream literature tends to focus on conflict at the international level in shared river basins. As such it is not entirely relevant to Southern Africa, because we do not have that high level of conflict at present. This leaves a gap in the hydropolitics literature, which this book seeks to address by focussing on elements of scale and range. It is hoped that by using this approach, we can spawn a new generation of literature that is applicable to developing countries that are facing water scarcity as limitations to their economic growth potential and are thus looking for sustainable and equitable solutions. This book is also an attempt to encourage and develop new authors. For this reason, each chapter represents a distinctive writing style that has not been artificially harmonized by the editor, simply because each style is unique to the cultural and professional background that each author is coming from. Some of the authors are well established already with an impressive publishing record, whereas others have never been published before. This is their chance to test ideas in the hydropolitical laboratory that Southern Africa offers. It is also the hope that this book will contribute meaningfully to the SADC Water Sector knowledge-base as they will play an increasingly important role in the functional integration of the region in future. Finally, this book is offered as a contribution to the debate on sustainable development that will take on a new life with the forthcoming World Summit on Sustainable Development in South Africa during 2002, and the 3rd World Water Forum in Japan during 2003.

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APPENDIX "B"

THE EXPANDED CONCEPT OF HYDROPOLITICS: TOWARDS A NEW RESEARCH AGENDA FOR SOUTHERN AFRICA

Introduction

In the introduction to this book, it was said that the study of hydropolitics as it is currently being practiced - with its main emphasis on conflict between states in a shared river basin - is in fact too narrow to accurately reflect Southern African situations. For this reason a case was made for the widening of that concept. In order to assist in this widening process, a definition was offered in which hydropolitics is the study of the authoritative allocation of values in society with respect to water. The introduction also suggested that two new elements were essential in this widening process. The first was the element of scale, ranging from the individual to the international level. The second was the element of range, with a wide spectrum of potential issue-areas having been identified. The rest of the book has dealt with some of these issues in more detail. All that now needs to be accomplished is to generate a research framework that can be used to develop these ideas a little further in an attempt to create a knowledge base that can serve the needs of the decision-making elites and other water sector role-players in Southern Africa.

Towards a New Research Agenda

The various chapters in this book have gone into some detail on a variety of issues in a way that has expanded the concept of hydropolitics both in terms of scale and range. It must be said emphatically however, that the examples used are by no means the final word on the matter. Instead, they should be seen as being representative samples of a wide variety of issue-areas that are becoming relevant to SADC, national governments within the Southern African region, and other role-players such as communities, river basin authorities, interest groups etc. In other words, the reader may feel free to develop other examples of both scale and range. What has been offered is the starting point to a long journey, rather than the final destination.

In order to keep this study systematic and scientifically valid, it is necessary to dwell for a few moments on the development of a viable research agenda. By taking the issues that have been raised in this book and analyzing them in a more systematic fashion, particularly by means of the scale and range dimensions, three main clusters can be isolated. While there may well be more, these three clusters can serve as a starting point as they represent the more important hydropolitical research areas in Southern Africa at present. It is also important to note that the intention with this analysis is to show the scale and range within each cluster, as there are distinct variations. This is obviously not a clear-cut issue and different scholars may have different opinions about the allocation. This is to be welcomed. What is significant however is that the research methodology and epistemology will differ from issue to issue and also with respect to scale.

Economic Cluster

The Economic Cluster consists of a conglomeration of issue-areas that primarily have an economic impact. The focus of research needs within this cluster is mainly at the strategic level of analysis, but given the element of scale, the impacts of these issue-areas range from the individual right through to the international level. There are six key issue-areas that can be represented in terms of the range dimension. These are as follows:

- Food security (abbreviated as FS in Table 1) is a strategic issue of great importance to Southern Africa. In fact, one could easily argue that some countries in Southern Africa such as the Republic of South Africa, Botswana, Namibia and Zimbabwe, are only water scarce if they each choose a strategy of national self-sufficiency in food as this would mean a massive mobilization of water for agriculture. If food security is practiced instead, water stress can be managed and political stability and economic growth can be ensured. This is one of the key issues that will be debated in the 3rd World Water Forum in Japan in 2003, and will probably also become an issue that is discussed in the forthcoming World Summit on Sustainable Development (WSSD) to be held in 2002 in South Africa. There is already attention being given to this in the World Water Vision (Cosgrove & Rijsberman, 2000; van Hofwegen & Svendsen, 2000) so this forms a natural starting point for research. Table 1 shows that the main emphasis of research is on the national scale, but the issue impacts all the way from the regional to the individual level.

- Water for the economy (abbreviated as ECON in Table 1) is also a strategic issue. Central to this is the use of water for the generation of economic activity within a given political economy. This links closely into various issue-areas such as food security, Inter-Basin Transfers (IBTs) of water, poverty, sustainable development and others. Table 1 shows that the main emphasis of research is at the national scale, but the issue impacts all the way from the international competitiveness of any given state to the individual level.
- Inter-Basin Transfers (abbreviated as IBT in Table 1) are also a strategic level issue. Given the maldistribution of precipitation when expressed in terms of human population and development needs, IBTs are a reality in Southern Africa. They are also linked with large dams, which are currently a contentious issue (WCD, 2000). IBTs can be seen in abstract terms as the linkage between spatial and temporal variations in precipitation and the spatial variation in population distribution and economic activities (Turton, 2000). As such IBTs are set to become strategically more important in Southern Africa in future, probably extending across international borders and therefore linking river basins, states and political economies. IBTs impact on a variety of other issues-areas such as the environment, sovereignty, international law and sustainable development. Table 1 shows that the main emphasis of research is on the basin scale, but the issue impacts all the way from the regional to the community level.
- Sectoral allocation of water (abbreviated as SAW in Table 1) becomes increasingly important as river basins reach closure. In this regard closure occurs when all of the available water has been allocated to some productive activity or other and there is no more water left to be allocated (Svendsen *et al.*, 2000). When this occurs, robust institutions must be in place to manage the conflict potential that can occur. This in turn places pressure on the 2nd Order Resources that are available (Ohlsson, 1999; Ohlsson & Turton, 1999; Turton, 1999; Turton & Ohlsson, 1999). Sectoral allocation also impacts on IBTs, food security, economic activity and other issue-areas such as the environment and sustainable development. Table 1 shows that the main emphasis of research is on the national scale, but the issue impacts all the way from the national competitiveness of a given state to the community level.
- Virtual Water (Allan, 2000)(abbreviated as VW in Table 1) is a strategic issue that is becoming increasingly important for Southern Africa. Water scarcities exist at the level of the river basin, whereas the remedy can be found in the international trade of water-rich cereals. As such this touches on other issue-areas like food security, economic growth, sectoral allocation, IBTs and sustainable development. There is a strong economic research element to this issue, so we need to mobilize economists in order to attack the problem and develop the necessary knowledge. Table 1 shows that the main emphasis of research is on the national scale, but the issue impacts the international to the basin level of analysis
- Sustainable development (abbreviated as SD in Table 1) is a hotly debated issue that lies at the very heart of the North/South divide. Water is central to this debate, which is linked to a host of other issue-areas such as poverty, food security and ecological issues. This will be the focal point of the forthcoming WSSD as well as being a component of the 3rd World Water Forum. Table 1 shows that the main emphasis of

research is on the national scale, but the issue impacts all the way from the international to the individual level.

- There are other issue-areas in this category that have not been raised in this book.

If we take this range of issues and plot them on a matrix, we can see the scale at which they are mostly relevant. This is done in Table 1.

Table 1. Economic Cluster showing Scale and Range of Issues.							
SCALE	RANGE						
	FS	ECON	IBT	SAW	VW	SD	OTHER
International		Yes		Yes	Yes	Yes	?
Regional	Yes	Yes	Yes	Yes	Yes	Yes	?
National	Main	Main	Yes	Main	Main	Main	?
Basin	Yes	Yes	Main	Yes	Yes	Yes	?
Provincial	Yes	Yes	Yes	Yes		Yes	?
City	Yes	Yes	Yes	Yes		Yes	?
Community	Yes	Yes	Yes	Yes		Yes	?
Family	Yes	Yes				Yes	?
Individual	Yes	Yes				Yes	?

Legal / Institutional Cluster

The Legal / Institutional Cluster consists of a conglomeration of issue-areas that primarily have an institutional focus. As institutions are based on rules and agreements, there is also a legal dimension to them. For this reason the two components of the cluster are law and institutions. Central to this is the role of 2nd Order Resources (Ohlsson, 1999; Ohlsson & Turton, 1999; Turton, 1999; Turton & Ohlsson, 1999) or what Homer-Dixon (1995; 2000) refers to as social and technical ingenuity. Linked to this is the capacity for political agreement versus the capacity for political discord (Heinzen, 2002). There are six key issue-areas that can be represented in terms of the range dimension. These are as follows:

- International law (abbreviated as IL in Table 2) is important because it determines the technical dimension and normative basis on which agreements are reached between states. Table 2 shows that the main emphasis is at the international scale, but it does impact down to the basin level if that river basin is shared between two or more riparian states. There is no real impact below that scale.
- The SADC Protocol (abbreviated as SP in Table 2) is also important because it is the basis of regional cooperation in the Southern African water sector. If coal and atomic cooperation was the basis of European integration, then water can also become the basis for Southern African regional integration. As such the SADC Protocol can be seen as being the foundation to functional integration and not simply a water-sharing agreement. Table 2 shows that the main emphasis is at the regional scale but the impacts are felt down to the national and river basin level if that basin is shared between two or more riparian states. There is no real impact below that scale.

- Institutions (abbreviated as INST in Table 2) are a crosscutting issue, impacting on a wide scale, particularly if technical cooperation in the water sector leads to other functional integration within SADC. Table 2 shows that there is no real main scale of impact, but clearly the type of institutions that are suited to manage water at the international level are fundamentally different from the type of institutions that are suited to manage community-level resources. In this regard the work by Ostrom (1990) is very illuminating. It is in this category that research into Integrated Water Resource Management (IWRM) will best fit in.
- River Basin Organizations (abbreviated as RBO in Table 2) are a fundamental component of the World Water Vision (Cosgrove & Rijsberman, 2000). One of the key elements that is becoming increasingly important is that of financing RBOs (Nicol *et al.*, 2001), with this issue likely to be a central one in the forthcoming WSSD and 3rd World Water Forum. Table 2 shows that the main focus is at the basin scale, but the impact ranges from the regional to the community level.
- Catchment Management Agencies (abbreviated as CMA in Table 2) are a component of RBOs and are a new set of institutions designed to reinforce democracy that have been created by South African water law. They represent the central issue of subsidiarity that is part of the World Water Vision (Cosgrove & Rijsberman, 2000; Nicol *et al.*, 2001), which means that they are relevant to the whole of SADC and not just South Africa. As this is embodied in the Dublin Principles (ICWE, 1992), which in turn are a component of Agenda 21, this issue is likely to emerge again at the WSSD and 3rd World Water Forum. Table 2 shows that the main focus is at the sub-basin scale but the impact ranges from the national to the community scale.
- Water Demand Management (abbreviated as WDM in Table 2) is an important issue that is related to sustainability. It becomes increasingly important as basin closure is being reached, which is the case in many Southern African river basins, particularly in the more developed countries of the region. The knowledge base of WDM is relatively weak in a Southern African context, so we need a lot of research on this issue. It is also linked with other issues such as Virtual Water, IBTs and Institutions. Table 2 shows that the main focus is at the basin level, but it impacts at various scales ranging from the national down to the individual level. National-level research priorities would focus on different issues to community-level research priorities, so methodologies and epistemologies would also be widely variable.
- There are other issue-areas in this category that have not been raised in this book.

If we take this range of issues and plot them on a matrix, we can see the scale at which they are mostly relevant. This is done in Table 2.

Table 2. Legal / Institutional Cluster showing Scale and Range of Issues.							
SCALE	RANGE						
	IL	SP	INST	RBO	CMA	WDM	OTHER
International	Main		Yes				?
Regional	Yes	Main	Yes	Yes			?
National	Yes	Yes	Yes	Yes	Yes	Yes	?

Basin	Yes	Yes	Yes	Main	Main	Main	?
Provincial			Yes	Yes	Yes	Yes	?
City			Yes	Yes	Yes	Yes	?
Community			Yes	Yes	Yes	Yes	?
Family						Yes	?
Individual						Yes	?

Social Cluster

The Social Cluster consists of a conglomeration of issue-areas that primarily have a societal focus. Linked with this are Ecological Issues, which are another important cluster, but given the fact that this book is about hydropolitics (or the authoritative allocation of values in society with respect to water) the ecological issues are included along with Social Issues. The reason is that one of the main manifestations of ecological issues within a study of hydropolitics is the interaction between water for people versus water for ecosystems. For this reason the two components of the cluster are social and ecological. There are four key issue-areas that can be represented in terms of the range dimension. These are as follows:

- Poverty (abbreviated as POV in Table 3) is a complex issue that clearly has significant ramifications for Southern Africa. It ranges from the individual to the international scale in the sense that poverty impacts on the international competitiveness of a state, while also providing pull and push factors for migration, some of which is across international borders. For this reason it is difficult to define a main focus for research. It is also obvious that research methodologies would differ according to the scale that has been selected by the researcher. Poverty also has strong linkages with other issues such as HIV/AIDS and Sustainable Development, which in turn has ecological implications. Table 3 shows the spread of focus with no discernable main level.
- HIV/AIDS (abbreviated as HIV in Table 3) is also a complex issue in which we have a limited knowledge base in the water sector. As with Poverty, it is also difficult to determine one main focal area, which is evident from Table 3. One could argue that it is primarily at the level of the individual that behavior is going to change, so this should be the main focus, but then again this is only possible if a national strategy is in place to deal with the pandemic. This is an extremely important research area with virtually nothing having been done with respect to hydropolitics in the past.
- Gender (abbreviated as GEND in Table 3) is closely linked to the water sector via the Dublin Principles (Turton *et al.*, 2000). As such it forms a vertical linkage from the international scale that is impacting right the way down to the level of the individual. It has a central role in institutional development and river basin management, and will also be relevant at the level of the CMA. In keeping with the other elements of range in the Social Cluster, it is difficult to determine a primary focal point, as shown in Table 3.

- Ecological issues (abbreviated as ECOL in Table 3) have become socially relevant, particularly in the context of developing countries, as the result of the Sustainable Development debate. As this is central to the WSSD process, it will become increasingly important at the WSSD and 3rd World Water Forum. The issue of water for people (social and economic) versus water for the environment is going to be a central debating point. At the hydropolitical level it embraces hot issues such as the North/South divide, but it also manifests at the sub-national level as the focal point of resource capture and the ecological marginalization of communities (Homer-Dixon, 1991; 1994a; 1994b; Homer-Dixon & Percival 1996; Percival & Homer-Dixon, 1995; 1998; Ohlsson, 1999; Turton, 2000). Due to the wide range of focal areas and impacts, it is difficult to determine one main focal area as shown in Table 3. This is a rich area for aspirant researchers as it covers so many crosscutting issues.
- There are other issue-areas in this category that have not been raised in this book.

If we take this range of issues and plot them on a matrix, we can see the scale at which they are mostly relevant. This is done in Table 3.

Table 3. Social Cluster showing Scale and Range of Issues.					
SCALE	RANGE				
	POV	HIV	GEND	ECOL	OTHER
International	Yes	Yes	Yes	Yes	?
Regional	Yes	Yes	Yes	Yes	?
National	Yes	Yes	Yes	Yes	?
Basin	Yes	Yes	Yes	Yes	?
Provincial	Yes	Yes	Yes	Yes	?
City	Yes	Yes	Yes	Yes	?
Community	Yes	Yes	Yes	Yes	?
Family	Yes	Yes	Yes	Yes	?
Individual	Yes	Yes	Yes	Yes	?

Quo Vadis?

Having isolated these three main clusters, we are now able to plot a course for hydropolitical research in the context of Southern Africa. In this regard a few points need to be highlighted:

- This is not an exhaustive list, so it is possible to find issues that are not mentioned but which are also felt by some scholars to be very important. For this reason an "other" category has been left in all three clusters. The issues that have been selected are known by the author to be important within Southern Africa at this moment in time.
- It is also clear that the researcher can select an issue as well as a level of scale on which to focus. It is to this end that the main thrust of this book is aimed. It therefore implies that research methodologies and epistemologies will vary from issue to issue in terms of range, and from level to level in terms of scale. There is no universal methodology to apply and multidisciplinary is often the best approach.

- Special attention is drawn to the apparent absence of the specific mention of Integrated Water Resource Management (IWRM) as an issue on its own. This is because while IWRM is a current buzzword in the water management discourse, the notion implies integration and therefore cross-linkage within an institutional setting. For this reason IWRM touches on so many of the specific issue-areas both in terms of range and scale that it is difficult to locate it at any one specific portion of the matrix, so it is best suited to an institutional form of analysis. This does not mean that IWRM is unimportant.
- The issue of conflict is important within the field of hydropolitics, but a closer examination of the three clusters will show that it is not the main focus in Southern Africa. For this reason it is felt that the widened concept of hydropolitics that has been defined as the authoritative allocation of values in society regarding water is a useful one. It is hoped that this will be taken up by other scholars and researchers, and developed further though rigorous testing in different research venues and on a variety of issues and scales.

As a result of this, it is the stated intention of the author to mobilize resources in order to develop a second volume to this series of books. The current book can be seen as being the first volume that has served to critique the existing focal point of mainstream hydropolitical writing (conflict in international river basins). It has also served to develop an alternative definition and make the case for widening the concept of hydropolitics. Central to this widening process are the two key elements of range and scale. Examples have been offered by various authors in this book illustrating these two aspects of hydropolitics. Consequently the second volume will be dedicated to a set of case studies that serve to develop these central themes further in a more systematic way.

Conclusion

The first region in the world to run into water deficit is the Middle East North Africa (MENA) region (Allan, 2000). This is having a significant impact on the political stability of the region, as well as becoming a limitation to the economic growth potential of each state. The second region in the world where this seems to be happening is Southern Africa, but this is at least a quarter of a century behind that of the MENA region. This means that we can learn the valuable lessons that will be needed to make the Southern African case a peaceful transition with a smooth landing. Unfortunately it takes about twenty-five years to change behavior, as the MENA case has shown (Allan, 2000). Researchers have a major role to play in making this happen and possibly in accelerating the process. This book has been written in an attempt to show that hydropolitics is a growing discipline in its own right. As such the current definition is too narrow, so a widening of the concept has been proposed. Linked to that widening process are the two essential elements of scale and range. Using this approach, a research agenda has been developed that is based on certain priorities that are relevant to contemporary Southern Africa. It is sincerely hoped that this will add some value to the efforts of the SADC Water Sector. As such the book is offered as an example of the African Renaissance that seeks to solve African problems by means of African solutions.

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Appendix "C"

BIBLIOGRAPHY OF INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

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Appendix "H"

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Appendix "I"

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