

WATER DEMAND MANAGEMENT PROGRAMME FOR SOUTHERN AFRICA: PHASE II

ANALYTICAL PAPER (Final Draft)

WDM AS A CONCEPT AND A POLICY: TOWARDS THE DEVELOPMENT OF A SET OF GUIDELINES FOR SOUTHERN AFRICA

By

Anthony Turton

(African Water Issues Research Unit - University of Pretoria)

1. Introduction

The IUCN study entitled "*Water Demand Management: Towards Developing Effective Strategies for Southern Africa*" (Goldblatt *et al.*, 1999) drew a number of conclusions, two of which are of direct relevance to this Analytical Paper. The first conclusion was that, "one of the critical outcomes ... has been the realization that so far, WDM is not an intrinsic part of water resource planning and management at the national and regional levels in Southern Africa" (Goldblatt *et al.*, 1999:11). The second conclusion was that "WDM ... needs to be seen within a regional context"(Goldblatt *et al.*, 1999:19). It is the intention of this paper to expand on these aspects by means of developing a model that can explain why this is so, and hopefully enable us to gain deeper insight into the underlying *problematique* of WDM as a concept and a policy within the context of a developing region like Southern Africa. More importantly, this paper seeks to lay the foundation for a common language register and an unambiguous set of concepts that can be of value to water resource planners, managers and researchers who are drawn from a variety of scientific disciplines, and who are confronted by a wide range of complex problems that need to be resolved.

2. Methodological and Epistemological Concerns

Water Demand Management (WDM) is the quintessential example of a complex multidisciplinary concern within the water sector. The reasons for this are that a number of disciplines are needed to effectively understand the process of WDM. These disciplines each have a different methodological foundation that is underpinned by a unique set of philosophies and supported by a specific rationale and logic. The problem that is soon encountered is that different concepts and words mean different things to different people, and as a result the whole effort quickly degenerates into a debate about interpretations. This is largely sterile as little progress can be made under such circumstances.

Luckily for us we have a way out of the dilemma by means of epistemology, which broadly refers to the science of determining truth. In other words what we are being

confronted with is the central notion of what is truth, and how can we ascribe the degree of truth (or untruth) to any given statement or conclusion. For those schooled in the Natural Sciences, the epistemological basis is generally derived from physics and chemistry, which by their nature seek to break complexity into the smallest possible units and thereby unlock the relationships of cause and effect by means of experimentation and observation. The epistemological basis of this approach is generally mathematically-based and therefore intimately linked with laws and paradigms, and as such tends to be extremely precise. For those schooled in the Social Sciences however, the epistemological basis is usually derived from other sources, with an obvious choice being truth by definition. As a result this is not based on any ironclad laws, usually defies mathematical predictability and is often pre-paradigmatic. The problem that arises is how can people, who are schooled in these fundamentally different approaches, work together in a multidisciplinary environment, on a problem that requires integration rather than reductionist thinking, and speak a common language that is intelligible to all?

An often-used adage that describes this is "if it cannot be measured it does not exist". This raises a number of questions, all of which are of great concern to this Analytical Paper on Water Demand Management:

- What is to be measured?
- How is this to be accomplished?
- What is the best instrument with which to take the measurements?
- How is this data to be recorded and interpreted?

Let us take a simple example in order to illustrate the point being made. A thermometer is a commonly-used instrument that records data about temperature. When used on a human being that appears to be unwell, the thermometer tells us that the temperature of the patient deviates from the norm, which has been established by years of experimentation and is known to be a specific value. Yet what does this data actually tell us? Apart from the fact that the temperature of the patient is above or below a known value, which we consider to be normal, it actually tells us very little. In order for the doctor to make an effective diagnosis, a range of other data is also needed.

This is certainly true with WDM. Here we are confronted with a range of complexity. What exactly do we mean by WDM? How do we know when we are succeeding or failing? How can we compare one country's performance with another? How can we measure the actual economic cost of water? What about the social cost? The environmental cost? Is water purely an economic good? What role does culture play in any given WDM policy? How can legitimacy for any given WDM strategy be derived? How can we measure this intangible dimension? The list of questions is endless, and we can rapidly degenerate into a meaningless discussion that converts energy to heat rather than light (Ashton, 2001).

It is therefore necessary to state quite unambiguously that this Analytical Paper is an attempt to delve into the epistemological quagmire that is known to exist around the topic of WDM. In fact, it is the central assumption of this paper that it is precisely this reason

why no acceptable model of WDM has ever been developed, and why little consensus exists on key concepts and definitions. *This accounts for the fact that while there have been a plethora of WDM case studies, there is very little in the form of interpretation, particularly of why certain approaches have succeeded while others have clearly failed.*

It must therefore be understood that any study of WDM is not a study of absolutes, but rather a study of ideas, many of which exist as a scale of grey rather than as clear-cut black and white. For example, there is no such thing as only Supply-Sided Management or Demand-Sided Management of water resources, but rather a continuum that ranges between those two extremes. This Analytical Paper is consequently about concepts, and in particular about throwing these concepts out for critical discussion and constructive debate. More importantly, this paper is about linking concepts together in an attempt to build a simple model, once a degree of consensus has been reached on the critical definitions of those concepts. Remember that the thermometer is unable to tell us that the patient has cancer, but the thermometer still remains a valuable instrument for the doctor.

3. Review of Literature

3.1 The Changing Water Management Paradigm

There is a strong normative basis that guides the development of management principles relating to water that has its origin outside of any given country. This can loosely be called the "global water sector", which derives these principles from a series of norms and values, some of which are encoded into international water law, with others being found as statements from world summits to which many governments have added their specific endorsements. Three issues of importance to an Analytical Paper on WDM emerge from this, all of which will be dealt with in greater detail as the paper develops. These are as follows:

- The philosophy of science provides the epistemological basis on which we understand the world, and in particular how we determine what is good and acceptable from what is bad and unacceptable. In essence this philosophy of science has established enduring paradigms that are difficult to challenge and change.
- There is a natural propensity towards complexity as a result of human development.
- Human ingenuity is a crucial resource in its own right.

All of this has been manifest in the water sector as a propensity over the Twentieth Century to build large dams. It can be said with some confidence that the last century was the era of dam-building, to the extent that today around 3,800 km³ of freshwater is withdrawn annually from the worlds lakes, rivers and aquifers, which is twice the volume abstracted just 50-years ago (WCD, 2000:3). In fact, the World Commission on Dams has shown that globally, the largest number of dams were constructed in the decade of the '70s, as shown in Figure 1. This was the golden age of Supply-Sided Management, or what some call the "hydraulic mission" period of water resource development (Allan, 2000:28-29; Reisner, 1993:112-114; Swyngedouw, 1999a; 1999b). This is a classic example of what Homer-Dixon (1994:16; 2000:22) calls "technical ingenuity".

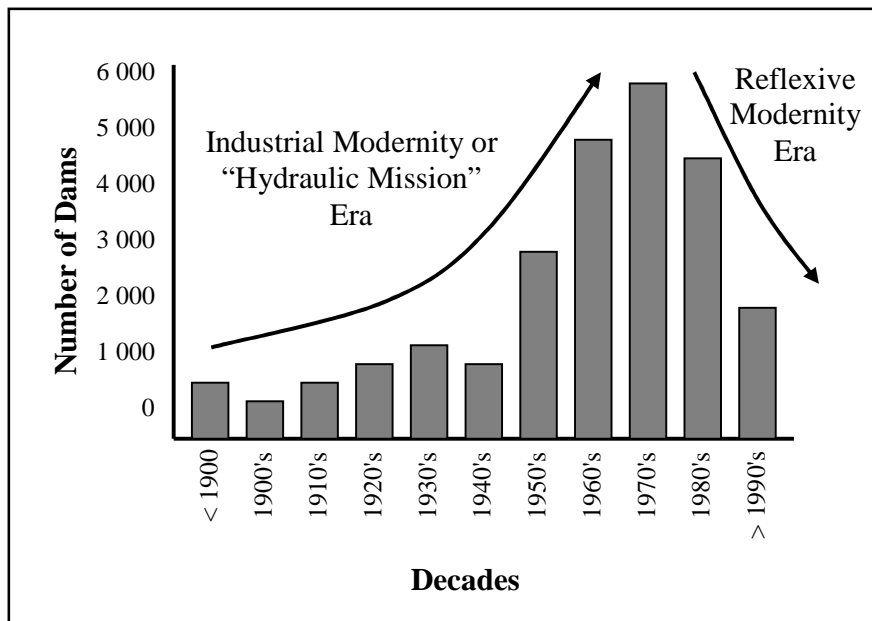


Figure 1. Global Construction of Dams by Decade (1900-2000) (WCD, 2000:9). The Industrial Modernity and Reflexive Modernity Era are clearly evident.

Two questions need to be posed at this stage of the Analytical Paper:

- Why did dam construction take off in the 1950's? The answer to this is the development of technology, with Hoover Dam being the first of the so-called "big ones" that effectively solved the technological problems relating to large dam construction.
- Why was there a sharp attenuation in dam construction after the 1970's? The answer to this is more complex, but is generally related to what has now become known as "reflexivity" (Giddens, 1990). Reflexivity has its roots in a number of historic events, the most notable of which was the space exploration that occurred in the 1960's, which sent back startling images of planet Earth, veiled by this relatively thin mantle of life-supporting atmosphere, floating as it were in the infinite vastness of lifeless space. For the first time the interconnectedness of all ecosystems were seen in dramatic images that could be understood by the average person. The powerful and enduring notion of "Spaceship Earth" started to emerge in the public discourse. This stimulated a strong intellectual response, one of which was encapsulated in the Club of Rome's now famous document entitled "The Limits to Growth", another being the equally famous "Blueprint for Survival" that was published by The Ecologist, both in the early 1970's (Turton, 2000a:135; Eckersley, 1997:11-12). For the first time development was seen as having limitations to it and humans became aware of environmental degradation as a potential threat to the very existence of life on Earth as we currently know it.

This in turn raises yet another fundamental question. If reflexivity is so important to the water sector, how exactly does it relate to WDM?

Reflexivity is said to exist when a given social grouping becomes concerned with the undesirable and unintended consequences of their actions (Giddens, 1990), such as environmental degradation caused by industrialization, and actively seek to limit those consequences by developing coherent strategies and policies to effect this desire (Turton, 2000b). Stated briefly, Giddens (1984; 1990) has noted that there are various periods of human development. The early period was called pre-modernity, which was followed by an era of industrial modernity after the industrial revolution occurred. Once technology had advanced to such an extent that humans became aware of the unintended consequences of their actions, then the period of reflexive modernity was born. Other authors such as Goldblatt (1996) and Beck (1992; 1995; 1996a; 1996b; 1999) refer to this as the emergence of "risk society" in which the technological development of human beings solved problems on the one hand, but created a new set of risks on the other.

In the USA the hydraulic mission became the casualty of the reflexive responses by the environmental movement (Allan, 2000:28). To this end Gleick (1998:15) offers a useful insight into this aspect by showing that the environmental movement in the United States was further stimulated in the 1960's by the apparent unwillingness of the federal dam builders to recognize any environmental values of wild rivers and their various proposals to build several particularly large and damaging reservoirs. In fact Gleick (1998:15) suggests that many conservationists believe that the successful battle to stop dams, and the Grand Canyon dams in particular, led to the modern conservation movement in the United States.

So one can say that in general terms, there is a global trend away from purely Supply-Sided Management approaches to water resource management, towards a more Demand-Sided Approach. This does not mean that these two approaches exist in isolation of one another, but it does mean that two distinct water management styles can be detected in the water sector. For illustrative purposes, these two approaches can be presented as opposite poles on a horizontal axis, as has been done in Figure 2.

So if we can say that there is a general shift in emphasis away from a paradigm that is based purely on a Supply-Sided Approach - the strong desire to mobilize more water as manifest in the hydraulic mission of most developing societies - we can also say that this is only part of the story. The whole environmental debate is far broader than just the issue of large dams. In fact, this environmental debate has a long history (Turton, 2000g), significantly starting roughly with the 1960's era and the birth of reflexivity as noted above. It is to this that we now briefly turn our attention.

The new normative order within the global water sector can be traced back almost 30 years to the groundbreaking conference that was held in Stockholm (Turton & Meissner, 2000). Entitled the "Stockholm Conference on the Environment", it focussed attention for the first time on water pollution. The next significant event took place at Mar del Plata, Argentina in 1977. Entitled the "Conference on Water Development and Management",

this event saw the start of a process that would seek to define new principles for water resource management (United Nations, 1978). This Conference was the origin of the notion of “basic needs” (Lundqvist & Gleick, 1997:21). While the initial response to Mar del Plata was mild – the 1987 Brundtland Report chose to ignore freshwater – a whole host of international dynamics were starting to become relevant at that time. The initial agenda for the 1992 United Nations Conference on Environment and Development (UNCED) also excluded water as a specific item, but due to the unleashing of a number of efforts by various governmental and non-governmental organizations, the birth of what has now become known as Agenda 21 occurred (UNCED, 1992; Lundqvist & Gleick, 1997: 28). For example, a glance at the history books shows that the early 1990’s were particularly rich with respect to water-related events at the international level. In 1991 the Nordic Freshwater Initiative resulted in the Copenhagen Informal Consultations with a wide range of interested parties (Lundqvist & Gleick, 1997: 30). This resulted in the Copenhagen Statement, which emphasized two key principles for future sustainable development strategies:

- Water and land resources should be managed at the *lowest appropriate levels*. This has now come to be known as the principle of subsidiarity that is widely found in the water sector discourse.
- Water should be considered as an *economic good* with a value reflecting its most valuable potential use.

The 1992 International Conference on Water and Environment in Dublin expanded on this. The Dublin Conference resulted in the so-called Dublin Statement (ICWE, 1992), endorsing four key principles (Lundqvist & Gleick, 1997:30) that have now come to be regarded as fundamental aspects of integrated water resource management. These are:

- *Freshwater is a finite and vulnerable resource*, essential to sustain life, development and the environment.
- Water development and management should be based on a *participatory approach*, involving users, planners and policy-makers at all levels.
- *Women* play a central role in the provision, management and safeguarding of water.
- *Water has an economic value* in all its competing uses and should be recognized as an economic good.

Interestingly, the concept of “basic needs” was again reaffirmed during the 1992 UNCED (the so-called Rio Summit) in Rio de Janeiro, expanding it to include the needs of aquatic ecosystems. Implicit within this development is the idea that basic resource requirements for human and ecological functioning, along with the allocation of sufficient resources to meet those basic needs, are the responsibility of national and local governments, as well as service providers (Lundqvist & Gleick, 1997: 21). In addition to this, the UNCED also concluded that links between the environment and development must be recognized at the highest political level. Agenda 21 consists of 40 chapters, with freshwater being dealt with in Chapter 18. The latter identifies seven program areas that tend to cover the same

issues that the eight recommendations from Mar del Plata highlighted. Notable exceptions are urban issues and climate change (Lundqvist & Gleick, 1997: 30).

The World Bank almost immediately translated these issues into policy. Encapsulated formally into the World Bank Policy Paper on Water Resources Management (World Bank, 1993), the Bank aimed at the adoption of a comprehensive policy framework, treating water as an economic good, and combining it with a decentralized management and delivery structure (Lundqvist & Gleick, 1997: 30). The World Bank thus effectively endorsed the Dublin Statement and Agenda 21. The latest water policy of the World Bank (Gleick, 1998:17) states amongst other things that:

- Water is an economic good.
- The management of water resources must be decentralized with fuller participation by affected stakeholders.

The Global Water Partnership (GWP) and World Water Council (WWC) are recent examples of global water sector initiatives (Lundqvist & Gleick, 1997:29). The activities of these two bodies relate to the establishment of a common framework that builds on the principles and visions that emerged from Dublin and that were later incorporated into Agenda 21. Significantly, the issue of governance and institutions has been identified as one of the six drivers in the global water scenario (World Water Council, 1999: 17). The significance with respect to an Analytical Paper on WDM is the fact that institutions are a key element in the successful application of WDM strategies. In fact, this is linked to what Homer-Dixon (1994:16-17; 2000:22) calls "social ingenuity". To this end, Sandra Postel (1997) offers a useful insight by saying,

"A new water era has begun. In contrast to earlier decades of unfettered damming, drilling, and diverting to gain ever greater control over water, the next generation will be marked by limits and constraints - political, economic, and ecological. Yet *enormous opportunities arise as well*. Exploiting the market potential of new water saving technologies is an obvious one. And in many cases, *achieving better water management will require decentralizing control over water, and moving from top-down decision-making to greater people's participation* - a shift necessary for better human and economic development overall" (emphasis added).

Central to this whole development is the underlying notion of subsidiarity, which is being seen as a critical element in achieving the goal of sustainable development. A strong element of this drive for subsidiarity, is the transformation of the management of the water sector away from an elite-driven centralized approach, to a more grassroots-based decentralized structure. For illustrative purposes, this can be shown as two extremes on the vertical axis of Figure 2. From the interaction of these two major paradigm shifts, we can now construct a simple model in order to understand where we are coming from, and in particular, where we are probably going with respect to water resource management. From this simple model it is evident that historically, water resource management has been dominated by supply-sided solutions, usually involving the development of infrastructure in order to improve the security of supply. This is located in the upper left

quadrant of the simple model that has been shown in Figure 2. That supply-sided approach – which we can call the “hydraulic mission era” of water resource management – tended to be managed in a highly centralized fashion. The managers at that time tended to come from similar University backgrounds, had been trained in similar methodologies and used similar text-books, meaning that the discourse of water resource management was relatively well defined and understood to this management cadre. In technical terms, there was a strongly articulated “sanctioned discourse” (Allan, 2000: 326; Turton, 2002a: 23; Jägerskog, 2002), which was centered on mobilizing water on which social and economic stability could be built. In essence, water resource management at this time was somewhat elitist and generally inaccessible to the broad population.

This is all changing however, with the global trend in water resource management reform tending to shift the newly emerging paradigm towards the lower right-hand quadrant in the model shown in Figure 2. This means that there is a strong shift away from pure augmentation of supply as the dominant approach, to one that increasingly involves the management of demand. At the same time, in the post-Dublin Principles era, the concept of subsidiarity is translating into a more decentralized and therefore more democratic, populist type of water resource management. The discourse in this quadrant is more muddled and less clear than its predecessor, because more role-players are involved, each with their own agenda, and each coming from a different philosophical and educational background.

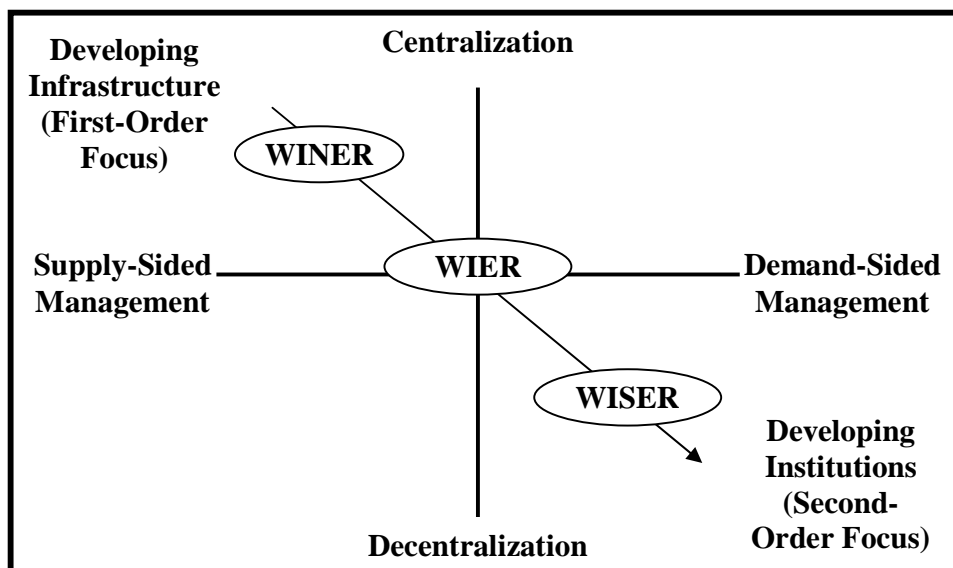


Figure 2. Integrated model showing the interaction between the two major competing international paradigms currently at work within the Water Sector (Turton & Meissner, 2000).

The significance of the labels WINER, WIER WISER, refer to three distinct discourses on water that coincide with the prevailing water management paradigm at different moments in historic time. WINER is the acronym for “Water Is Not an Economic

Resource” (Allan, 2000:24), which was the prevailing view before the Dublin Principles were accepted. In this approach water was seen as a free gift from God. The Dublin Principles changed that approach to a new one called WIER (Water Is an Economic Resource) (Allan, 2000: 23; 172). The third discourse is called WISER (Water Is a Social and Economic Resource) (Allan, 2000:172), which seeks to take into account the fact that water is multi-faceted and does not readily fit any overly-simplistic classification such as either WINER or WIER.

A First-Order Focus means that the main management objective of water management is related to mobilizing water as a natural resource. In short, this is about getting more water, improving the security of supply, and solving water scarcity-related problems by developing infrastructure. This can be called the hardware option that is closely linked with the “hydraulic mission” of society. A Second-Order Focus is about doing better things with available water, and consequently solving water scarcity-related problems by developing policy options, which are largely centered on what is technically known as allocative efficiency. It is about developing institutions rather than infrastructure, and can be called the software aspect of water resource management.

A good way to understand the difference between a First and Second-Order Focus is to view it as a Paradox of Perception using the proverbial glass of water that is neither full nor empty. To some people the glass is half empty, implying that a desirable condition is a full glass so they seek to remedy the situation by getting more water. This equates to a First-Order Focus as the paradigm of a full glass suggests a specific solution – the management of supply. To other people however, the glass is half full, implying that a desirable condition is not necessarily a full glass, but rather the ability to do the best with what is available. As such the remedy would then be to stretch the available water to the limit by doing better things with the limited water. This equates to a Second-Order Focus as the paradigm of doing more with what you already have suggests a specific solution – the management of demand. ***This Paradox of Perception is crucial to an understanding of the problematique of WDM as both a concept and a policy.***

3.2 Why is this Relevant to Southern Africa?

In the post-Cold War era, there is a trend towards regional integration. In the case of Southern Africa, this is being manifest as a greater propensity to cooperate and trade within the region, rather than exclusively outside of the region. As a result of historic factors (which are beyond the scope of this Analytical Paper), there are different levels of development in Southern Africa. Suffice it to say that four of the most economically developed countries in the region – South Africa, Botswana, Namibia and Zimbabwe – are also the most water stressed (Turton, *et al.*, 2000a:9-10). In fact, it can be argued that left unchecked, water scarcity can impact negatively on the economic growth potential (Falkenmark *et al.*, 1990) of those four countries specifically, and therefore affect regional economic growth in a negative way.

Coupled with this, is the emerging global dialogue on sustainable development, with the forthcoming Johannesburg Summit (World Summit on Sustainable Development)

offering a window of opportunity during which the complex issues relating to the notion of sustainable development will be unpacked and examined. Seen in this light, ***WDM can be regarded as being an empirically verifiable form of reflexivity in the water sector, and as such a measurement of sustainability in development programs.*** For this reason WDM is emerging as a key factor in transforming our economic development paradigm into one that is sustainable over time.

3.3 Theoretical Distinction between First and Second-Order Resources

The water scarcity debate has generated a lot of literature. One of the elements of this literature has been the tendency to establish a linear linkage between water scarcity and the possibility for violent conflict (Turton, 2000c; 2000d; 2001; 2002b). Some of this has even concluded that “water wars” are more or less inevitable as water scarcity increases beyond certain thresholds (Bulloch & Darwish, 1993; Cowell, 1990; de Villiers, 1999; Falkenmark, 1989a; 1994; Gleick, 1994; Starr, 1991). An important element of this is the use of numbers to measure levels of water scarcity, in an attempt to determine what thresholds exist, with the classic case being the prolific work by Falkenmark (1984; 1986; 1989b; 1990), all of which tends to make a strong linkage between population growth, water availability per capita, and consequent degrees of water scarcity with their resultant barriers or thresholds. This is what Ohlsson & Lundqvist (2000) have called “the numbers game”, which tends to be another formulation of the classic Malthusian Catastrophe genre of literature.

The fact that water wars have failed to break out despite being so confidently predicted has increasingly been the subject of a lot of research (Allan, 2000; Homer-Dixon, 1999; Turton, 2000c; 2000d; Wolf, 1998). In general, the conclusion has been that there is a propensity to co-operate rather than fight over dwindling water resources, with one of the key remedies being the trade in water-rich products – so-called Virtual Water (Allan, 1992; 1994a; 1994b; 1996a; 1996b; 1997; 1998a; 1998b; 1999a; 1999b; 1999c; 1999d; 2000; Turton, 1998; 2000e; Turton *et al.*, 2000a) – as a component of a WDM strategy that enables local water deficits to be managed without recourse to violence. ***So it can be shown that the ability to manage demand, and in particular to do better things with available water, is an important element in mitigating the conflict potential that water scarcity unleashes.***

In an effort to unpack these issues in a more sophisticated way, a lot of research has been done on the concept of a resource. We speak rather glibly of a resource, without ever really thinking about the various subtle nuances that are inherent within the concept. An important point of departure in this Analytical Paper is that an epistemological and conceptual distinction can be made between what we will define as a “first-order” and a “second-order” resource (Turton & Warner, 2001). To our knowledge, Dr. Leif Ohlsson (1998; 1999) was the first to systematically analyze resources in this way. In his analysis, a first-order resource is any natural resource such as water, land, minerals etc., with which a country can be either well endowed or poorly blessed. In other words, a first-order resource like water can be either scarce or abundant, with the degree of scarcity and/or abundance being a relative thing spatially, temporally and in terms of quality.

What is stressful in one environment is not a problem in another. A second-order resource on the other hand, is not a natural resource, but a social resource. It is the need, acutely perceived by societies, administrative organizations, and managers responsible for dealing with natural-resource scarcities (the first-order level of analysis), to find societal tools appropriate for dealing with the social consequences of the first-order natural resource scarcity (Ohlsson, 1999:161). ***The ability to develop a sound WDM policy, along with the necessary institutional arrangements needed to sustain this policy option over time, are an example of a second-order resource at work in the water sector*** (Turton, 2002a:46).

Seen in this light, ***what is critically important in terms of this conceptual split, is not so much the availability of the natural resource itself*** (first-order level of analysis), ***but rather how society adapts to changes in that supply*** (second-order level of analysis), either by way of long-term increases in water scarcity as a result of population growth and/or climate change, or short-term water abundance in the form of floods. In terms of this thinking, water management is depicted as being a series of oscillations between first and second-order resources over time, much like the turning of a screw (Ohlsson & Turton, 1999a; Ohlsson & Lundqvist, 2000), in which priorities change from supply-sided management (mobilizing more water) through demand-sided management (doing better things with available water) ultimately to adaptive management (adapting to absolute scarcity) (refer to Figure 7).

Couched differently, Ohlsson's (1998; 1999) second-order resource is another way of looking at Thomas Homer-Dixon's (1995; 1996) concept of "ingenuity", but the importance of this conceptual difference is that it allows the analyst and policy-maker to now effectively develop coping strategies with which to deal with the bottlenecks inherent in water management globally. This has particular relevance for an understanding of the problems confronting developing countries in the field of WDM.

A number of combinations of first and second-order resource are possible in relative terms within a given social entity. For purposes of this Analytical Paper, only three of these possible combinations are relevant (Turton & Warner, 2001).

- A combination that consists of a relatively high level of first-order resource availability in conjunction with a relatively low level of second-order resource availability will be called "Structurally-Induced Relative Water Scarcity" (SIRWS). In other words, water scarcity is inevitable in a relative sense as a result of the inability to mobilize sufficient social resources with which to effectively manage the problem. Under this set of conditions, one would expect to find a country that is relatively well endowed with water (first-order analysis), but as a result of a lack of institutional capacity and other problems (second-order analysis), is unable to mobilize that water via dams and related hydraulic infrastructure and reticulate it to the end user. A logical outcome of this condition would be low economic activity, poor public health and a general low level of infrastructure development. Clearly this condition is an unfavorable one, heralding as it does the possibility of Malthusian catastrophe at some time in the future if combined with high population

growth, but creative and responsible decision-making can still save the day provided that the alarm bells are heeded in time. It is these societies that offer examples of the debilitating effects of Homer-Dixon's (1995; 1996; 2000) so-called "ingenuity gap".

- A combination that consists of a relatively low level of first-order resource availability in conjunction with a relatively high level of second-order resource availability will be called "Structurally-Induced Relative Water Abundance" (SIRWA). In other words, water abundance is made possible in a relative sense as a result of the ability to mobilize sufficient social resources with which to effectively manage the problem. Under this set of conditions, one would expect to find a country that is relatively poorly endowed with water resources (first-order analysis), but as the result of a relative abundance of social resources (second-order of analysis), is able to develop a set of management solutions that are effective and legitimate in the eyes of the population and therefore sustainable over time. A logical outcome of this condition would be sustained economic growth, good public health and a high level of infrastructure development even in the face of endemic water scarcity. This condition resembles the Cornucopian argument that is often presented as an alternative to Malthusian collapse. Indeed there are rich examples of the positive impact of Homer-Dixon's (1995; 1996; 2000) concept of ingenuity to be found in an analysis of the water sector in many countries.
- A combination that consists of a relatively low level of first-order resource availability in conjunction with a relatively low level of second-order resource availability will be called "Water Poverty" (WP). In other words, the debilitating effects of water scarcity cannot be managed simply because of the lack of social resources, so a spiral of underdevelopment is unleashed with a gradual decline in almost all developmental indicators over time. A logical outcome of this condition would be long-term economic stagnation, deteriorating public health, a low level of infrastructure development and a high probability of social instability and political decay as the black hole that is caused by a combination of expanding population and a declining resource-base takes hold. In short, this is an example of the classic Malthusian collapse. Clearly this condition is one to be avoided at all costs.

When it comes to second-order analyses, we are confronted with a basic problem. If social adaptive capacity is a second-order resource, then how do we identify and measure this? How do we know when it exists and when it is absent? It is a vexing problem indeed and currently the subject of a research project at the African Water Issues Research Unit (AWIRU) (Turton, 1999b; Turton *et al.*, 2000b; Turton *et al.*, 2001). What is needed are a set of indicators of second-order resource presence (or absence). Again one needs to make certain assumptions in order to gain insight. For the purposes of this Analytical Paper, two key indicators will be used.

- Let us assume that the existence of second-order resources will result in a higher degree of economic prosperity than the absence of those resources, in line with Homer-Dixon's (1995; 1996; 2000) ingenuity thesis. If this is true, then the adjusted

GNP per capita to Purchasing Power Parity (PPP) as presented by the World Bank (2000:42-43) can be used as an indicator.

- The percentage of a given national population that has access to reasonably safe drinking water is an indicator of the capacity of a government to provide basic services. For this purpose World Bank (1999) data will be used as an indicator.

Table 1 presents these indicators in the following sequence. Column 1 names the country concerned. First-order indicators are presented in Columns 2 and 3. Column 2a shows the population growth rate for that country as shown by Turton & Warner (2001). This provides an indicator of the population dynamics over the last 38 years, which is shown as a High/Low split in Column 2b. The criterion for this split has been arbitrarily chosen (three-fold population increase is High, with less than that being Low). Column 3a presents the availability of first-order water resources per capita expressed as cubic meters per annum as shown by Turton & Warner (2001). Column 3b shows this data as a High/Low split using an arbitrarily defined criterion ($>10\,000\text{ m}^3/\text{cap}/\text{yr}^{-1}$ is High, $<10\,000\text{ m}^3/\text{cap}/\text{yr}^{-1}$ is Low). This provides a crude but useful indicator of first-order water resource availability *assuming that the country can develop those resources*. Second-order indicators are presented in Columns 4 and 5. Column 4a shows the GNP per capita as US Dollars adjusted in terms of Purchasing Power Parity (PPP). Column 4b presents this data as a High/Low split with the criterion being arbitrarily defined as $> \$5\,300$ being High and $< \$5\,299$ being Low. While this is an unsophisticated way of processing the data, it serves the purpose of a filter that shows a relative tendency that is ultimately useful. Column 5a shows the percentage of a given national population that has access to relatively safe water. Column 5b presents this data as a High/Low split with the criterion being arbitrarily defined as $> 65\%$ being high and $<64\%$ being Low. This is also crude but serves the same purpose of filtering out a general tendency. The combination of these indicators, when subjected to the High/Low filtering process can then form the foundation of some potentially useful hypothesis development, which in turn can be empirically tested thereby increasing our knowledge base.

Country	First-Order Indicators				Second-Order Indicators			
	Population Growth since 1961		Water Availability $\text{m}^3/\text{cap}/\text{yr}^{-1}$ 1998		GNP/cap US\$ Purchasing Power Parity (PPP) 1998		Access of Population to Safe Water %	
Angola	2.58	Low	15 783	High	999	Low	32%	Low
Botswana	3.06	High	9 413	Low	5 796	High	70%	High
Congo (DR)	3.20	High	21 134	High	733	Low	27%	Low
Lesotho	2.38	Low	2 527	Low	2 194	Low	52%	Low
Malawi	2.94	Low	1 775	Low	551	Low	45%	Low
Mauritius	1.64	Low	1 897	Low	8 236	High	98%	High
Mozambique	2.52	Low	12 746	High	740	Low	32%	Low

Namibia	2.53	Low	27 373	High	5 280	Low	57%	Low
Seychelles	1.79	Low	n/a		10 185	High	97%	High
South Africa	2.24	Low	1 208	Low	8 296	High	70%	High
Swaziland	2.96	Low	4 552	Low	4 195	Low	43%	Low
Tanzania	3.14	High	2 770	Low	483	Low	49%	Low
Zambia	2.78	Low	12 001	High	678	Low	43%	Low
Zimbabwe	2.94	Low	1 711	Low	2 489	Low	77%	High

Sources of data:

Population growth since 1962 (Column 2a) - (FAO, 2000 in Turton & Warner, 2001).

High/Low population growth split (Column 2b) - Arbitrarily defined as >3.0 is High, <2.9 is Low.

Water availability m³/cap/ yr⁻¹ 1998 (Column 3a) - World Bank Atlas (2000:34-35).

High/Low water availability (Column 3b) - Arbitrarily defined as > 10 000 m³/cap/ yr⁻¹ is High, < 9 999 m³/cap/ yr⁻¹ is Low.

GNP/cap 1998 (Column 4a) - World Bank (2000:42-43)

High/Low GDP/cap split (Column 4b) - Arbitrarily defined as > \$5 300 is High, < \$5 299 is Low.

Access of Population to Safe Water (Column 5a) - World Bank (1999).

High/Low Access of Population split (Column 5b) - Arbitrarily defined as > 65% is High, <64% is Low.

By concentrating exclusively on Columns 3 - 5 in Table 1 an assessment can be made using the following logic (Turton & Warner, 2001). Suppose one (mistakenly) assumed that first-order resource abundance (independent variable) naturally predisposes a country to economic prosperity (dependent variable), then one would anticipate finding a rough correlation in terms of High/Low splits between Columns 3 and 4. Our knowledge of reality shows that this is not the case, so one can conclude that first-order resource abundance on its own is an insufficient condition to guarantee economic prosperity, suggesting that some form of interceding variable is at work. If this interceding variable is expressed in terms of a second-order resource, then a comparison of Columns 4 and 5 reveals that in all cases except one (Zimbabwe) the existence of such resources as reflected by a higher GNP per capita determines the capacity of the government to deliver basic services like the provision of clean water.

Here the logic of Homer-Dixon's (1995; 1996; 2000) ingenuity thesis is relevant. Where a higher level of second-order resource is present, this translates into a higher level of economic activity, which in turn impacts on the ability of the State to deliver basic services. In this sense Botswana offers a revealing insight as it has a relatively small population size with a high population growth rate. This is confronted with a severe constraint in terms of low water availability, yet there is still a high level of service delivery. A similar trend is evident in Mauritius and South Africa where high levels of service delivery are possible in the face of severe first-order water constraints. Namibia is also revealing. In this case, a small population in absolute terms impacts on the availability of water by showing a high potential for development. This is not possible however as a low level of economic activity, coupled with a small tax base acts as a severe constraint that is reflected in the low level of service delivery. Another aspect

about Namibia and Botswana deserves to be noted. In both cases there are no permanently flowing rivers within either of these countries of any great magnitude. Where rivers are found, they form the borders of the country, leaving the hinterland dry and consequently difficult to develop. Both countries also have a relatively small population and consequently a small tax base. The fact that the GNP/capita indicator is split differently for these two countries is probably irrelevant, given the crudeness of the criterion used.

By applying this filter to Table 1, a neat differentiation of cases is evident in keeping with the key concepts that are being used in this Analytical Paper. In the regard, particular emphasis is placed on the three conditions, which were defined as SIRWA, SIRWS and WP. This typology is presented in Table 2.

Table 2. Classification of Various Southern African States in terms of Proposed Typology (after Turton & Warner, 2001:130).			
	First-Order Problems	Second-Order Problems	More Complex Problems
	SIRWA	SIRWS	WP
Southern Africa	Botswana Mauritius South Africa	Angola Congo (DRC) Mozambique Namibia Zambia	Lesotho Malawi Swaziland Tanzania (Zimbabwe?)

It is evident from Table 2 that the typology that was developed above as manifest in the concepts of SIRWA, SIRWS and WP can be applied to all cases where data is available with only one exception (Turton & Warner, 2001). Zimbabwe presents an anomalous situation that does not fit neatly into this framework with a combination of low levels of both first and second-order resources resulting in a high level of service delivery. The explanation for this is not self-evident, but it probably relates to the fact that the current political leadership has impacted negatively on the economy so as to create an acute shortage of second-order resources. The high levels of service delivery in Zimbabwe are manifestations of past achievements that occurred during the early-Mugabe era. As such this suggests that Zimbabwe has a high potential for development provided that the negative ramifications of poor political leadership can be resolved.

Southern Africa has a spread of cases from all three categories, with all results corresponding with what is known about each country. The three cases that are classified under SIRWA are known to be the most prosperous countries in the region. Should data have been available for Seychelles, then this country would probably also fall into this category. For these countries the water-related problems are primarily of a first-order nature, namely the continued search for and mobilization of alternative sources of water supply. Given the relative economic prosperity of these countries, the range of options is wide, covering supply-sided solutions (development of ever more distant water resources via IBTs and desalination where appropriate), WDM and the importation of Virtual Water in an attempt to balance the national water budget. All three strategies are known

to be taking place at present. The role of Virtual Water trade as a critical component of a strategic water management strategy for these countries is only recently becoming known (Turton *et al.*, 2000a).

The five cases that are classified under SIRWS are all countries that ostensibly have an abundance of water, but lack the institutional, financial or intellectual capital to translate this into economic growth and development (Turton & Warner, 2001). As such the type of problems facing these countries are primarily of a second-order nature. Angola and the DRC are politically unstable, largely as the result of civil war. Unfortunately no end to this debilitating condition is in sight, although there are some indications that this may be changing in Angola. Mozambique offers a glimmer of hope as it has turned its back on civil war and is seemingly on the road to economic recovery. Institutional capacity is extremely weak however, and a high debt burden continues to hamper this recovery. The major floods that took place in early 2000 set the economic recovery back significantly (Christie & Hanlon, 2001) and were also a manifestation of the inability to respond to the crisis. Namibia is politically stable but has become embroiled in the war in Angola and the DRC. This does not bode well for the future as it is starting to hemorrhage precious financial resources that could be used on institutional development instead. Namibia also presents an interesting case in the sense that the first-order type of indicators shows the country to be relatively well endowed with water. This is highly misleading however as the water that exists is found only on the northern and southern borders of the country, and is difficult to mobilize. The low population levels also create a false impression by presenting a relatively high per capita water availability, showing the flaws in first-order analyses. Zambia is politically stable but has a low level of economic activity. It is also being negatively impacted on by the civil war in both Angola and the DRC. Should Angola, the DRC, Mozambique and Zambia manage to solve these problems, then they could conceivably become the regional breadbaskets, using their natural resource endowment to balance the regional water scarcity by becoming Virtual Water exporters within SADC (Turton, 1998; Turton *et al.*, 2000a).

The four cases that are classified under WP present a complex set of problems indeed. In these cases, there is a relative scarcity of both first and second-order resources so dependence on external aid is likely to grow over time. Lesotho is an interesting case as it is first-order resource poor, yet it is the source of water for South Africa via the Lesotho Highlands Water Project (LHWP). This represents one of the few natural resources that Lesotho can exploit (the other being labour and to a lesser extent diamonds), so it sells this to South Africa, using the royalties to finance other development projects.

Armed with the results that are presented in Tables 1 & 2, a series of hypotheses have been developed (Turton & Warner, 2001). Four hypotheses are evident.

- In all cases presented, the relative abundance (or scarcity) of the second-order resource determines the outcome.
- Where there is a relative abundance of first-order resources in conjunction with a relative scarcity of second-order resources, the developmental potential is likely to

remain low. This condition can be labeled Structurally Induced Relative Water Scarcity (SIRWS), which is an unhealthy condition that policy development should seek to actively counter. WDM policies are unlikely to succeed under these conditions, as the necessary institutional capacity is unlikely to be developed and sustained over time.

- Where there is a relative scarcity of first-order resources in conjunction with a relative abundance of second-order resources, the developmental potential is likely to be high. This condition can be labeled Structurally Induced Relative Water Abundance (SIRWA), which is a healthy condition to be actively sought as a policy-outcome. WDM policies are likely to succeed under these conditions as the necessary institutional capacity can be developed and sustained over time.
- Where there is a relative scarcity of both first and second-order resources, the developmental potential is likely to remain low. This condition can be labeled Water Poverty (WP), which is a debilitating condition that is likely to result in a spiral of social and economic decay over time, with no apparent end in sight short of external intervention in some form. Under these conditions, policy intervention is likely to be exogenous in nature, being dependent on third party involvement. WDM policies are unlikely to succeed under these conditions, as the necessary institutional capacity is unlikely to be developed and sustained over time.

These hypotheses have direct relevance to WDM, and can be used to explain why an earlier IUCN study found that “WDM is not an intrinsic part of water resource planning and management at the national and regional levels in Southern Africa” (Goldblatt *et al.*, 1999:11). The answer to this is likely to be found in the relative scarcity (or abundance) of second-order resources in Southern Africa. In particular, the answer to this riddle lies in the notion of complexity and the resultant need for institutional development with which to manage the unintended consequences of this complexity.

3.4 Complexity and its Implications for Water Managers

We are confronted with three key questions at this juncture.

- What is complexity?
- Where does it come from?
- Why is it relevant to WDM?

Complexity is a central component of modern living and is the very foundation on which modernizing ideologies have been founded. A useful analysis of this can be found in the work by Homer-Dixon (2000:101-121), which for reasons of brevity will not be summarized here. (Should the reader wish to know more, the full-length Analytical Paper can be consulted). The world we know is a product of our own ingenuity, but in turn it demands increasingly more of our ingenuity to maintain it. This can be found in the philosophical work by Descartes (1637; Anscombe & Geach, 1954:46), where the main driving force of the Natural Sciences has been to become “master and owners of Nature”.

Most of us have been forced to hand over control of key aspects to so-called specialists (Homer-Dixon, 2000:107). The fact that specialists are now working on WDM as a specific element of water resource management is a manifestation of this propensity towards complexity.

This has led Homer-Dixon (2000:173) to conclude that we are increasingly living in a world that is fraught with what he calls “unknown unknowns” – we are ignorant about our own ignorance. As the result of this increasing complexity and interdependence, there is a greater chance of nonlinearity, which tends to boost the number of unknown unknowns in the natural, social and technological systems around us. For example, the way that we deal with natural resources is revealing about our constructed knowledge. The people we train to manage these systems, have usually been taught that it is possible to have a precise and detailed knowledge about their specific system - fisheries, logging or river basin management. They have been taught basically that these systems are relatively predictable with few unknown unknowns, so when they get into the field they see their resources as finite and closed systems capable of being managed (Homer-Dixon, 2000:174).

Tenner (1996) has catalogued what he called "revenge effects" (Homer-Dixon, 2000:178). These are the "ironic, unintended consequences of mechanical, chemical, biological, and medical ingenuity". The technological world we have created around us has the tendency "to get even, to twist our cleverness against us". Many examples exist, but the most relevant to the water sector are the debilitating effects of *Schistosomiasis* (bilharzia), *Simulium Chuteri*, salinization and the loss of biodiversity, all of which are the unintended consequences of the construction of water infrastructure such as large dams and Inter-Basin Transfers (IBTs) (Davies *et al.*, 1993:135-170; Davies & Day, 1998:242-310).

These aspects are all relevant to the management of water demand, because water resource management has a natural tendency to become more complex over time, particularly as river basin closure is being reached. ***It is precisely at this stage in infrastructure development that WDM policies are considered for the first time, so it is no wonder that they very often fail.*** We simply do not understand them within the context of an increasing degree of complexity that arises when we start to become “masters and owners of Nature”. In fact, WDM policies and practice add yet another level of complexity to existing bureaucracies and institutions, many of which are already overburdened.

4. Development of a Potential Model

Let us briefly recap on the critical elements of the argument that has been developed so far in this Analytical Paper. Having noted that there is a shift in water resource management paradigm away from a strictly supply-sided approach with its resultant first-order focus; to a more demand-sided approach with its resultant second-order focus (Figure 2), we went on to say that there is a Paradox of Perception at work. This Paradox forces us to seek a solution to a given problem based on our perception of the reality that

underpins that problem. We then went on to show that there is an increasing propensity towards complexity, with many examples of this being manifest in the water sector. One element of complexity arises from the nonlinearity that starts to occur when we try to manage ecosystems. The philosophy of Natural Science implores us to become “masters and owners of Nature”, which in turn implies that we enter a race against increasing complexity. In order to keep ahead of this race, we need to muster increasingly large amounts of what Homer-Dixon (1995; 1996; 2000) calls “ingenuity”, or what Ohlsson (1998; 1999) and Ohlsson & Turton (1999) call a “second-order resource”. We then looked at what a resource actually is, and concluded that there are two distinct types of resource. Natural resources we chose to call a first-order resource, of which there may be a relative scarcity or abundance. Social resources we chose to call second-order resources, of which there may also be a relative scarcity or abundance. We then went on to show that it is primarily the availability of second-order resources that determine the outcome of first-order resource mobilization. From this we categorized three conditions that can be applied to the water sector in Southern Africa (SIRWA, SIRWS and WP), each defined by the relationship between the relative scarcity and/or abundance of both first and second-order resources. It has also been shown that an increased level of second-order resources are needed to manage the effects of this propensity for complexity.

Let us now turn our attention to river basin closure, and in particular to a deeper understanding of what this implies in terms of water management institutions. From this we can develop a more sophisticated model of the institutional development needed to generate WDM solutions, and then to sustain those policies over time.

4.1 The Implications of Basin Closure on Water Management Institutions

Basin closure is a useful concept that is central to our understanding of the *problematique* of WDM as both a concept and a policy. A river basin with no utilizable outflow of water is a closed basin (Seckler, 1996). A river basin is said to be facing closure when all of the available water has been allocated to some productive activity and there is no more water left to be allocated (Svendsen *et al.*, 2001:184). This means that issues such as sectoral water efficiency (SWE) become increasingly important as basin closure is reached, so consequently decisions regarding the inter-sectoral and intra-sectoral allocative efficiency become relevant. This in turn implies that competition increases between users making the allocative decisions increasingly politicized, particularly when this allocation is between sovereign states, calling for a robust conflict resolution mechanism such as effective regimes in international river basins (Turton, 2002a:13). This differs from the hydrological definition of the term where a closed basin is a basin that has an outflow into internal seas, lakes or other sinks (Wester *et al.*, 2001:161). ***Only when a river basin approaches closure, does WDM start to become relevant, so it is necessary to know where this threshold is in any given situation if we are to understand WDM as a concept and a policy more profoundly.***

Working on the development of the concept of basin closure, and in particular the changing institutional arrangements that are needed in order to manage this condition, Molden *et al.*, (2001:73-87) have developed a useful model. This model shows what

happens as the water resources within a given river basin are developed for economic use over time. Their central hypothesis is that changing patterns of water use within a given river basin require “adaptive institutions” for the sustainable, equitable and productive management of water resources (Molden *et al.*, 2001:74). As the water resources are developed over time, the institutional arrangements needed to manage those resources change. According to Molden *et al.*, (2001:77-78) three distinct phases of institutional development can be isolated, each associated with a specific level of resource development, and consequently each needing a different set of rules, procedures and management priorities. These three phases consist of the following:

- The Development Phase. This is found in the early stages of river basin development. During this phase, there is no scarcity of naturally occurring water, so the main emphasis is on developing the resources that exist in nature. Due to the abundant availability of water, the laws of economics dictate that it is not a scarce good and consequently the value is relatively low. *As such WDM is not necessary at this time, and if introduced as a policy would probably fail.* Increasing demand for water results in increased development of hydraulic infrastructure such as dams and pipelines. This starts to place an economic cost on water, but in general the economic value stays low due to its relative abundance. Institutional priorities at this stage are centered mainly on engineering-related issues and are a classic example of the First-Order Focus noted in Figure 2.
- The Utilization Phase. This starts to occur once there has already been significant development of the hydraulic infrastructure. As such there has been considerable economic cost involved in mobilizing water and guaranteeing the assurance of supply to a given level. In this phase efficiency starts to become an issue, so the institutional arrangement changes to adapt to this new management requirement. The institutions tend to focus on sectoral issues such as the management of irrigation projects or the supply of bulk water to domestic or industrial users. Scarcity is not yet a major problem, but the economic cost of water delivery starts to become a concern. Small new infrastructural projects are also developed as the depletion curve approaches the available curve, but these are less attractive and more costly for various engineering-related reasons, so their improved yield is rather limited. In a sense this is roughly like the economic law of diminishing returns. *At this time WDM starts to become a management issue, but at best this is used to buy time before the next stage of infrastructure such as a dam needs to be developed.*
- The Allocation Phase. This starts to become relevant as basin closure is being reached, and depletion approaches the potentially available water curve. This means that there is limited scope for new infrastructural development, so increased efforts need to be made to increase the productive use of the water. The increasing scarcity of water means that the economic laws of supply and demand start to operate and the value of water rises. *At this stage allocative efficiency becomes an issue, with the need to start inter-sectoral allocation from lower sectoral value users to higher sectoral value users.* Managing the demand for water also starts to become a central issue at this time. The institutional focus now changes to the allocation of water

between competing users and sectors, the resolution of conflict that now becomes endemic within the river basin, and the regulation of water supply. Coordination becomes increasingly important involving significant transaction costs. The apportionment of water to different riparian states becomes a key issue in international river basins at this time.

While Molden *et al's.*, (2001) model is helpful in showing how institutional arrangements within a given river basin need to change over time, it does not cast enough light on some important conceptual issues. In order to achieve this, some additional research work has been done with the purpose of developing a more comprehensive model (Turton, 1999a; Turton & Ohlsson, 1999; Lundqvist & Turton, 2001). Central to this work is the need to understand the various transitions that are implicit in the model that has been developed by Molden *et al.*, (2001).

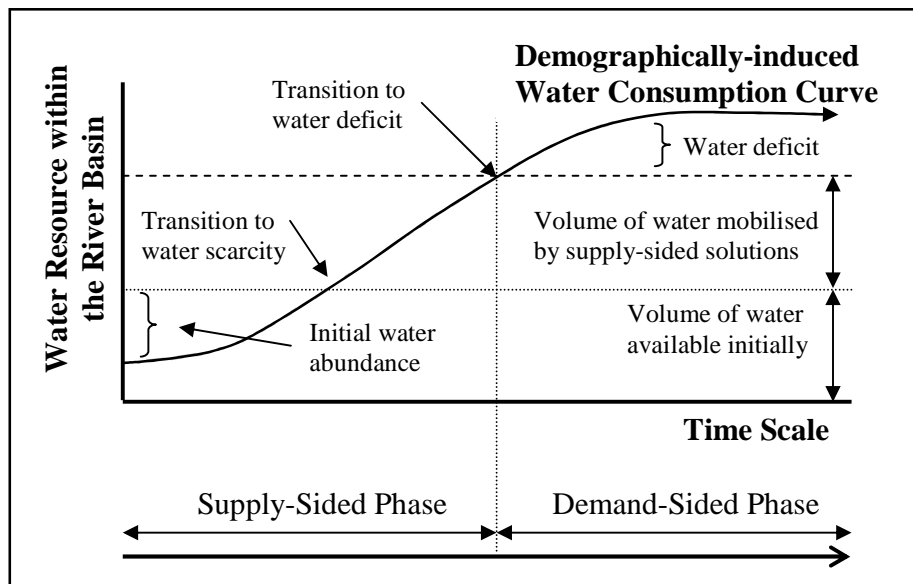


Figure 3. Simplistic model showing transition from Supply-Sided Phase to Demand Management Phase within a given river basin (Turton, 1999a).

The starting point of this refined model as shown in Figure 3 is similar to that of Molden *et al.*, (2001), but was developed independently of that model. The central need was to understand what social triggers, if any, would become important for institutional development as various phases of water resource management were encountered over time. As such the identification of thresholds would be important, as these would trigger off a new set of institutional needs, which if not met, would result in an increase in conflict potential and a delegitimization of the institution. This model is based on the assumption that it is largely demographic factors that drive the demand for water in a given river basin. This is represented as an "S" curve. There are five important concepts that are central to this model (Turton, 1999a) which need to be highlighted. These are as follows:

- As the demographic base of a given river basin changes over time, there is an increase in the demand for water. In this sense there is a close correlation between demographic growth and the growth in water demand. As a result, the main curve on the graph is called the "Demographically-Induced Water Consumption Curve" (DIWCC). The word "consumption" is used loosely in the sense that water is used but not really consumed as one would consume a resource like coal, which once ignited would no longer be available for burning as an energy source. Water is consumed but returned to the hydrological cycle in some form or either, either as effluent or as water vapour. The important aspect is that this water is not readily available for direct re-use, so in a loose sense it has been consumed. In reality effluent can be treated, but this adds cost and is normally beyond the capacity of most developing countries to do, resulting in pollution as a significant element in the depletion of a resource-base. Lundqvist (1998) has labeled this phenomenon "hydrocide", which is a manifestation of a specific - and particularly debilitating - second-order resource problem for the developing world in general.
- During the early stages of development within the given river basin, there is an initial period of water abundance. In this sense the term "water abundance" means that the volume of water that is available exceeds the demand for that water. Under such conditions, demand is relatively low, water availability is relatively high and consequently water has a low economic value. This in turn means that the incentive for the abuse of water is high during the early stages of river basin development.
- Economic development takes place, very often having been triggered off by a specific event such as the discovery of gold on the Witwatersrand (Turton & Meissner, 2000), which in turn creates a rapid increase in the demand for water. This forces the DIWCC upwards, to a point where it crosses the horizontal line that represents the volume of water that was available initially. This specific moment in time is known as the transition to water scarcity.
- Water scarcity exists within the given river basin when the DIWCC exceeds the locally available supply of water. The transition to water scarcity results in the birth of the hydraulic mission in society, as politicians seek to mobilize water in order to create a stable infrastructural platform on which future social and economic development can be built. Engineers are commissioned with the task of mobilizing water by means of the development of hydraulic infrastructure. Institutional development that has been created by the transition to water scarcity is similar to the "development" and "utilization" phase of water resource management depicted in Molden *et al's.*, (2001) model. Basin closure is approached, and possibly even reached in this phase of water scarcity. If basin closure is reached, then there is a strong stimulus to augment supply within the given river basin by capturing the resource-base in another river basin by means of an IBT. ***This increases the volume of water that can be mobilized through human ingenuity, thereby enabling water supply to continue even after basin closure has been reached.*** This acts as a primary stimulus for resource capture, with direct implications for other downstream riparian states in shared international river basins. This important element of water resource

management is not evident in Molden *et al's.*, (2001) model, which presumes that water is managed within the context of a given river basin with no linkage to other river basins.

- Continued economic development causes water to be mobilized to such an extent that the DIWCC starts to approach, and eventually passes, the maximum volume of water that can be mobilized by supply-sided solutions such as IBTs. This represents the transition to water deficit, beyond which no further water can be mobilized without severe long-term ecological impacts. Under these conditions water can become securitized as the strategic implications of water as a fundamental component of the economic growth potential of the state become apparent (Turton, 2001). ***Institutional development in this phase is centered on water allocation, conflict resolution and the management of demand***, with specific implications for other riparian states in shared international river basins, given the potential impact that resource capture has had on their own resource base.

4.2 Concept of Adaptation as a Result of Second-Order Resources

Molden *et al.*, (2001) have shown that water management institutions must adapt over time as river basin closure approaches. It therefore becomes necessary to dwell for a few moments on the dynamics of this adaptive institutional development because ***in reality the problematique of WDM as a concept and a policy is that this adaptation often does not occur, which is why WDM is not being widely applied in Southern Africa***. Haas (1983:57) notes that organizations learn and adapt, which is accomplished via the processing of information and the development of institutionalized knowledge. As such, knowledge creates the basis for cooperation by illuminating complex interconnections that were not previously understood (Krasner, 1983:19). Knowledge is therefore a function of cooperation, which in turn is the foundation of adaptation. Institutionalized knowledge, learning and adaptation are closely linked, but are also different from each other. A critical element of both the Molden *et al.*, (2001) and Turton (1999a) model is the central role that adaptation plays within any institutional arrangement for water management in a closing river basin. The weakness of both these models is that they assume that adaptation will occur, without explaining what the specific elements of adaptation are. This is where the work by Ohlsson (1998; 1999) becomes highly relevant (Allan, 2000:323). Ohlsson (1999:5) was initially concerned about the Malthusian-related issues of abundance and scarcity, seen within the context of natural resources and this linkage to human populations. Central to Ohlsson's (1999:23-24) argument is the existence of three distinct forms of scarcity. These are as follows:

- The scarcity of non-renewable resources such as minerals (which generally becomes a scarcity of environmental space over time).
- The scarcity of renewable resources such as water that are used for the production of biomass and food.
- The scarcity of social resources that will be needed by societies to adapt to changing levels of renewable and non-renewable resource scarcity.

These three forms of resource scarcity lie at the very heart of Ohlsson's research work, and have major significance for explaining and predicting the institutional adaptation that is assumed by Molden *et al.*, (2001) and Turton (1999a). It must be noted that social adaptation - or more accurately stated, the lack of appropriate social adaptation - is a central feature of many water-related conflict patterns. This has led Ohlsson (1999:161) to distinguish between two specific types of resource that are relevant to any analysis of resource scarcity. These are as follows:

- A First-Order Resource: is a natural resource such as minerals, land and water, which may be scarce or abundantly available. There are also two distinct types of first-order natural resource, each with fundamentally different characteristics:
 - Non-Renewable Resources: have a finite availability, and once depleted cannot be replaced. One characteristic of these resources is that they are consumed, which is an irreversible process. Typically, consumption of these resources results in a whole series of other problems such as pollution and environmental deterioration, so the management of the resource needs to factor this in.
 - Renewable Resources: are not depleted and therefore are not consumed. Consequently, effective management of these resources can result in continued economic growth over time. The operative word therefore becomes “effective” management, establishing a linkage to second-order resources.
- A Second-Order Resource: is a social resource, which may be either scarce or abundantly available. More appropriately, it is the need that is acutely perceived by societies, administrative organizations and the managers responsible for dealing with first-order natural resource scarcities, to find the societal tools appropriate for dealing with the social consequences of changing levels of first-order scarcities. ***The failure to mobilize the appropriate amount of social resources with which to accomplish institutional transformation and change must be seen as a special form of resource scarcity.***

Seen in this light, Ohlsson (1999) has identified two different discourses on resource scarcity, which he presents graphically as shown in Figure 4. This work represented a substantial shift forward in the way that water resource management could be explained and understood, prompting the author to develop these concepts a little further (Turton, 1999a; Turton & Ohlsson, 1999). The starting point for this development was the model that has been presented in Figure 3. If Ohlsson's (1998; 1999) work is valid, then ***there are essentially three phases to water resource management, and consequently three specific focal points of water policy, each necessitating a different institutional arrangement.*** This has specific relevance to an understanding of the *problematique* of WDM as a concept and policy, making it central to the logic of this Analytical Paper.

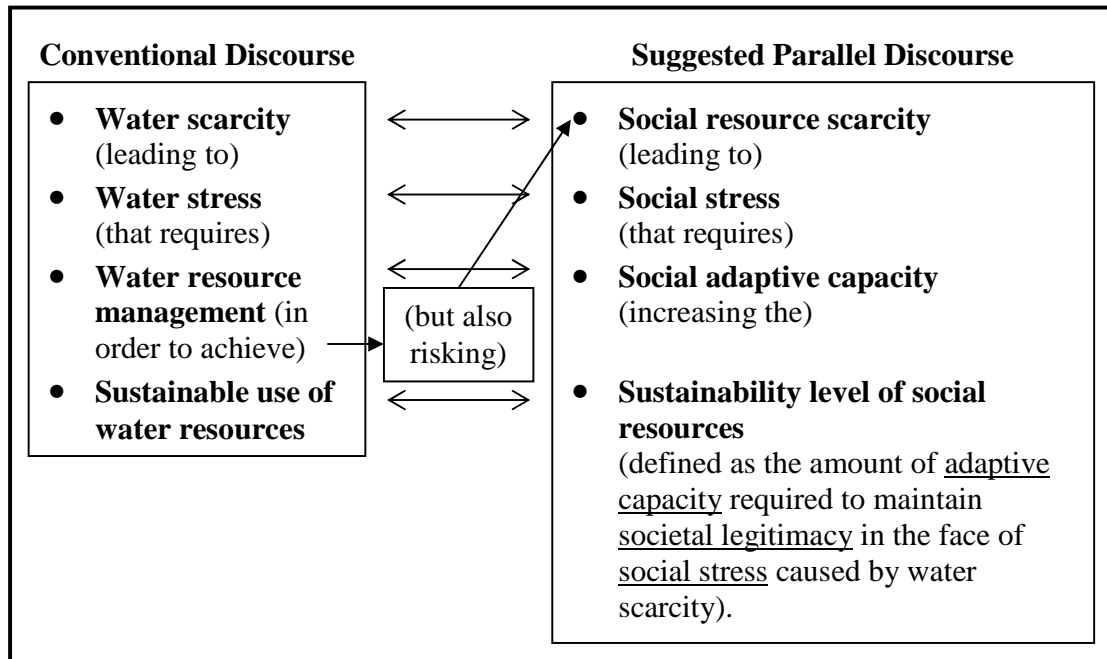


Figure 4. The parallel discourse of First-Order Natural Resource and Second-Order Social Resource Scarcity as depicted by Ohlsson (1999:164).

Using the same concepts as those inherent in Figure 3, the assumption was made that water deficit is an unsustainable condition, much like an overdrawn bank account or balance of payment deficit in economic terms. Consequently, if water demand continues above the level of water mobilized by supply-sided solutions, then ecological collapse is likely. This would become a classic type of threshold event, heralding in a non-linear collapse of economies and the social systems that they support. To use Homer-Dixon's (2000:173) terminology, "greater complexity ... and a higher chance of nonlinearities tend to boost the number of unknown unknowns in the natural, social, and technological systems around us". If this condition were to be averted, then any policy choice would have to involve the decision to re-align the DIWCC with the sustainability level of engineered water supply shown in Figure 5. This would change the shape of the "S" curve, and would split the water demand curve from the population growth curve (Ashton & Haasbroek, 2002).

As noted earlier, this is called reflexivity (Giddens, 1990; Beck, 1992; 1995; 1996a; 1996b; Allan, 2000:29). *Reflexivity constitutes an empirically verifiable indicator of the effectiveness of water policy as an output of any given institutional arrangement, because it shows the ability of the management unit to reduce the deficit* and realign the demand for water with the sustainable levels of supply. In other words, the change in trajectory of the water demand curve is the result of effective adaptation and institutional learning. Reflexivity is like paying back the bank overdraft before the point of bankruptcy is reached, or reducing the national balance of payments deficit before the whole economy stagnates. *Reflexivity therefore enables the unknown unknowns* - to use

Homer-Dixon's (2000:173) terminology - *that are associated with the threshold effect to be avoided before they occur.*

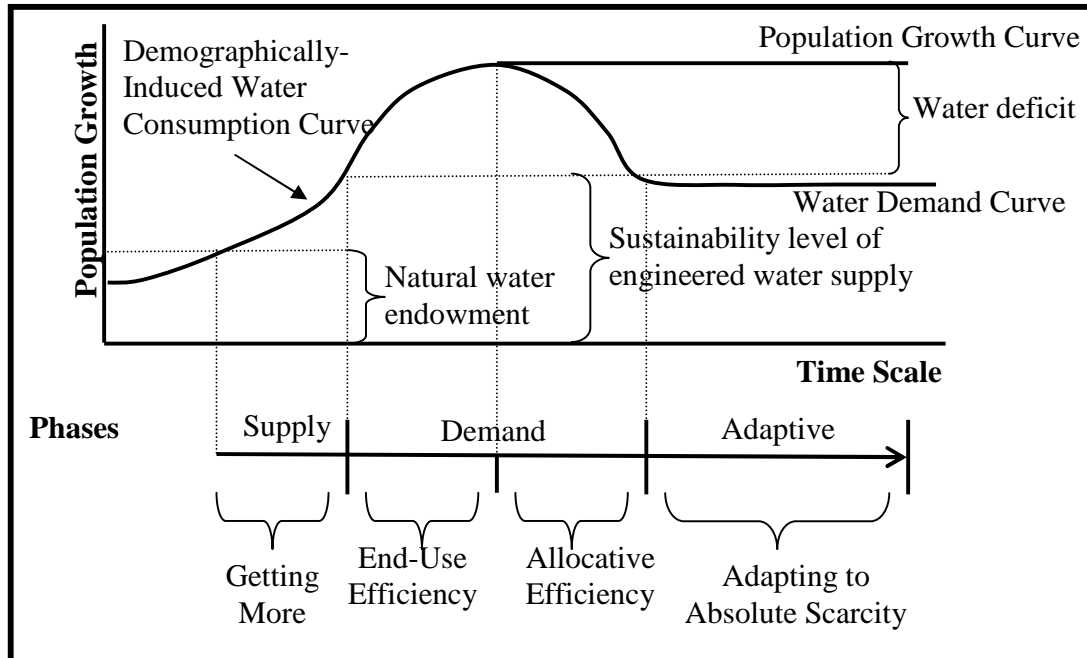


Figure 5. Schematic representation showing how reflexivity is needed to realign population-induced demand for water with the maximum level of sustainable supply (Turton, 2000b; 2002a:175).

From this more sophisticated model, *three distinct phases of water resource management can be isolated:*

- The Supply-Sided Phase: of water resource management starts when the DIWCC crosses the first threshold from water abundance into water scarcity. This acts as a stimulus for the hydraulic mission of society, which goes by different names in different parts of the world. Reisner (1993) originally coined the term "hydraulic mission" when describing the American experience at mobilizing water in order to settle the arid West. Breznhev (1978) describes a similar occurrence in the former Soviet Union. Swyngedouw (1999a; 1999b) has used it in his study of the mobilization of water in the modernization of Spain. Platt (1999) refers to this as the phase of "heroic engineering" in the mobilization of water resources for the development of the Boston and New York metropolitan areas. This is what Waterbury (1979:116) refers to as the "High Dam Covenant" in the case of the Nile and the construction of the Aswan High Dam as a foundation for economic modernization in Egypt. Allan (2000:28) notes that the hydraulic mission is essentially a feature of modernity, which is a term used to describe the processes of change in the industrialized North during the nineteenth and twentieth centuries.

- The Demand Management Phase: starts when the DIWCC crosses the second transition from water scarcity to water deficit. In reality this consists of two distinct sub-phases.
 - *The early phase is about end-use efficiency, where intra-sectoral allocative efficiency occurs at the level of the production unit away from water-related activities that yield a low return to water, towards productive activities that show a higher return to water.* This is not too complex to manage as it involves limited social disruption and is thus preferred by politicians (Turton & Ohlsson, 1999; Allan, 2000:184).
 - *The later phase is about allocative efficiency, and in particular inter-sectoral allocative efficiency, where water is moved away from economic sectors involving a low return to water (typically agriculture), towards economic sectors showing a higher return to water (typically industry).* This is highly disruptive in social terms, and consequently tends to be avoided by politicians (Turton & Ohlsson, 1999; Allan, 2000:184), but is necessary if a reflexive response is to be achieved in the long-term.
- The Adaptive Phase: occurs when the social entity concerned needs to learn how to live with absolute scarcity and still manage to survive in a rapidly globalizing economy where efficiencies of production are important. This is a difficult phase of water resource management because it implies that economic growth and social stability will need to be managed in the face of endemic and debilitating water deficit. It also means that the complexity related to the management of the environmental problems that result after first-order resource depletion has occurred would need to become part of the institutional objectives. In the water sector this includes issues such as the acid mine drainage that occurs after exhausted gold mines flood and decant their toxic waters into streams, which is currently happening in parts of the former Witwatersrand (now called Gauteng). In shared international river basins this also includes managing the thorny issue of riparian relations and water allocations between the various riparian states in a way that prevents the securitization of the dwindling water resource-base (Turton, 2002a:177).

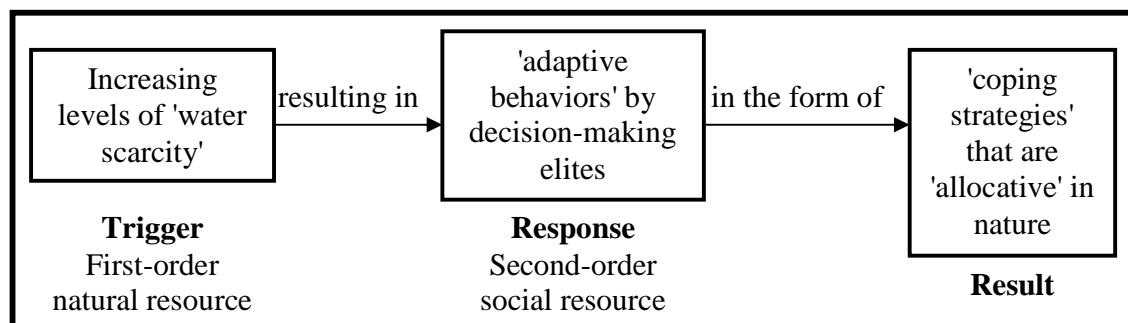


Figure 6. Schematic representation showing how water scarcity generates an adaptive response that results in some form of allocative measure such as WDM being introduced (Turton & Ohlsson, 1999; Turton, 2002a:177).

It is therefore evident that adaptation, which involves institutional learning, is really a key concern for sustainable water resource management, as suggested by the model that has been developed by Molden *et al.*, (2001). In fact, it can now be deduced that changes in the first-order resource availability trigger responses that are needed to manage those changes. These responses are second-order resource dependent as shown in Figure 6. There is thus an intimate link between first-order and second-order resources which is not evident in Molden *et al's.*, (2001) model that needs to be explored further.

There are consequently a number of great challenges facing water-policy makers in countries where water scarcity is a major factor determining the economic growth potential of the state. Ohlsson (1999:189) has identified three generic challenges, which he elaborates as follows:

- The management of conflict.
- Getting more use out of the same volume of water.
- Making better use of the available water.

In order to manage these three challenges, Ohlsson (1999:189) notes that *three policy goals are needed*. These goals would have to be incorporated into water management institutions if they are to function in a sustainable and satisfactory manner over time. These policy goals are as follows:

- The management of competing demands: for water from different societal sectors and population groups (within a given river basin) in order to achieve a distribution of the scarce resource that is deemed to be equitable. This essentially entails developing and maintaining effective WDM strategies.
 - This will require robust institutions capable of withstanding the potentially delegitimizing demands that will be made of them in their quest to mitigate and resolve endemic conflict.
- The facilitation of technological changes: in order to achieve greater end-use efficiency of existing water.
 - This has a First-Order Focus: because it seeks to limit the use of water as a resource, and therefore requires a specific form of technical ingenuity to accomplish successfully (Homer-Dixon, 2000). This is central to Falkenmark's (1990:181) concept of a “water barrier” that she considers to be relevant to the Jordan River Basin case (Falkenmark, 1986:197) and other developing countries such as those found in Southern Africa. This barrier only exists if sufficient ingenuity (of the right type and at the right moment in time) cannot be mobilized (i.e. if there is a second-order scarcity in society).
- The facilitation of socioeconomic changes: in order to achieve greater allocative efficiency of water.

- This has a Second-Order Focus: as it seeks to do better things with the available water. Because it involves changes to the social fabric of society, such as those caused by the reduction of non-specialized agriculture that is usually performed by unskilled rural dwellers; the increase in mechanized factory farming using fewer unskilled workers; the resultant migration from rural areas to urban areas; and the redeployment of scarce water into the industrial sector, this is a highly complex process that carries considerable political risk. As such it places high demands on the second-order resource-base of any given society.

The policy tools that are available in order to reach these policy goals can be divided roughly into two generic groups (Ohlsson, 1999:189):

- The administrative approach.
- The market approach.

From this Ohlsson (1999:189) develops a matrix linking the water policy goals with the available tools. This is presented in Table 3. *Significantly, it is the development of appropriate institutional arrangements, and the generation of viable coping strategies in the form of policies, that lie at the heart of the water management dilemma. It is these very issues that are also second-order resource dependent*, so the first-order resource focus inherent in most water scarcity narratives - such as the story being told about rivers running dry - is deeply flawed (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000).

Table 3.			
Matrix Showing Water Policy Goals and Available Tools			
Goals (right): Tools (down):	Equitable Distribution	End Use Efficiency	Allocative Efficiency
Administrative Approach	Recommended but not necessarily the best	Clumsy but probably still necessary	Government faces tough decisions
Market Approach	Needs administrative measures as well	Getting the prices right is difficult	Markets can be cruel decision-makers
Source: Ohlsson (1999:189).			

From this analysis it is evident that the problems confronting institutions as the result of basin closure are extremely complex indeed. *This complexity is a mixture of both a first-order resource scarcity (water deficit), and a second-order resource scarcity (inability to reform or adapt institutions effectively) that cannot be understood in terms of a linear model.*

4.3 First-Order and Second-Order Resource Oscillations: The Turning of a Screw Model

The *problematique* arising from this complexity can best be understood in terms of a series of bottlenecks or oscillations between first-order and second-order resources over time. This can be likened to the turning of a screw (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000) in which there is a form of non-linear progression between:

- Identifying bottlenecks in water resource management.
- Finding and mobilizing the appropriate social tools to meet the challenges as they arise.
- Dealing with the conflicts that are being created by the new adaptive ways in which water resources are being managed.

This progression oscillates in a non-linear fashion, between a perceived scarcity of water (first-order resource), and a perceived scarcity of the social means (second-order resource) needed to overcome this initial first-order water scarcity, all the while spiraling upwards because increasing amounts of social resources need to be mobilized as water deficit becomes endemic due to basin closure. With each of these oscillations, the level of complexity increases. The tasks of managing this oscillation is about the process of learning, preferably within an institutional context, how to effectively deal with:

- The conflicts encountered as a result of the water scarcity (First-Order Focus as shown in Figure 2), including those within both the international and domestic political environments.
- The conflicts encountered as a result of the social resources applied to overcome this natural resource scarcity (Second-Order Focus as shown in Figure 2), including conflicts that are aimed at reducing state legitimacy.

It can therefore be seen that there is a shift in emphasis over time, from managing first-order resource problems (getting more water) initially, and ultimately managing second-order resource problems (managing water allocation between riparian states, competing economic sectors and doing better things with the available water). These correspond to the three water management phases shown in Figure 5. Details of some of these issues are as follows (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000):

- During the Supply-Sided Phase: the problem is perceived as water scarcity. The logical solution is therefore to build hydraulic infrastructure and mobilize water as part of the hydraulic mission of society. Central to this is the Paradox of Perception noted earlier. This is entirely first-order in focus, but second-order issues arise in the form of:
 - Conflict over access to the water resource being mobilized - the so-called pipelines of power thesis in which hydropolitical privilege is not evenly

spread throughout society - in water scarce regions such as Southern Africa (Turton, 2000a).

- Conflict between people who are displaced by the dam-building projects and the government.
 - Conflict between riparian states within an international river basin, which is usually configured around the zero-sum principle inherent in the upstream/downstream hydropolitical game - sometimes called the Rambo option (Turton, 2000f; Ohlsson & Lundqvist, 2000). This has particular relevance to Southern Africa where a large number of rivers are shared between more than one country (Chenje & Johnson, 1996:151; Pallett, 1997:71).
- During the Demand Management Phase: the problem becomes more complex because it is essentially about doing more in economic terms, with less available water. Here again the so-called Paradox of Perception becomes highly relevant, because the core perception of the problem needs to change. Sustainability is at stake and very little new water can be mobilized due to basin closure, so the perception of the problem changes from the management of water supply (first-order focus), to the management of demand (institutional transformation as a second-order focus) (refer to Figure 2). ***Central to this is the transformation of the management of water as an absolute scarcity, to one of a relative scarcity that can be managed provided that society is prepared to pay the necessary price in social and economic terms.*** This results in a new emphasis being placed on second-order problems - what Edward Tenner (1996) (cited by Homer-Dixon (2000:178)) calls "revenge effects" - such as:
 - Conflicts arising from the adjustment to rules, norms and administrative procedures, which change the pattern of hydropolitical privilege that has become the norm in society.
 - Conflicts arising over the metering of water to previously non-metered users who have grown accustomed to free water.
 - Conflicts arising when people have to start paying full cost recovery level tariffs for their water services.
 - Conflict arising from displaced farmers as the shift to water-saving technology forces people off the land.
 - Conflict between rural and urban users of water.
 - Conflict between riparian countries in international river basins, especially where one country is more developed than another and has consequently already mobilized the majority of the water.
 - Conflict between economic sectors, as sectoral water efficiency (SWE) issues become more relevant.
 - During the Adaptive Phase: the problem is extremely complex, as it is about doing alternate and even-more economically productive things with the now highly scarce, probably polluted and very expensive available water. This involves a major emphasis shift towards second-order issues. This in turn unleashes a new series of revenge effect-styled second-order problems which come in the form of:

- Conflicts arising from the restructuring of society, away from an agrarian-based economy, to an industrially based economy.
- Conflicts arising from rural/urban migrations and the increase in slums around large metropolitan areas.
- Conflicts arising from increasing levels of crime, as the rapidly urbanizing work force is unable to gain full employment due to inadequate education levels, and the effects of economic stagnation.
- Conflicts between riparian states over the allocation of water in shared river basins.
- Conflicts arising from new political and economic dependencies, that arise from the need to balance local water deficits, by importing virtual water from the global grain market.
- Conflicts arising from economic marginalization, as the developing country battles to integrate into the globalizing economy, because the nett outflow of hard currency needed to achieve food security (for the importation of virtual water) becomes inflationary.

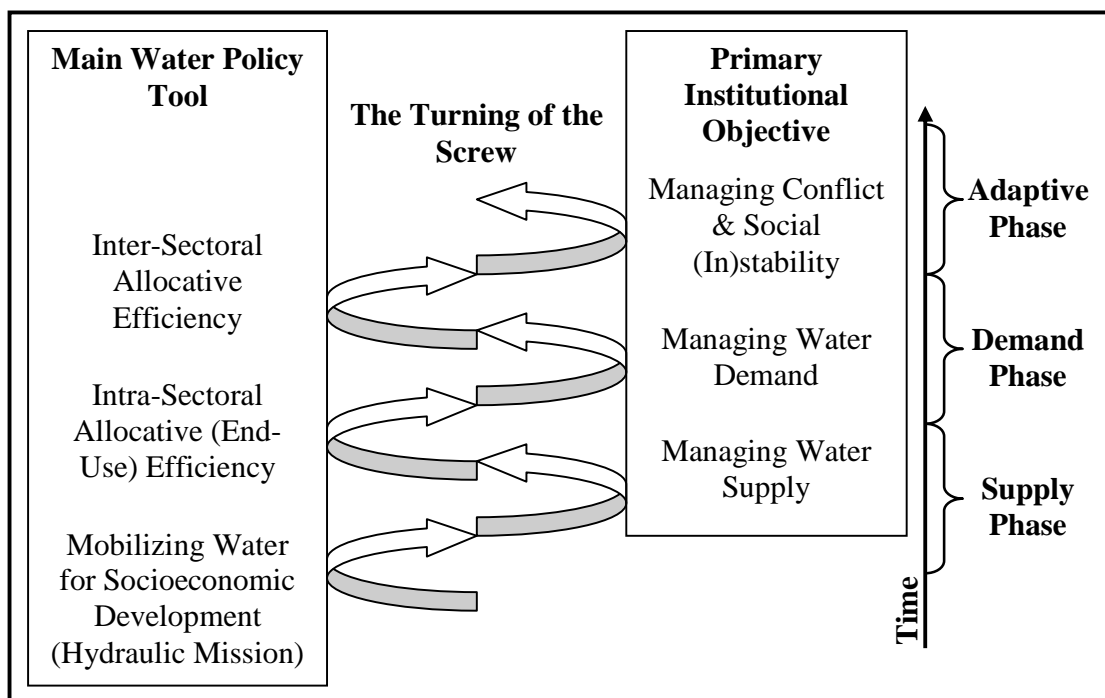


Figure 7. The Turning of the Screw Model showing the oscillations between a First-Order and Second-Order Focus over time (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Turton, 2002a:183).

The oscillations within the turning of the screw model (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000) can be visually depicted as shown in Figure 7. The left-hand column shows the main policy tool that is used in each of the water management phases. The

right-hand column shows the primary institutional objective for each of the water management phases, as initially defined in Figure 7, which are shown on the time-line at the extreme right of the diagram. The oscillations between first and second-order resource priorities are depicted as the turning of the screw between the main policy tool and the primary institutional objective columns.

Let us summarize the argument for the importance of second-order resources that has been developed so far. Having noted that adaptive management is needed in the water sector from Molden *et al.*, (2001), we have moved on to explore the connection between institutional learning and the various phases of water resource management over time (Turton, 1999a; Turton & Ohlsson, 1999). The turning of the screw model (Ohlsson & Turton, 1999a; Ohlsson & Lundqvist, 2000; Turton, 2002a:183) has shown that there is an intimate linkage between a first-order and a second-order resource focus, with an oscillation in emphasis between these two types of resource in a way that is more complex than the simple linear relationship shown in Figure 2. ***From this we have concluded that second-order resources***, which we have crudely defined as social adaptive capacity, ***are the actual determinants of social stability in water-scarce states*** (Ohlsson, 1998; 1999; Turton, 1999a; Turton & Ohlsson, 1999; Turton & Warner, 2001). In support of this, Trottier (1999:134) has shown that this theoretical aspect is valuable in explaining the conditions in the occupied territories of the Jordan River Basin. In his work on the Middle East in which he has sought to develop an integrated theoretical base for the study of hydropolitics as a unique discipline, Tony Allan (2000, xvi; 322-323) has emphasized the importance of second-order resources.

Stated differently then, ***it can be said that second-order resources are an independent variable, because the quality, quantity and timing of the availability of those resources determine the final outcome of basin closure***. In other words, if basin closure occurs at a place and time where there is also a low level of social adaptive capacity (i.e. a second-order resource scarcity), then WDM policies cannot be developed and the securitization of water is likely to occur as the conflict potential takes on a zero-sum configuration (Turton, 2001; 2002a). Conversely, if basin closure occurs at a place and time where there is a high level of social adaptive capacity (i.e. a second-order resource abundance), then the conflict potential is likely to take on a plus-sum configuration, as regimes are negotiated, WDM policies are developed and adaptive institutions are created and maintained. ***Second-order resources seem to be the determining variable*** (Turton, 1999a; Turton & Ohlsson, 1999; Allan, 2000:322-325; Turton & Warner, 2001).

4.4 Ingenuity as a Second-Order Resource

Having reached this point in our argument, we still know very little about what second-order resources actually are, beyond the generic description of why they are needed. Even Ostrom's (1990:184) work merely notes that something which she calls "social capital" is needed to make common pool resource management effective, without going into details of what this might actually consist of. Fortunately, Thomas Homer-Dixon (1991; 1994; 1995; 1996; 1999; 2000) has been doing some groundbreaking research into what he calls "ingenuity", which is nothing more than a second-order resource or a form of social

capital. (For more detail the reader is referred to the longer version of this Analytical Paper).

One of the possible adaptive responses to increasing levels of environmental scarcity is related to technology, where it is argued by Cornucopians - another name for a techno-economic optimist - that rising levels of resource scarcity will become the stimulus for invention. Seen in this way, society will somehow find the remedy when it is needed, because history has shown that necessity is the mother of invention. Refuting this argument as being overly simplistic, Homer-Dixon (1991:101) notes that market-driven adaptation to resource scarcity is most likely to succeed in wealthy societies. It is in these developed countries that sufficient reserves of capital, knowledge and talent help economic actors invent and adapt technologies that result in changes to consumption patterns. He goes on to suggest that this argument is deeply flawed, because the majority of countries that are in fact being confronted by increasing levels of environmental scarcity are developing countries, which are economically poor, with inefficient markets, a lack of financial capital and a paucity of knowledge and know-how. *Consequently, the “water barrier” that Falkenmark (1986:197; 1990:181) speaks of is dependent on second-order resource availability*, which Israel has in abundance, but which the Palestinians, Syrians and Jordanians have in varying degrees of scarcity (Allan, 2000: 324) by way of example.

When being confronted by increasing levels of resource scarcity, societies can avoid the resultant social disintegration and turmoil (second-order scarcity) if they can adapt to the rising levels of (first-order) scarcity. In this regard, Homer-Dixon (1994:16) notes that adaptive strategies essentially fall into two broad categories:

- Societies can continue to rely on their indigenous resources, but use them more sensibly. Economic instruments such as taxation and other incentives could be used to increase the price of resources, thereby encouraging conservation and innovation while reducing depletion.
- Alternatively, societies might choose to decouple themselves from dependence on its own environmental resources, by producing goods and services that do not rely on those resources. This would involve the reinvestment in capital and skills in order to achieve the shift to other forms of wealth creation. Central to this would be effective WDM policies.

In order to achieve either of these two options however, what Homer-Dixon (1994:16-17) calls “ingenuity” will be needed. Central to this concept of ingenuity is the notion of “social capital”. It is the same concept that Ostrom (1990; 1994; 2000) utilizes. First used in the English language by Hanifan (1916) (Fine, 2001:28), there is also a strong French sociological tradition that is mostly associated with the work of Pierre Bourdieu (1986)(Fine, 2001:53). Putnam (1993:167) defines social capital as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions. It is these very elements that are needed to develop effective WDM strategies and to negotiate and maintain water-sharing regimes in closing river basins. Putnam (1993:172)

notes that reciprocity is a highly productive component of social capital, so the reduction in reciprocal behavior erodes the social fabric. This is the underlying driver of resource capture, which over time delegitimizes the State and other institutions charged with the responsibility of managing the adaptive responses needed (Percival & Homer-Dixon, 1998:281). Again this raises the issue of legitimacy.

Ingenuity in its broadest sense is thus the set of ideas that can be applied to solve practical technical and social problems such as those arising from the depletion of natural resources (Homer-Dixon, 2000:21). So if ingenuity is the key to the solution, what exactly is ingenuity? More importantly, how does it work and can it be stimulated?

Homer-Dixon (2000:21) says that ingenuity includes a wide range of aspects including new ideas - which he calls innovation - but more importantly, also those ideas that are not necessarily novel but are nonetheless very useful. In this regard, ingenuity can be considered as being the sets of instructions that tell humans how to arrange the constituent parts of their social and physical worlds in a way that helps them achieve specific goals. Ingenuity has both a quantitative and a qualitative element to it. In a quantitative sense, the amount of ingenuity needed to continue running a system that has been developed, is not the same as the amount needed to initially create that system in the first place (Homer-Dixon, 2000:22). This is because the nonlinearity associated with both threshold effects and revenge effects, increases the degree of complexity that needs to be managed. In a qualitative sense, the type of ingenuity needed to create new technologies differs from that needed to reform old institutions and social arrangements.

Homer-Dixon (2000:22) has consequently isolated two key forms of ingenuity:

- Technical Ingenuity: helps us solve the problems that arise in the physical world.
 - An example in the water sector would be the construction of hydraulic infrastructure as part of the hydraulic mission to mobilize water on which social and economic development can be sustained.
 - This can be likened to the First-Order Focus shown in Figure 2.
 - It is also evident as one component of the so-called Paradox of Perception noted earlier.

- Social Ingenuity: helps us meet the challenges that humans face in their social world.
 - An example in the water sector is the development of WDM strategies, the negotiation of water-sharing regimes in closing river basins and the reform of water institutions.
 - This can be likened to the Second-Order Focus shown in Figure 2.
 - It is also evident as the other component of the so-called Paradox of Perception noted earlier.

Seen in this light, the Paradox of Perception is actually a manifestation of the dynamic interaction between these two forms of ingenuity. Each element of the paradox

represents to need to mobilize one dominant form of ingenuity, either technical or social, but always in harmony with the other. Thus the First-Order Focus noted in Figure 2 implies Technical Ingenuity dominance, but still with elements of Social Ingenuity being present; whereas the Second-Order Focus implies Social Ingenuity dominance, but still with elements of Technical Ingenuity being present. ***The key concern is getting the correct mix of the two main ingredients at the right moment in historic time. This is the core challenge to WDM policy-making and implementation.***

More significantly, there is a critical link between the two forms of ingenuity. ***Social ingenuity is a critical pre-requisite for the generation of technical ingenuity*** (Homer-Dixon, 2000:22-23). The reason for this is that markets provide the necessary mechanisms and incentives for inventiveness and the creation of new technologies. Politicians bargain for and create coalitions, underpinning them with the necessary incentives to put new institutional arrangements in place. Competent bureaucrats plan and implement public policy, while ordinary people in communities and households build local institutions and change their behavior in order to solve the problems that they face. These forms of social capital are all supplying a continuous source of social ingenuity. One of the outputs of this mobilization of social ingenuity is technical ingenuity. Social ingenuity is thus the independent variable in this equation. Society therefore needs ingenuity in order to develop more ingenuity (Homer-Dixon, 2000:232). This explains the complexity that is inherent in the Paradox of Perception, as well as the reason why the transition from a First-Order Focus to a Second-Order Focus as shown in Figure 2 raises so many vexing issues.

In the development of technological systems, the philosophical basis of modern science is to control nature rather than to understand it. Understanding nature is tolerated insofar as it enables man to ultimately gain control (Turton, 1999a). This is evident in the work of Francis Bacon (1620; Kitchen, 1855:129) and Rene Descartes (1637; Anscombe & Geach, 1954:46). The control of nature aspect is still relevant today within the Natural Sciences, and is particularly manifest in hydraulic engineering, where in essence human ingenuity is applied to alter the naturally-occurring hydrological flow patterns, the result of which both lentic and lotic ecosystems have evolved over millions of years of geological time. Seen in this way, dam building is a profoundly unnatural act, because it seeks to control nature, which is why sometimes "things bite back" (Tenner, 1996) in the form of revenge effects that basically increase the degree of complexity that needs to be managed. This philosophical foundation affects the way that we construct knowledge, which in turn impacts on the way that we interpret information. This has urged social theorists like Giddens (1984: 335) to conclude that there are social barriers to the reception of scientific ideas and provable truths.

Driven by our belief in the control over nature that is inherent in our scientific knowledge and resultant techno-economic optimism, the world has increasingly become human-impacted, with very few natural systems still occurring. One of the results of this is an increase in the level of complexity (Arthur, 1994 in Homer-Dixon, 2000:103) and interdependence between the natural, social and technological systems (Homer-Dixon, 2000:173), which in turn means that a greater chance exists to encounter the unintended

consequences of nonlinearities and threshold effects as environmental scarcity increases. In this regard it has been shown that the ingenuity requirement goes up as environmental problems worsen, because societies need more sophisticated technologies and institutions to reduce pollution and to conserve, replace and share natural resources (Homer-Dixon, 2000:23). ***It is precisely these aspects that are in short supply in the developing world, which is one of the reasons why WDM policies are generally poorly developed and largely ineffective in Southern Africa as shown by Goldblatt et al., (1999:11).***

The supply of ingenuity thus involves both the generation of good ideas, as well as their implementation within society (Homer-Dixon, 2000:23). When examining this in more detail, it was discovered that many of the critical obstacles occur not when the ingenuity is created - there is usually not a shortage of good ideas - but rather when people try to implement these ideas. This is clearly the case with WDM policies, making this aspect highly relevant to this Analytical Paper. In fact, the biggest obstacle is often political competition among powerful groups in society, which stalls or prevents key institutional reform (Homer-Dixon, 2000:23). The supply of social ingenuity is therefore the major bottleneck in society (Homer-Dixon, 1995).

Stated simplistically, it is the inability of developing states to innovate in the face of complex challenges, which causes them to fail (Barbier & Homer-Dixon, 1996). ***It is this very condition that mitigates against the development and implementation of effective WDM strategies, which accounts for the fact that policy guidelines have not been forthcoming, despite the effort that has been made to develop them.*** Central to this observation is the conclusion that developing countries tend to fail because they are unable to generate or use new technological ideas in order to reap greater economic benefits. The crucial factor in this equation is the quality of public institutions, where resource scarcities affect the potential for innovation. Seen in this light, first-order resource scarcities directly affect the adaptive capacity of society, thus increasing second-order social resource scarcity (Ohlsson, 1999:156).

Emerging from this argument, Homer-Dixon (2000:1) notes that there is a concept called the “ingenuity gap” which he sees as being a shortfall between the rapidly rising need for ingenuity, as the result of increasing levels of environmental scarcity, and the inadequate supply of the correct form of ingenuity to solve the resultant problems. This is the main reason why developing countries fail (Barbier & Homer-Dixon, 1996; Homer-Dixon, 1995; 1996). ***It is also why WDM policies are not being readily developed, and where they are developed, are not being effectively implemented and sustained over time.*** It seems therefore that ingenuity cannot easily be created or stimulated, because in essence it is a product of social capital, which in turn can be understood as being the synergistic application of second-order resources in society.

4.5 Ingenuity and Institutional Learning

We have shown that complexity is a naturally occurring phenomenon in all aspects of human life, and is also manifest in the water sector. Institutions, which are broadly defined as “sets of formal and informal rules, including their enforcement arrangements”

(Furubotn & Richter, 1998:6), allow for the development of solutions to the problems arising from this complexity because they “define the incentive structure of societies and specifically economies” (North, 1990:4). Krasner (1983:12) has shown that regimes are needed to manage complexity. In fact, the increase in complexity can become one of the fundamental stimuli for regime creation in the first place. In this regard a regime is simply another form of institution, but with an international dimension to it. In the water sector, regimes refer to water-sharing agreements and their associated rules, procedures and institutional arrangements (Turton, 2002a) and as such have a WDM function as one of their core functional areas, especially in closed river basins where competing demands for water allocations are high. Central to this is the generation of knowledge, which is the sum of technical information and theories about that information which commands consensus at a given time among interested actors (Haas, 1980). So in essence there are five completely distinct, but extremely important, elements to this form of knowledge that needs to be understood:

- Technical information is the foundation of knowledge, but data on its own does not constitute knowledge.
- This technical information must be processed and evaluated before it becomes knowledge, so there must be agreed-upon scientific methodologies at work within the chosen institutional setting.
- Consensus needs to be generated on the validity of the initial data, as well as the methodologies used to evaluate those data, if the resultant output is to become knowledge. Consensus building is a social process with a strong political dimension to it.
- The resultant output of this process must result in changed perceptions about the core problem being confronted by the institution or regime. The so-called Paradox of Perception is consequently of central importance, and can be used as an empirical indicator of change. If there is no change in perceptions about this core problem over time, then the knowledge is probably not legitimate simply because insufficient consensus has been reached on the initial data, the methodology used to evaluate those data, and the final result of this process.
- This new knowledge must become the basis of new policy (such as WDM) that guides the institution or regime in the attainment of the primary goal that arises from the changed perception of the core problem being confronted.

Seen in this light, the difference between information and knowledge is the process of legitimization. Knowledge is institutionalized and is seen to be legitimate, whereas information need not necessarily be so. ***Legitimate knowledge, when captured in an institutional setting, results in more than adaptation - it results in institutional learning as well.*** Adaptation becomes the institutional response to the process of institutionalized

learning, which in turn is the result of social processes of consensus building and legitimization. Yet again the issue of legitimacy becomes relevant.

It should come as no surprise then that institutional development is an incremental process, particularly in contested arenas where suspicion is high. For the same reason, the fact that earlier WDM studies have shown that such policies are “not an intrinsic part of water resource planning and management at the national and regional levels in Southern Africa” (Goldblatt *et al.*, 1999:11) should also come as no shock. Learning is necessary, because adaptations need to be made as regimes are created and institutions are developed. In this regard Ostrom (1990:190) found that the activities of external political regimes were positive factors in helping most of the groundwater producers in southern California to self-organize, but such activities were negative factors in preventing continued self-organization in other cases that she has studied. As a result of this, a theory of self-organization and self-governance of smaller units within larger political systems will need to take the activities of the surrounding political systems into account (Ostrom, 1990:190). ***This means in effect that successful models from a given location cannot necessarily be transplanted into other hydropolitical settings and be expected to work.*** The reason for this is the culture-bound nature of problem definitions, threat perceptions and norms governing cooperative behavior, all of which are intimately linked to the specific historic experiences of the various role-players. ***This is part of the reason why previous WDM studies (Goldblatt et al., 1999) have shown such policies to be unevenly developed and implemented in Southern Africa. This unevenness merely represents the different stages of institutional adaptation within the study area.***

Ostrom (1990:191) has concluded that there are three problems that current theories of collective action fail to take into account. These have major ramifications for WDM analysis such as that conducted by Goldblatt *et al.*, (1999), because they reduce the effectiveness of existing theoretical models for providing the foundation for the policy analysis of institutional change. These three shortfalls in existing theory are as follows:

- The need to reflect the incremental, self-transforming nature of institutional change.
- The importance of the characteristics of external political regimes in an analysis of how internal variables affect levels of collective provision of rules.
- The need to include information and transaction costs.

It seems therefore that while institutions are capable of learning and adapting - to which we can now say with a degree of confidence that this is related to second-order resources - there is in effect little by way of acceptable theory that can guide us in our understanding of how and why institutions succeed (or fail).

4.6 Legitimacy and WDM Policies

Having noted that legitimacy is an important aspect of WDM, it is necessary to dwell for a few moments on this aspect in order to gain a better understanding of the concept. In this regard it has been shown that “because resource allocation is driven by political reasons it entails inefficiencies, but these inefficiencies are regarded as expedient because

this is the price the [government] has to pay for political security and support” (Turton, 2000a:144). Stated simplistically, illegitimate and unpopular governments are willing to tolerate inefficient resource allocation practices because this buys them support. The converse therefore also holds true, and a “legitimate government with broad-based popular support, can in fact introduce water demand management schemes, as the [government] under those conditions is not under constant threat” (Turton, 2000a:144). From this we can deduce that ***popular support for government is a necessary condition for the successful implementation of WDM policies and strategies.***

In his classic study of the evolution of the American Hydraulic Mission, Reisner (1993) mapped out the history and political dynamics of water resource management in that country. What emerges from this case study is the following (Turton, 1999a):

- There are powerful vested interests that become linked with water availability and allocation. So powerful in fact, that Presidents can fall from office as a result.
- Water means livelihood and security in arid regions, so this fact politicises water supply and allocation measures. This can lead to resource capture.
- Supply-sided solutions are favoured, as they are the easiest to apply. This gives birth to what is known as a sanctioned discourse that places supply-sided solutions at the foundation of a water-related paradigm, which can be called the hydraulic mission of that particular society. This is linked with the political ideology of the State.
- Steady supply of water gives rise to increased demand, which in turn feeds a vicious cycle using the rationale of supply-sided solutions. This makes water a somewhat peculiar commodity. The sources of supply consequently become increasingly distant and costly in terms of both finance and environmental impact.
- This gives rise to the birth of a hydraulic social conscience, usually embodied in the form of environmentalism, which causes a change in what has been called the Hydrosocial Contract that exists between the Government and the people being governed (Turton & Meissner, 2002). This challenges the sanctioned discourse, but initially the alternative set of solutions that the environmentalists espouse are ignored.
- Because of a temporary crisis, usually in the form of a serious drought during which supply-sided solutions become incapable of meeting demand, forms of WDM can be considered. Drought therefore opens a window of opportunity that politicians and environmentalists can use to change the prevailing sanctioned discourse. Timing with regard to water sector reform is thus extremely important.
- WDM is introduced, but results in political stress. These political stresses can be so severe that even Presidents can fall from power, as happened with Jimmy Carter (see Carter, 1982:78-80 in Allan, 2000:29). For this reason, ***there is a natural social dynamic at work, which acts as a disincentive to implement long-term WDM***

strategies. Politicians are therefore hesitant to act, which becomes a serious impediment to the implementation of successful WDM policies.

The latter aspect is extremely important as it hints at the existence of different degrees of WDM, each carrying different political risk. It is probably this reason that causes writers such as Kessler (1997) to lament that “the terminology used in the relevant literature is confusing”. We have now shown that this is so because in reality there are many more aspects to demand management than a simple model based on notions of a transition from a supply management mode to a demand management mode as shown in Figure 2.

In order to understand why legitimacy is so important, we need to examine two key concepts in more detail. Figure 8 is a schematic representation of “End-Use Efficiency” and “Allocative Efficiency” at work. The point of departure in understanding the subtleties of each strategy is to accept that in any given political economy, there are essentially three broad sectoral consumers of water, which can be identified as agricultural, industrial and domestic users. These sectoral consumers have two critical components that need to be carefully differentiated. Each sector has a different:

- Water need or requirement in terms of both quality and quantity.
- Financial connotation attached to the way that it uses or converts water into a product. This can be best understood as “sectoral water efficiency” (SWE). This is operationalized by means of a comparison showing the volume of water consumed by that sector as a percentage of the total water consumed in that political economy, expressed as a ratio of the percentage contribution to the overall economy (GDP) of that sector (Turton, 1998: 7). This brings in a type of gearing aspect.

By introducing the element of efficiency into the equation, it now becomes possible to make choices between water allocations in terms of two major criteria regarding the contribution of that specific volume of water to:

- The overall economy in monetary terms.
- The number of jobs that can be created as a result.

Various authors use different sectoral breakdowns in terms of water consumption. Ohlsson (1999:178) notes that agriculture uses 65-70%, industry uses between 20-25% and domestic users account for between 5-10% of the total water used in a given country. There are of course variations. Agriculture consumes 81% (Reisner, 1993:333) of the water in the state of California alone, and 99% in the Sa’dah region of Yemen (Lichtenthaler, 1996). Allan (1998c: 170) notes that agriculture can consume as much as 90% of the national water budget of certain political economies. Figure 8 uses conservative figures for illustrative purposes.

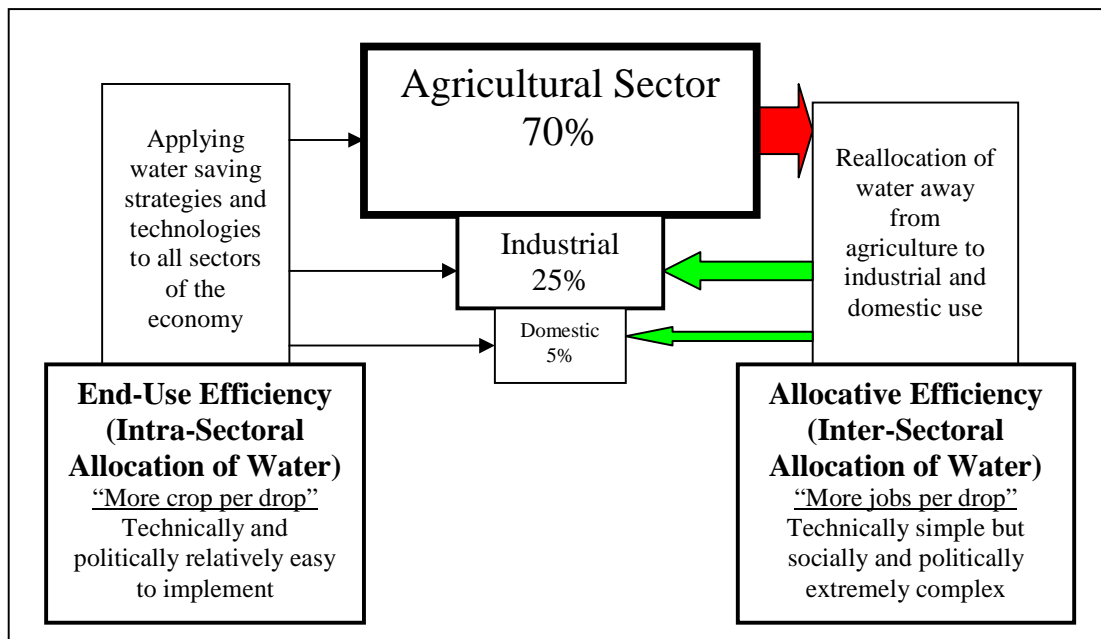


Figure 8: Schematic representation of two different policy instruments typically found in WDM strategies (after Turton, 1999a).

What becomes evident from this diagram is the fact that because each sector has a vastly different consumption pattern, they cannot all be treated as equals when WDM strategies are being planned (Perry *et al.*, 1997:3). For example, if only a 10% saving can be achieved from agriculture alone, this will free up a massive volume of water, which can be allocated to alternative sectoral consumers. Making a similar saving of 10% in the domestic sector will not free up quite the same volume in overall terms. The cost of increasing efficiency versus the resulting actual improvement therefore becomes very relevant. It also becomes evident that there are two distinct policy instruments that can be integrated into WDM strategies.

- **End-Use Efficiency:** (also known as Intra-Sectoral Allocation) aims at developing a series of water saving strategies and technologies, which can be applied to all economic sectors (Allan, 1998d), usually at the level of the production unit or household. Obviously the big target would be agriculture, simply by virtue of the fact that it is the largest consumer, so even a small improvement here would be significant in terms of the overall water budget of a political economy. This is also relatively simple to achieve in both technical and social terms. Technically, it involves aspects such as leak detection, pressure control, retrofitting using low volume devices, alternative irrigation hardware and scheduling etc. Significantly, these technical innovations need not be developed within the country concerned, and are thus not regarded as being a critical component of the technical ingenuity within a given society. If these aspects are not available in society, they can be brought in from outside without too much bother. Socially, this is also true. *The introduction of water-saving devices and technologies are unlikely to cause a disruption beyond the*

level of minor irritation so they do not impact on legitimacy. These negative aspects are mostly offset by the rewards to the consumer in the form of reduced expenditure as evidenced in their monthly water bill.

- Allocative Efficiency: (also known as Inter-Sectoral Allocation) is something quite different however (Allan, 1998d). This aspect of WDM is relatively easy to design in terms of the purely technical aspects of the strategy (in the sense that a technocratic specialist may do this work far removed from the locus of the actual problem). The rationale is quite simple. By taking water away from agriculture, which is a heavy consumer of water and which normally contributes only a small amount to the GDP (low SWE) of a country, significant savings of water can result without a major loss in overall income. This liberated water can then be re-allocated to economic uses with a higher SWE, such as in industry or commerce. This is where the relative ease ends unfortunately. *The social disruptions caused by such re-allocations can be significant and political fallout can be more than most politicians would be prepared to countenance.* This is evidenced by the case of Jimmy Carter as reviewed earlier (Turton, 1999a; Allan, 2000:128). These disruptions are caused by:
 - The shift away from a national policy of food self-sufficiency to one of food security, which may be unpopular if a strong nationalistic element exists within the prevailing political ideology. This induces the State concerned to move into a position of some degree of dependence on foreign suppliers for foodstuffs.
 - The loss of jobs within the agricultural sector, in turn means that new employment opportunities need to be created in other sectors, to absorb this surplus of labour. This implies a strong element of human migration, which in turn places pressure on urban centres in the form of housing demands and service provision.

This is why politicians tend to avoid this option if they can, leading Allan (2000:184) to note that there are distinct forms of rationality, with a sharp contrast between political rationality, economic rationality and environmental rationality. This political avoidance is especially true if the Government concerned is unpopular or facing some form of legitimacy crisis (Turton, 2000a). The rewards for successfully managing this transition from End-Use Efficiency to Allocative Efficiency can be enormous however. Allan (1999) notes that allocatively effective water using activities can provide 10 000 times the returns to water of agriculture. An improvement in the order of four levels of magnitude is extremely attractive for water-scarce states. By using this strategy, more jobs are created, hence the label “more jobs per drop”. The economic efficiency is improved to such an extent that products requiring a large amount of water to produce, such as cereals, can be imported. Since it takes 1 000 tonnes of water to produce 1 tonne of wheat, and 16 000 tonnes of water to produce 1 tonne of beef (Allan, 1999), it becomes feasible to import these from the global market (Turton *et al.*, 2000a). By importing such products, it is effectively like importing the volume of water that is needed to produce them in the first place. *This “virtual water” is significant to water-scarce political economies for three main reasons, all of which serve the valuable purpose of not undermining the legitimacy of Government.*

- It provides a politically silent way of balancing the water budget. In other words, it de-emphasises the problem of a first-order water-scarcity.
- It is more efficient to import the water-rich product than to build an engineering solution to import the water and produce the product. In other words it is more sustainable financially and ecologically.
- It reduces the social tensions that would otherwise be caused by the need for the major structural adjustment that a transition to the final Adaptive Phase (Figures 5 & 7) of water management entails.

The sensible choice of WDM strategies would therefore be to initially launch End-Use Efficiency (Intra-Sectoral Allocation of water) projects, and then to gradually phase in the Allocative Efficiency (Inter-Sectoral Allocation of water) strategies at a rate that is socially and politically acceptable. Both strategies have a role to play and each require a specific set of social pre-conditions. Significantly, the former can buy time in order that the complexities arising from the application of the latter can be resolved through effective institutional development. This again strengthens the argument that Second-Order Resources are the determining factor in the long-term. ***Intra-Sectoral Allocation does not impact on legitimacy as much as Inter-Sectoral Allocation does.***

In order to illustrate the relevance of legitimacy, and in keeping with the concepts used in the rest of this Analytical Paper, we can now turn our attention to integrating this aspect into our emerging model. We have shown that there are two components to the transition in water resource management, and we called these a First and Second-Order Focus. Both impact on institutions, but with the Second-Order Focus being primarily about the reform and further development of those institutions in a way that can cater for the increased level of complexity that needs to be managed. Onto this model we have now shown that legitimacy is a key factor, which can impact on the development and implementation of WDM strategies. This enables us to now examine some of the aspects within an institution that has primarily a Second-Order Focus in more detail.

If we envisage an institution as a building of sorts, then we can see a number of distinct components to that building. Such a model has been presented in Figure 9, using a foundation, two pillars, a lintel and an apex. The foundation we can likened to the stock of Second-Order Resources available in society. If there are sufficient resources of this nature, then the foundation will be strong and the building will be steady. The left-hand pillar we can then call the Structural Component, which contains a number of distinct elements. These elements include institutional capacity and intellectual capital, which when combined generates an output. This output is about the way that the core problem is identified, and consequently about the generation of a set of coping strategies such as WDM policies. The right-hand pillar is the Social Component. This pillar looks deceptively simple, but in reality is extremely complex because it cannot be engineered and as such it remains unpredictable. The key element of this component is the willingness and ability of the people concerned to accept the output of the Structural Component as being fair and reasonable. One cannot force people to regard government policy as being fair and reasonable – and consequently legitimate – because this lies in

the hearts and minds of the broad population that are affected by those policies. There is consequently a dynamic interaction between the two pillars. This dynamic interaction can be loosely described as being the support or opposition to those policies, and consequently lie at the very heart of legitimacy.

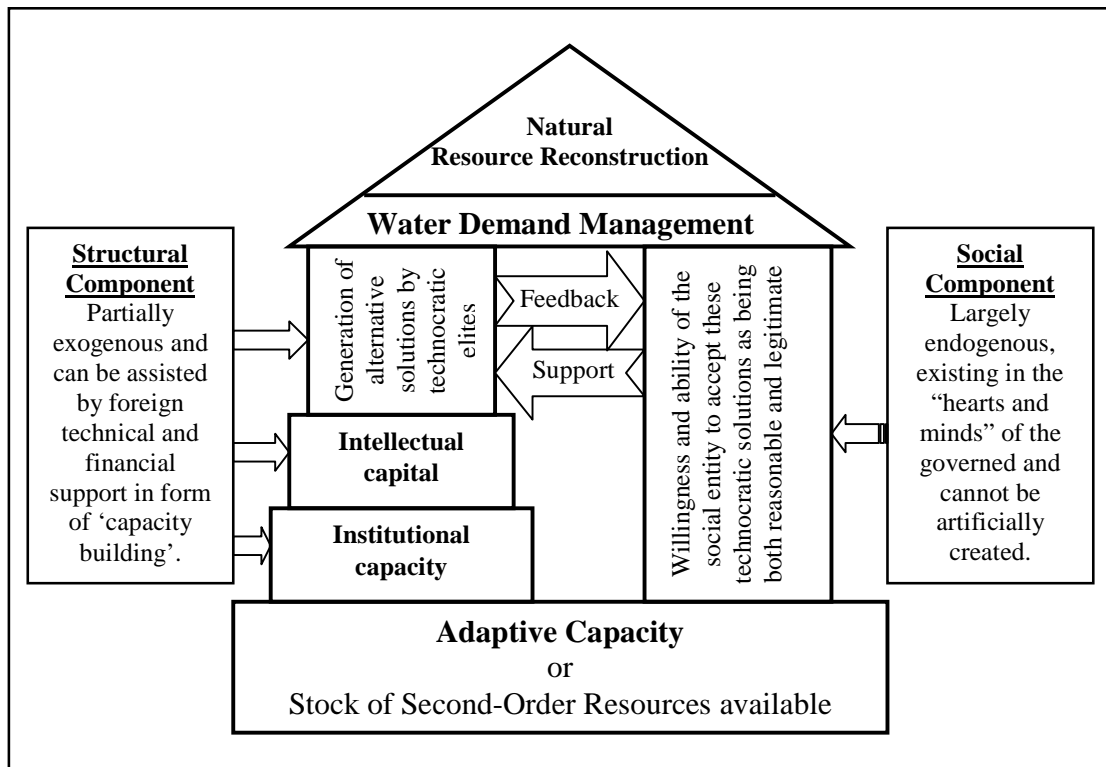


Figure 9. Model linking Natural Resource Reconstruction via Water Demand Management to the Second-Order Resource base of a given social entity.

If WDM policies are effective, then they will lead to sustainable use of water resources in the country, resulting ultimately in the reconstruction or rehabilitation of the natural resource-base. In concluding this discussion *it is important to note that the issue of legitimacy becomes increasingly important as the transition from End-Use Efficiency (Intra-Sectoral Allocation of water) to Allocative Efficiency (Inter-Sectoral Allocation of water) occurs*. It is for this reason that the aspect of legitimacy must always be kept in mind when developing WDM policies as political stability can be negatively impacted. This is one of the unknown unknowns that arise from the propensity towards complexity that has been discussed earlier, which is not found in the existing literature on WDM.

4.7 Indices of Second-Order Resource Availability

We have shown how important Second-Order Resources are in the context of WDM, but this raises a new question. How can we link ingenuity to the management of water

resources in a closing river basin? More importantly, what indicators can we use to measure the existence (or absence) of Second-Order Resources in society?

Central to this is the role of institutions, which specify the range of socially permissible, required or recommended actions in any given situation (Homer-Dixon, 2000:283). Institutions also generate and make available key information about the actions of others (i.e. institutions reduce uncertainty, which is a key function of water-sharing regimes in closing river basins if the zero-sum result of securitization is to be avoided)(Turton, 2002a:203). President Jefferson realized two hundred years ago, that the complexity of our institutions must rise with the complexity of the human interactions that they are intended to manage, and the tasks that they are expected to perform (Homer-Dixon, 2000:283). This takes us back to the adaptation that is assumed in the models that have been developed by Molden *et al.*, (2001) and Turton & Ohlsson (1999) (Figures 5 & 7).

It has been shown that second-order resources are the key determining factors of basin closure (Turton, 1999a; Turton & Ohlsson, 1999; Turton & Warner, 2001; Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Allan, 2000:323), yet there is nothing available in the literature to take us beyond this point. In reality, we still do not know what indicators can be used to measure the existence of second-order resources in society. In an attempt to overcome this problem, Allan (2000:322-325) has taken the initial conceptual development that was done by Turton (1999a), Turton & Ohlsson (1999), and Ohlsson & Turton (1999), and concretized this into an indicator of second-order resources. Using GNP per capita adjusted to purchasing power parity, Allan (2000:324) has produced a matrix for the MENA countries. This matrix shows on the vertical axis, the level of water security in each country, measured as the volume of freshwater available per capita per year. On the horizontal axis the degree of adaptive security is measured, using the World Bank data on GNP per capita per year. This shows a good split of countries between possible combinations of water-rich but adaptive societies; water-rich and non-adaptive societies; water poor and non-adaptive societies; and oil rich and adaptive societies. The selection of GNP as an indicator was taken to embrace the capacity of society to mobilize resources for the development of institutions and consequently to generate a range of adaptive coping strategies. Alcamo (2000:164) supports the use of such data as an indicator of “state susceptibility”. In this regard, this highly aggregated data is valuable because it exists over long time sequences, and it can be linked to the state capacity to respond to crisis. In similar vein, Homer-Dixon (2000:101) has shown that adaptation is unlikely to occur in poor countries, so a measure of relative wealth, particularly if this can be used in a comparative fashion, is a valid albeit crude indicator. From the application of this methodology, *Allan (2000:325) has concluded that it is the social and political process that in turn enables water policy reform, and not vice-versa.*

Taking this further by incorporating the concepts that have been presented earlier, Turton & Warner (2001) have developed a similar matrix using the following concepts, for an analysis of various countries that are found in Southern and East Africa. The Southern African component is presented in Figure 10.

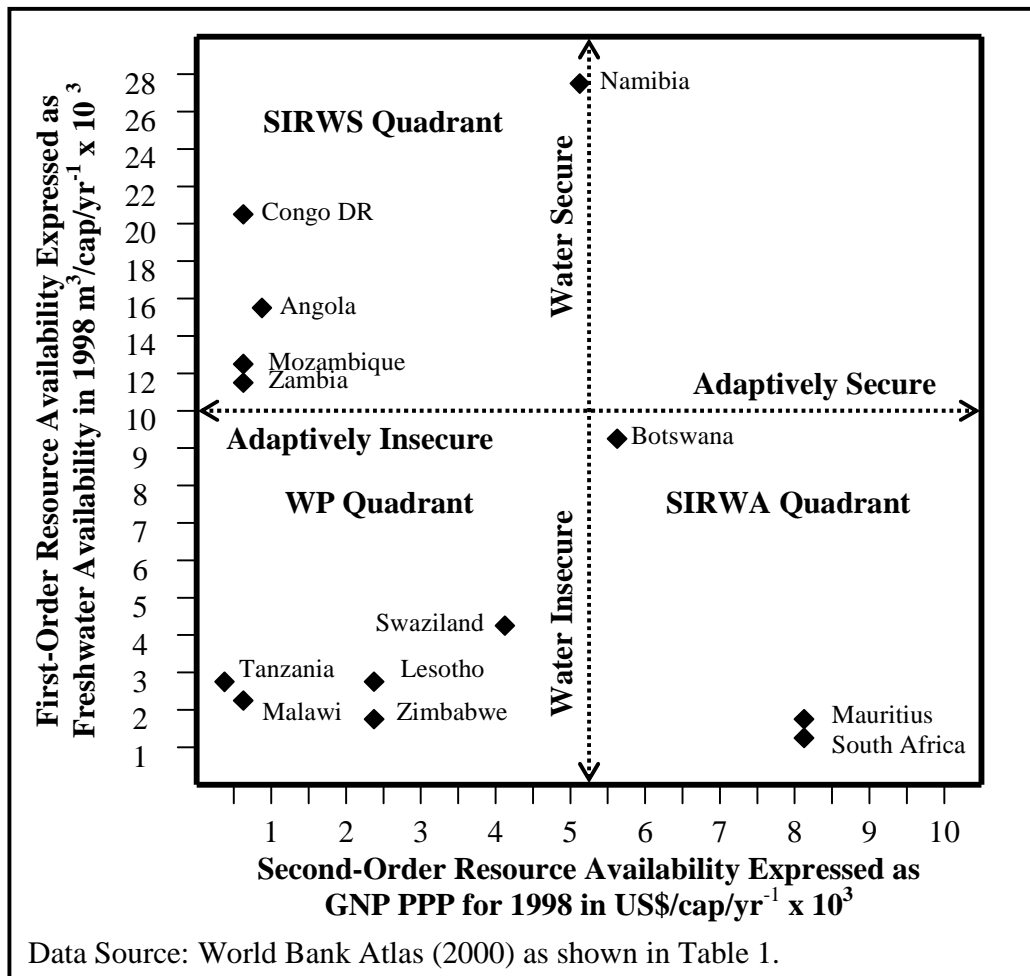


Figure 10. Matrix showing the relationship of both First and Second-Order Resources in Southern Africa (Turton & Warner, 2001; Turton 2002a:199).

This shows the following:

- Structurally-Induced Relative Water Abundance (SIRWA). (Refer to Paragraph 3.3 for a definition of this term).
 - This includes Botswana, Mauritius and South Africa, which mostly have first-order type of water resource problems (i.e. problems primarily related to the availability of water rather than the development of institutions).
 - Stated differently, the Second-Order Focus noted in Figure 2 is generally being taken care of in this category of country.
 - Significantly, WDM policies are being developed and implemented in these countries. This can be interpreted as being a manifestation of the successful mobilization of second-order resources in this group of countries.

- Structurally-Induced Relative Water Scarcity (SIRWS). (Refer to Paragraph 3.3 for a definition of this term).
 - This includes Angola, the Democratic Republic of Congo (DRC), Namibia, Mozambique and Zambia, which mostly have second-order type of water resource problems (i.e. problems related to the development of institutions and infrastructure with which to mobilize and distribute water as a basis for economic growth and social development).
 - It must be noted that Namibia falls into this category because of its small population base and relatively high level of wealth. This set of indicators fails to take into consideration the spatial distribution of water, which in Namibia is a serious problem.
 - Significantly, with the exception of Namibia, formal WDM policies are generally not being developed in these countries.
 - Stated differently, the First-Order Focus noted in Figure 2 is the primary area of concern for this category of country.

- Water Poverty (WP). (Refer to Paragraph 3.3 for a definition of this term).
 - This includes Lesotho, Malawi, Swaziland and Tanzania, which have a complex set of problems relating to both first and second-order resource scarcities (i.e. they have insufficient water for sustained economic growth and development, and they also have limited institutional capacity with which to resolve these problems).
 - Significantly, WDM policies are not strongly developed in this category of country.
 - Stated differently, this category of country embodies a complex set of developmental problems caused by the convergence of both first and second-order resource scarcities simultaneously.

From this matrix (Figure 10) it can be shown that the four hypotheses that have been presented in Paragraph 3.3 are valid (Turton & Warner, 2001). Other indicators are also under development (Turton, 2002a:45-46), but it is not necessary within the context of this Analytical Paper to go into more detail about them. For more details the reader is referred to the longer version of this Analytical Paper.

5. Discussion

From this analysis, *it becomes evident that there is no single set of policy guidelines that will be universally valid for the entire Southern African situation*. The reason for this is that policy initiatives are specific to a given social, cultural, economic and political setting. This explains why despite the best of intentions, and with the valuable material support from NGOs such as the IUCN, no set of guidelines has been developed. It also shows the approach that has been outlined in the document entitled “An Analytical Paper to Support the Development of WDM Guidelines for the Southern African Region” to be flawed, largely because it is based on the key assumption that the South African and

Namibian experiences with respect to WDM can be replicated elsewhere in the region. This is unlikely to succeed for the host of reasons that have been presented in this Analytical Paper. This does not mean to say that the effort is futile however. Quite the contrary is true. The current IUCN initiative is valuable because it has allowed these complex issues to be analyzed, and in particular, it has allowed for the sharing of the ideas presented in this Analytical Paper to be critically discussed among water professionals from the entire Southern African Region.

So, if the intention of generating one coherent set of policy guidelines is likely to fail, what can we do to overcome this natural hurdle?

The analysis of the various concepts, theories and models that have been presented above suggest that there are seven strategic issue-areas in which a concerted effort should be made. It is the contention of the author, that by focusing on these key issue-areas, the whole *problematique* of WDM as a concept and a policy can be developed and effectively implemented in Southern Africa. These seven strategic issue-areas are as follows:

- Strategic Issue-Area No. 1: Accept that Diversity is the Norm. As the result of our deepening understanding of the conceptual difference between first and second-order resources, we can now explain why each country is different and somewhat unique. This is the fundamental reason why policy options that work in one setting, are likely to fail in another. Each country, river basin or catchment area has a different mixture of first and second-order resources at their disposal. This fact should be recognized and accepted as the primary point of departure in any future attempts to develop regional guidelines.
- Strategic Issue-Area No. 2: Focus on Institutional Development. It has been shown that the key problem in Southern Africa is the general failure to effectively develop institutions. This does not mean that there are no institutions, but rather that institutions are generally under pressure. The cause of this is the rising level of complexity that needs to be managed, and in particular the complexity arising from the need to manage demand. This needs a fundamental change to the so-called Paradigm of Perception that forms the very foundation of institutions as they currently exist. We have seen that each country has a different institutional challenge. Those countries that can be categorized as SIRWS have primarily a First-Order Focus, whereas those countries that can be categorized as SIRWA have primarily a Second-Order Focus. Each of these has a fundamentally different logic, rationale and philosophy to it. Those countries that have been categorized as WP have a more complex mix of problems. It is this category that will benefit the most from the involvement of external role-players.
- Strategic Issue-Area No. 3: Focus on Data Generation, Flow and Management. It has been shown that complexity is a natural outcome of management interventions, particularly with respect to ecosystems. This complexity needs to be modeled if it is to be understood. Central to this is the need for data, which needs to be generated. This is particularly true for WDM, where critical data such as water balances, water loss,

payment levels, cost-benefit analyses of alternative options and suchlike are of crucial importance. That data then needs to be managed in some way in order to be processed on time, accurately and then provided to the relevant decision-maker in a format that can be understood. It is generally known that data management is a weakness in most developing countries, and Southern Africa is no exception.

- Strategic Issue-Area No. 4: Focus on the Broader Socio-Economic Setting. It has been shown that policy decisions do not take place in a vacuum. Similarly, it has been shown that complexity results in feedback loops, some positive and some negative. There is consequently an intimate linkage between the policy-making environment and the broader socio-economic setting in which it is embedded. WDM needs both policy generation and sanction for non-compliance if it is to succeed. This is unlikely to occur in a setting where socio-economic development does not allow for the generation of sufficient income streams with which to support institutions, let alone to allow them to adapt to changing needs. The linkage between poverty and second-order resource scarcity is a fundamental one that needs to be taken cognizance of if WDM policies are to be effective.
- Strategic Issue-Area No. 5: Focus on Political Will. Because water brings privilege, its allocation in society will always be politicized. As one commentator has noted, “water flows [uphill] towards power and money” (Reisner, 1993: 296). Politicians seek power and generally have a short-term focus (about getting elected), whereas water resource managers generally have a long-term focus. The political environment constrains the water resource management environment however, so there is a distinct difference between what should be done to manage resources sustainably, and what can be done to manage those resources sustainably (Allan, 2000:184). One therefore needs to get political buy-in before WDM policies can become viable. As long as politicians try to seek re-election by offering free water to potential voters, WDM policies will continue to be undermined.
- Strategic Issue-Area No. 6: Focus on Windows of Opportunity. A well-documented factor in hydropolitics is what some have called “emblematic events” (Hajer, 1996) and others have called “windows of opportunity” (Kingdon, 1984; Allan, 2000:190). While this has not been discussed in detail in this Analytical Paper, its relevance is that it provides an opportunity for intense public debate on a given issue, and in general it provides for a narrowing of opinion on a given issue. Windows of opportunity allow for changes to be made in water policy. This is one of the reasons why water policy reform is never uniform, and generally appears as a series of incremental adjustments and adaptations rather than sweeping once-off initiatives. Every effort should be made to concentrate efforts to reform policy at times that coincide with emblematic events. One such opportunity is the forthcoming Johannesburg Summit (World Summit on Sustainable Development) during which issues of sustainability will be examined in great detail.
- Strategic Issue-Area No. 7: Focus on Incremental Applications of WDM. It has been shown that institutions are capable of learning, and that this learning results in a

redefinition of the core problem being managed (the so-called Paradox of Perception). This incrementalism is entirely natural and is in fact a healthy manifestation as it allows for corrections to be made before the results become catastrophic. For this reason any initiative designed to stimulate best practices and therefore to develop a set of WDM guidelines, should harmonize itself with this natural incrementality rather than seek to make one major effort. In this regard cognizance can be taken of the different factors raised in the other six strategic issue-areas, particularly with respect to the differing combinations of first and second-order resource availabilities within given countries. This will stimulate the development of sustainable WDM policies, and then encourage the cascading and adaptation of these policies to other countries and social settings.

6. Conclusion

It has been shown that a central component of the *problematique* of WDM as a concept and a policy is what has been called the Paradox of Perception. This in turn is linked to the changing water management paradigm, which is shifting in response to external stimuli that are too strong for any one country to resist, from a highly centralized water supply perspective, to a decentralized demand management perspective based on the principle of subsidiarity. Underlying this transition as a basic driver is the notion of reflexivity. This shift is incremental, which is a healthy condition, as institutions need time to adapt. An important element of this adaptive response is what has been called Second-Order Resources, where it has been shown that such resources are an independent variable in the majority of cases. A set of hypotheses has been generated in order to test this notion out, and currently available evidence supports this conclusion. A central problem is the relative crudeness of our measuring instruments, caused in part by the fact that the concepts relating to Second-Order Resources are under-developed at present. It is hoped that as these are refined, our scientific knowledge about institutional development will increase exponentially.

It has also been shown that as a result of the dynamics of complexity, the management of water resources actually consists of a series of oscillations between First and Second-Order Resource focal points, which has been likened to the turning of a screw. The important aspect to note however is the fact that complexity increases over time, and that WDM represents yet another layer of management that is superimposed onto an already overburdened set of water management institutions. While the need to manage demand is a manifestation of increased complexity, a new set of complexities are introduced as well, some of which have unintended consequences. Emerging from this is the notion of different phases of water resource management, with three generic phases having been identified (the Supply, Demand and Adaptive Phases); each with a fundamentally different focal point; each representing an increasing level of complexity; and each containing a progressively greater degree of political risk, thereby introducing the importance of legitimacy into the overall management equation.

In conclusion a set of seven strategic issue-areas have been isolated. It is hoped that third-party role-players such as the IUCN and others can use this emerging knowledge in order

to select projects where their impact can be maximized. In this regard the role of such third-party role-players is invaluable because they bring with them a degree of impartiality that increases the chances of success, along with their ability to mobilize the necessary intellectual capital, which improves the prognosis. Such efforts are to be encouraged indeed!

7. Acknowledgements

The author wishes to acknowledge the following persons and organizations whose support has been invaluable in developing this Analytical Paper.

- The IUCN is gratefully acknowledged for their support. Without this it would not have been possible to present the findings of what has been a concerted but diverse research effort, covering a few continents and a number of years. In particular Ruth Beukman is thanked for her professional management of the project, along with her enthusiastic support whenever needed. The valuable support by Tertia Uitenweerde is also acknowledged with deep appreciation. The input and support by the IUCN WDM Core Team is also appreciated and acknowledged.
- The information that has been summarized in this Analytical Paper is largely part of a Doctoral Thesis (Turton, 2002a) that is being completed at Pretoria University, but with the unselfish support of Prof. Tony Allan at the Water Issues Study Group (WISG) in the School of Oriental and African Studies (SOAS), at the University of London. In this regard some of the material presented in this Analytical Paper is a replication of parts of that thesis, a lot of which was researched while at the WISG in London. Both Pretoria University and SOAS are thanked for their support, which has enabled this research work to be disseminated to a wider audience.
- The Water Research Fund for Southern Africa (WARFSA) is also acknowledged. Through their generous funding some of the key elements of this larger research project have been tested in various Southern African settings (Turton, 1999b; Turton *et al.*, 2000b; Turton *et al.*, 2001; Mucheleng'anga, 2001; Musonda, 2001). This has improved the epistemological basis of the concepts under development.
- The Woodrow Wilson Institute (WWI) in Washington is thanked for their generous support that enabled some of the core concepts to be refined and tested in Southern and East Africa. They also provided the opportunity to share aspects of this research with a wider international audience.
- Finally, Prof. Tony Allan (SOAS), Dr. Frank van Steenberg (Euroconsult) and Dr. Allan Nicol (Overseas Development Institute) are all thanked for reviewing the First Draft.

While these institutions and people are thanked for their support, the author alone accepts responsibility for the contents of this Analytical Paper.

8. Bibliography

Alcamo, J. 2000. The GLASS Model: Assessing Environmental Threats to Food and Water Security in Russia. In *Environmental Change and Security Project Report*, The Woodrow Wilson Centre. Issue 6 (Summer 2000); 164-165.

Allan, J.A. 1992. Substitutes for Water are Being Found in the Middle East and North Africa, in *GeoJournal*, Vol. 28, No. 3: 375-385.

Allan, J.A. 1994(a). Economic and Political Adjustments to Scarce Water in the Middle East, in *Water and Peace in the Middle East. Studies in Environmental Science*, No. 58; 375-387.

Allan, J.A. 1994(b). Overall Perspectives in Countries and Regions, in **Rogers, P. & Lydon, P.** (Eds.). 1994. *Water in the Arab World: Perspectives and Progress*. Harvard University Press: Cambridge.

Allan, J.A. 1996(a). The Political Economy of Water: Reasons for Optimism but Long Term Caution, in **Allan, J.A. & Court, J.H.** (Eds.) 1996. *Water, Peace and the Middle East: Negotiating Resources in the Jordan Basin*. I.B. Taurus Publishers: London.

Allan, J.A. 1996(b). Policy Responses to the Closure of Water Resources: Regional and Global Issues. In **Howsam, P. & Carter, R.C.** (Eds.) *Water Policy: Allocation and Management in Practice*. Proceedings of International Conference on Water Policy, Cranfield University, 23-24 September 1996. London: E & FN Spon.

Allan, J.A. 1997. 'Virtual Water': A Long Term Solution for Water Short Middle Eastern Economies. British Association Festival of Science. University of Leeds. 9 September 1997.

Allan, J.A. 1998(a). 'Virtual Water': An Essential Element in Stabilizing the Political Economies of the Middle East. *Yale University Forestry & Environmental Studies Bulletin*, No. 103; 141-149.

Allan, J.A. 1998(b). Virtual Water: A Strategic Resource. Global Solutions to Regional Deficits. In *Ground Water*, Vol. 36, No. 4 ;545-546.

Allan, J.A. 1998(c). Why Value Water? Some Perspectives on the Political Economy of Water and the Environment in the Mediterranean Region. In **Ferrangina, E.** (Ed.) *L'Acqua Nei Paesi Mediterranei*. Atti del Convegno Internazionale, Istituto Motori del CNR, 4-5 December 1997, Naples.

Allan, J.A. 1998(d). Productive Efficiency and Allocative Efficiency: Why Better Water Management may not Solve the Problem. In *Agricultural Water Management*, No. 1425; 1-5. Elsevier Sciences.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Allan, J.A. 1999(a). Global Systems Ameliorate Local Droughts: Water, Food and Trade. Paper presented at the Exploratory Workshop on Drought and Drought Mitigation in Europe, 1-3 March 1999, Space Applications Institute, European Commission, DG Joint Research Centre. Also available as *MEWREW Occasional Paper No. 10* from Website <http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html>

Allan, J.A. 1999(b). Now you See it, Now you Don't. A Convenient Solution, in *The UNESCO Courier*; 29-32. February 1999.

Allan, J.A. 1999(c). *Water in International Systems: A Risk Society Analysis of Regional Problemsheds and Global Hydrologies*. Paper presented at the Conference "Sustainability, Risk and Nature: The Political-Ecology of Water in Advanced Societies", Oxford University, 15-17 April 1999.

Allan, J.A. 1999(d). Avoiding War over Natural Resources. In **Fleming, S.** (Ed.) *War and Water*. Geneva: ICRC Publication Division (<http://www.irc.org>).

Allan, J.A. 2000. *The Middle East Water Question: Hydropolitics and the Global Economy*. London: IB Tauris.

Anscombe, E. & Geach, P. (Eds.) 1954 *Descartes: Philosophical Writings*. Edinburgh: Nelson & Sons.

Arthur, W.B. 1994. On the Evolution of Complexity, in **Cowan, G., Pines, D. & Meltzer, D.** (Eds.) *Complexity: Metaphors, Models and Reality*. Reading, Ma: Santa Fe Institute Studies in the Sciences of Complexity.

Ashton, P. 2001. Personal communication with the author.

Ashton, P. & Haasbroek, B. 2002. Water Demand Management and Social Adaptive Capacity: A South African Case Study. In **Turton, A.R. & Henwood, R.** (Eds.) 2002. *Hydropolitics in the Developing World: A Southern African Perspective*. Pretoria: AWIRU.

Bacon, F. 1620. The Novum Organon. In **Kitchen, G.W.** (Ed.) 1855. *The Novum Organon*. Oxford: Oxford University Press.

Barbier, E. & Homer-Dixon, T.F. 1996. *Resource Scarcity, Institutional Adaptation, and Technical Innovation: Can Poor Countries Attain Endogenous Growth?* Washington: American Association for the Advancement of Science.

Beck, U. 1992. From industrial to risk society, in *Theory, Culture and Society*, Vol. 9; 97-123.

Beck, U. 1995. *Ecological Politics in an age of risk*. Cambridge: Polity Press.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Beck, U. 1996(a). The sociology of risk, in **Goldblatt, D.** (Ed.) *Social Theory and the Environment*. Cambridge: Polity Press.

Beck, U. 1996(b). *The reinvention of politics*. Cambridge. Polity Press.

Beck, U. 1999. What is a 'risk society'? In *Prometheus*, Vol. 1, No. 1; 75-79.

Bourdieu, P. 1986. *Distinction: A Social Critique of the Judgement of Taste*. London: Routledge.

Breznev, I. 1978. *The Virgin Lands*. Moscow: Progress Publishers.

Bulloch, J. & Darwish, A. (Eds.) 1993. *Water Wars. Coming Conflicts in the Middle East*. London: Victor Gollancz

Carter, J. 1982. *Keeping Faith: Memories of a President*. New York: Bantam Books.

Chenje, M. & Johnson, P. (Eds.) 1996. *Water in Southern Africa*. Harare: Southern African Research and Documentation Centre (SARDC), IUCN and SADC.

Christie, F. & Hanlon, J. 2001. *Mozambique and the Great Flood of 2000*. Oxford: James Currey.

Cowell, A. 1990. Now a Stream: Later, maybe, a water war? In *New York Times*, 7 February 1990.

Davies, B.R., O'Keefe, J.H. & Snaddon, C.D. 1993. *A Synthesis of the Ecological Functioning, Conservation and Management of South African River Ecosystems*. Water Research Commission Report No. TT 62/93.

Davies, B.R. & Day, J. 1998. *Vanishing Waters*. Cape Town: University of Cape Town Press.

Descartes, R. 1637. Discourse on Methods. In **Anscombe, E. & Geach, P.** (Eds.) 1954 *Descartes: Philosophical Writings*. Edinburgh: Nelson & Sons.

de Villiers, M. 1999. *Water Wars: Is the World's Water Running Out?* London: Weidenfeld & Nicolson.

Eckersley, R. 1997. *Environmentalism and Political Theory*. London: UCL Press.

Falkenmark, M. 1984. New Ecological Approach to Water Cycle: Ticket to the Future, in *Ambio*, Vol. 13, No. 3; 152-160.

Falkenmark, M. 1986. Fresh Water: Time for a Modified Approach, in *Ambio*, Vol. 14, No. 4; 194-200.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Falkenmark, M. 1989(a). Middle East Hydropolitics: Water Scarcity and Conflicts in the Middle East, in *Ambio*, Vol. 18, No. 6; 350-352.

Falkenmark, M. 1989(b). The Massive Water Scarcity now Threatening Africa: Why isn't it Being Addressed? In *Ambio*, Vol. 18, No 2; 112-118.

Falkenmark, M. 1990. Global Water Issues Facing Humanity, in *Journal of Peace Research*, Vol. 27, No. 2; 177-190.

Falkenmark, M. 1994. The Dangerous Spiral: Near-future Risks for Water Related Eco-conflicts, in **ICRC**. 1994. *Water and War. Symposium on Water in Armed Conflicts*. Montreux, 21-23 November 1994. Geneva: International Committee of the Red Cross.

Falkenmark, M., Lundqvist, J. & Widstrand, C. 1990. *Water Scarcity - an Ultimate Constraint in Third World Development*. Tema V, Report 14: Department of Water and Environment Studies, University of Linköping, Sweden.

FAO. 2000. *The Food and Agricultural Organization of the United Nations. Population: Annual Time Series*. Available from the Website <http://apps.fao.org/page/collections?subset=agriculture>

Fine, B. 2001. *Social Capital versus Social Theory*. London: Routledge.

Furubotn, E.G. & Richter, R. 1998. *Institutions and Economic Theory: The Contribution of the New Institutional Economics*. Lansing: University of Michigan Press.

Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge: Polity Press.

Giddens, A. 1990. *The Consequences of Modernity*. Cambridge: Polity Press.

Gleick, P. 1994. Water Wars and Peace in the Middle East. In *Policy Analysis*, Vol. 36, No. 4.

Gleick, P.H. 1998. *The World's Water 1998 - 1999: The Biennial Report on Freshwater Resources*. Washington, DC: Island Press.

Goldblatt, D. (Ed.) 1996. *Social Theory and the Environment*. Cambridge: Polity Press.

Goldblatt, M., Ndamba, J., van der Merwe, B., Gomes, F., Haasbroek, B. and Arntzen, J. 1999. *Water Demand Management: Towards Developing Effective Strategies for Southern Africa: Phase I*. Pretoria: The World Conservation Union (IUCN) – South Africa.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Haas, E. 1980. Why Collaborate? Issue-Linkage and International Relations. In *World Politics*, Vol. 32, No. 3; 367-68.

Haas, E. 1983. Words can hurt you; or, who said what to whom about regimes. In **Krasner, S.D.** (Ed.) *International Regimes*. Ithaca: Cornell University Press.

Hajer, M. 1996. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxford: Clarendon Press.

Hanifan, L. 1916. The Rural School Community Centre, in *Annals of the American Academy of Political and Social Science*, Vol. 67; 130-138.

Homer-Dixon, T.F. 1991. On the Threshold: Environmental Changes as Causes of Acute Conflict, in *International Security*, Vol. 16, No. 2, Fall; 76-116.

Homer-Dixon, T.F. 1994. Environmental Scarcities and Violent Conflict: Evidence from Cases, in *International Security*, Vol. 19, No. 1; 5-40.

Homer-Dixon, T.F. 1995. The Ingenuity Gap: Can Poor Countries Adapt to Resource Scarcity? In *Population and Development*, Vol. 21, No. 3; 587-612.

Homer-Dixon, T.F. 1996. Environmental Scarcity, Mass Violence and the Limits to Ingenuity, in *Current History*. No. 95; 359-365.

Homer-Dixon, T.F. 1999. The Myth of Global Water Wars. In **Fleming, S.** (Ed.) *War and Water*. Geneva: ICRC Publication Division (<http://www.irc.org>).

Homer-Dixon, T.F. 2000. *The Ingenuity Gap*. London: Jonathan Cape.

ICWE. 1992. *The Dublin Statement on Water and Sustainable Development*. International Conference on Water and Environment, Dublin, Ireland.

Jägerskog, A. 2002. *The Sanctioned Discourse – a Crucial Factor for Understanding Water Policy in the Jordan River Basin*. Department of Water and Environmental Studies, Linköping University, Sweden. (Available in digital form from the author at andja@tema.liu.se).

Kessler, P. 1997. Economic Instruments in Water Management, in **Kay, M., Franks, T. & Smith, L.** (Eds.) *Water: Economics, Management and Demand*. London: E & FN Spon.

Kingdon, J. 1984. *Agendas, Alternatives and Public Policies*. New York: Harper-Collins.

Kitchen, G.W. (Ed.) 1855. *The Novum Organon*. Oxford: Oxford University Press.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Krasner, S.D. 1983. Structural Causes and Regime Consequences: Regimes as Intervening Variables. In **Krasner, S.D.** (Ed.) *International Regimes*. Ithaca: Cornell University Press.

Lichtenthäler, G. 1996. *Tribes and Trends: Changing Perceptions of the Value of Water in Yemen*. Proceeding of the European Seminar on Water Geography, 6-10 September, School of Oriental and African Studies (SOAS), University of London.

Lundqvist, J. 1998. Avert Looming Hydrocide, in *Ambio*, Vol. 27, No. 6; 428-433.

Lundqvist, J. & Gleick, P. 1997. *Comprehensive Assessment of the Freshwater Resources of the World: Sustaining our Waters into the 21st Century*. Stockholm: Stockholm Environment Institute.

Lundqvist, J. & Turton, A.R. 2001. Social, Institutional and Regulatory Issues, in *Frontiers in Urban Water Management: Deadlock or Hope?* UNESCO: IWA Publishing.

Molden, D., Sakthivadivel, R. & Samad, M. 2001. Accounting for Changes in Water Use and the Need for Institutional Adaptation. In **Abernethy, C.L.** (Ed.) 2001. *Intersectoral Management of River Basins*. Colombo: International Water Management Institute (IWMI).

Mucheleng'anga, C.G. 2001. Water Demand Management, Natural Resource Reconstruction and Social Adaptive Capacity: A Case Study from Chongwe-Chalimbana Area of Zambia. In the *Proceedings of the WISA 2002 Biennial Conference*, Durban 19-23 May 2002.

Musonda, W. 2001. Research Project on Water Demand Management, Natural Resource Reconstruction and Traditional Value Systems: A Focus on Kalomo District, Republic of Zambia. In the *Proceedings of the WISA 2002 Biennial Conference*, Durban 19-23 May 2002.

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Ohlsson, L. 1998. *Water and Social Resource Scarcity - An Issue Paper Commissioned by FAO/AGLW*. Presented as a discussion paper for the 2nd FAO E-mail Conference on Managing Water Scarcity. WATSCAR 2.

Ohlsson, L. 1999. *Environment, Scarcity and Conflict: A Study of Malthusian Concerns*. Department of Peace and Development Research. University of Göteborg. ISBN 91-87380-43-9

Ohlsson, L. & Turton, A.R. 1999. The Turning of a Screw. Paper presented in the Plenary Session of the 9th Stockholm Water Symposium "Urban Stability through Integrated Water-Related Management", hosted on 9-12 August by the Stockholm Water

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Institute (SIWI) in Stockholm, Sweden. Also available as *MEWREW Occasional Paper No. 19* from Website

<http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html>

Ohlsson, L. & Lundqvist, J. 2000. The Turning of a Screw - Social Adaptation to Water Scarcity, Part 3 of **Falkenmark, et al.**, *New Dimensions in Water Security - A Study Prepared for FAO*, AGLW, Rome.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Ostrom, E. 1994. Constituting Social Capital and Collective Action, in *Journal of Theoretical Politics*. Vol. 6, No. 4; 527-562.

Ostrom, E. 2000. Social Capital: A Fad or a Foundation Concept? In **Dasgupta, P. & Serageldin, I.** (Eds.) *Social Capital: A Multifaceted Perspective*. Washington, D.C.: World Bank.

Pallett, J. (Ed.) 1997. *Sharing Water in Southern Africa*. Desert Research Foundation of Namibia: Windhoek.

Percival, V. & Homer-Dixon, T. 1998. Environmental Scarcity and Violent Conflict: The Case of South Africa, in *Journal of Peace Research*. Vol.35, No. 3; 279-298.

Perry, C.J., Rock, M. & Seckler, D. 1997. Water as an Economic Good: A Solution, or a Problem? In **Kay, M., Franks, T. & Smith, L.** (Eds.) *Water: Economics, Management and Demand*. London: E & FN Spon.

Platt, R. 1999. Presentation given at Oxford University at the 4th Meeting of METRON Project Partners on 7th and 8th June hosted by the Oxford School of Geography.

Postel, S. 1997. *Last Oasis: Facing Water Scarcity*. Washington, DC: Worldwatch Institute. New York: Norton.

Putnam, R.D. 1993. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton, NJ: Princeton University Press.

Reisner, M. 1993. *Cadillac Desert: The American West and its Disappearing Water*. Revised Edition. New York: Penguin.

Seckler, D. 1996. The New Era of Water Resources Management: From "Dry" to "Wet" Water Savings. *IIMI Research Report No. 1*. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

Starr, R. 1991. Water Wars, in *Foreign Policy*, No. 82, Spring; 17-36.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Svendsen, M., Hammond Murray-Rust, D., Harmancioglu, N. & Alpaslan, N. 2001. Governing Closing Basins: The Case of the Gediz River in Turkey. In **Abernethy, C.L.** (Ed.) 2001. *Intersectoral Management of River Basins*. Colombo: International Water Management Institute (IWMI).

Swyngedouw, E. 1999(a). Hybrid Waters: On Water, Nature and Society. In the *Proceedings of the Conference entitled "Sustainability, Risk and Nature: The Political Ecology of Water in Advanced Societies"* that was held at Oxford University on 15-17 April 1999.

Swyngedouw, E. 1999(b). Modernity and Hybridity: The Production of Nature: Water and Modernization in Spain. Paper presented to the Water Issues Study Group, SOAS, University of London, 25 January 1999.

Tenner, E. 1996. *Why Things Bite Back: Technology and the Revenge of Unintended Consequences*. New York: Knopf.

Trottier, J. 1999. *Hydropolitics in the West Bank and Gaza Strip*. Jerusalem: PASSIA Publication.

Turton, A.R. 1998. *The Hydropolitics of Southern Africa: The Case of the Zambezi River Basin as an Area of Potential Co-operation Based on Allan's Concept of 'Virtual Water'*. Unpublished M.A. Dissertation, Department of International Politics, University of South Africa, Pretoria, South Africa.

Turton, A.R. 1999(a). Water Scarcity and Social Adaptive Capacity: Towards an Understanding of the Social Dynamics of Managing Water Scarcity in Developing Countries. *MEWREW Occasional Paper No. 9*, Water Issues Study Group, School of Oriental and African Studies (SOAS), University of London. Also in the *Proceedings of the Conference entitled Sustainability, Risk and Nature: The Political Ecology of Water in Advanced Societies* that was held at Oxford University on 15-17 April 1999. Available from Website
<http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html>

Turton, A.R. 1999(b). 'Water Demand Management' (WDM), 'Natural Resource Reconstruction' and 'Adaptive Capacity': Establishing the Linkage between Variables. Project PJ02/99. Project Proposal for the Water Research Fund for Southern Africa (WARFSA). Pretoria: African Water Issues Research Unit (AWIRU).

Turton, A.R. 2000(a). Precipitation, People, Pipelines and Power: Towards a Political Ecology Discourse of Water in Southern Africa. In **Stott, P. & Sullivan, S.** (Eds.) 2000. *Political Ecology: Science, Myth and Power*. London: Edward Arnold.

Turton, A.R. 2000(b). Water and Sustainable Development: A Southern Perspective. Forthcoming in the *Encyclopaedia of Life Support Systems (EOLSS)*. UNESCO: EOLSS Publishers Ltd. Available in draft from the Website

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

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

Turton, A.R. 2000(c). Water Wars in Southern Africa: Challenging Conventional Wisdom. In **Solomon, H. & Turton, A.R. (Eds.)** *Water Wars: An Enduring Myth or Impending Reality? African Dialogue Monograph Series No. 2.* Durban: Accord Publishers. ISSN 1562-7004.

Turton, A.R. 2000(d). Water Wars: An Enduring Myth or Impending Reality? In **Solomon, H. & Turton, A.R. (Eds.)** *Water Wars: An Enduring Myth or Impending Reality? African Dialogue Monograph Series No. 2.* Durban: Accord Publishers. ISSN 1562-7004.

Turton, A.R. 2000(e). *A Strategic Decision-Makers Guide to Virtual Water.* Paper presented at the Workshop Virtual Water in Southern Africa, held at Maseru 3-4 October 2000. Available from Website <http://www.up.ac.za/academic/libarts/polsci/awiru>

Turton, A.R. 2000(f). Discussion Note for the World Commission on Dams Regarding a Possible Approach to the Management of Dams on International and Inter-Provincial Rivers. In **WCD.** 2000. *Dams and Development: A New Framework for Decision-Making - The Report of the World Commission on Dams.* London: Earthscan. Also available as River Basin Management: Its Role in Major Water Infrastructure Projects. World Commission on Dams Thematic Review: Institutional Processes Version 3.0. Cape Town: Secretariat of the World Commission on Dams.

Turton, A.R. 2000(g). Water Policy in Southern Africa: A Brief Synopsis of some of the Macro Driving Forces, in the *African Journal of Aquatic Science*, Vol. 25; 156-161.

Turton, A.R. 2001. Towards Hydrosolidarity: Moving from Resource Capture to Cooperation and Alliances. In *Stockholm International Water Institute (SIWI) Report No. 13, Proceedings of the SIWI Seminar on Water Security for Cities, Food and Environment – Towards Catchment Hydrosolidarity*, Stockholm, August 18, 2001; 19-26. Stockholm: SIWI.

Turton, A.R. 2002(a). The Political Aspects of Institutional Developments in the Water Sector: South Africa and its International River Basins. Unpublished draft of a D.Phil. Thesis. Department of Political Sciences. University of Pretoria.

Turton, A.R. 2002(b). Hydropolitics: The Concept and its Limitations. In **Turton, A.R. & Henwood, R. (Eds.)** *Hydropolitics in the Developing World: A Southern African Perspective.* Pretoria: African Water Issues Research Unit (AWIRU).

Turton, A.R. & Ohlsson, L. 1999. Water Scarcity and Social Adaptive Capacity: Towards an Understanding of the Social Dynamics of Managing Water Scarcity in Developing Countries. Paper presented in the Workshop No. 4: Water and Social Stability of the 9th Stockholm Water Symposium "Urban Stability through Integrated Water-Related Management", hosted on 9-12 August by the Stockholm International

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

Water Institute (SIWI) in Sweden. Also available as *MEWREW Occasional Paper No. 18* from Website

<http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html>

Turton, A.R. & Meissner, R. 2000. Final Report of the Institutional Support Task Team of the Shared Rivers Initiative on the Incomati River. Available from Website <http://www.up.ac.za/academic/libarts/polsci/awiru>

Turton, A.R., Moodley, S., Goldblatt, M. & Meissner, R. 2000(a). *An Analysis of the Role of Virtual Water in Southern Africa in Meeting Water Scarcity: An Applied Research and Capacity Building Project*. Johannesburg: Group for Environmental Monitoring (GEM) Available in draft from the Website <http://www.up.ac.za/academic/libarts/polsci/awiru>

Turton, A.R., Khupe, J.S.N. & Mucheleng'anga, C. 2000(b). Research Project on Water Demand Management, Natural Resource Reconstruction and Traditional Value Systems: What are we Learning so Far? In the *Proceedings of the WARFSA/WaterNet Symposium* that was held in Maputo on 1-2 November 2000. Available from Website <http://www.up.ac.za/academic/libarts/polsci/awiru>

Turton, A.R. & Warner, J.F. 2001. Exploring the Population / Water Resources Nexus in the Developing World. In *Environmental Change and Security Project Report*, The Woodrow Wilson Centre. Issue 7 (Summer 2001); 129-132.

Turton, A.R., Mucheleng'anga, C., Mbao, E., Musonda, W., Mukubesa, L. & Ng'oma, M. 2001. Water Demand Management, Natural Resource Reconstruction and Social Adaptive Capacity: A Case Study from Kalomo, Zambia. In the *Proceedings of the 2nd WARFSA/WaterNet Symposium "Integrated Water Resources Management: Theory, Practice, Cases"* held in Cape Town 30 - 31 October 2001.

Turton, A.R. & Meissner, R. 2002. The Hydro-Social Contract and its Manifestation in Society: A South African Case Study. In **Turton, A.R. & Henwood, R.** (Eds.) 2002. *Hydropolitics in the Developing World: A Southern African Perspective*. Pretoria: African Water Issues Research Unit (AWIRU). Available in draft form from the Website <http://www.up.ac.za/academic/libarts/polsci/awiru>

United Nations. 1978. *Water development and management. Proceedings of the United Nations Water Conference, Mar del Plata, Argentina*. Volume 1. Part 1. London: Pergamon Press.

UNCED. 1992. United Nations Conference on Environment and Development. *Agenda 21: Chapter 18, Freshwater*. United Nations Publications.

Waterbury, J. 1979. *Hydropolitics of the Nile Valley*. New York: Syracuse University Press.

Turton, A.R. 2002. WDM as a Concept and a Policy: Towards the Development of a Set of Guidelines for Southern Africa. Commissioned Analytical Paper for the IUCN Water Demand Management Programme for Southern Africa: Phase II. Pretoria: IUCN.

WCD. 2000. *Dams and Development: A New Framework for Decision-Making - The Report of the World Commission on Dams*. London: Earthscan.

Wester, P., Burton, M. & Mestre-Rodríguez, E. 2001. Managing Water Transition in the Lerma-Chapala Basin, Mexico. In **Abernethy, C.L.** (Ed.) 2001. *Intersectoral Management of River Basins*. Colombo: International Water Management Institute (IWMI).

Wolf, A.T. 1998. Conflict and Cooperation along International Waterways, in *Water Policy* (1); 251-265.

World Bank. 1993. *"Water Resources Management." A World Bank Policy Paper*. Washington, DC: World Bank.

World Bank. 1999. *Developing Countries - Water Supply and Sanitation - 1999*. Available from the Website
<http://devdata.worldbank.org/exte...comp.asp?rmdk=110&smdk=473898&w=0>

World Bank. 2000. *World Bank Atlas 2000*. Washington D.C.: The World Bank

World Water Council. 1999. *World Water Vision: Making Water Everybody's Business. Draft Report of the Commission. First Draft of Full Report*. Version of 14 November 1999. Available from wjcosgrove@compuserve.com or f.rijsberman@unesco.org