WATER DEMAND MANAGEMENT PROGRAMME FOR SOUTHERN AFRICA: PHASE II

ANALYTICAL PAPER (First Draft)

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

By

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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

As a starting point for this journey, a few points need to be made about methodological concerns that are inherent in any multidisciplinary endeavor. 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. One needs look no further than a definition of what WDM is, to immediately be confronted by a confusing cacophony of ideas and words. It is also the contention of the authors that 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.

By way of concluding this brief caveat, the authors are reminded of a lesson from an earlier undergraduate course on the interpretation of statutes in which Justice M.T. Steyn once said, "a word is not a crystal, transparent and unchanged, but the skin of a living thought". This is particularly true for the rest of this Analytical Paper, to which we can now turn our attention.

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. From a WDM perspective, it is important to dwell for a few moments on the development of these principles, and in particular to seek to unravel the subtle changes that have been occurring in the dominant water management paradigm.

Historically, human development has been closely linked with the management of water resources. Ancient civilizations have grown as they have learned how to manage water resources in such a way as to overcome the ravages of food insecurity. Thus we have the rise of ancient hydraulic civilizations such as the Sumerians, Babylonians and Assyrians in the Tigris and Euphrates Basin; the Egyptians in the Nile Basin; various civilizations in the Indus and Yellow River Basin; some desert dwellers in the American South West, central Mexico and coastal Peru (Postel, 1999:13) and irrigation farmers in Sri Lanka (Mendis, 1999). In more modern times, large urban metropoles such as the City of London could be developed only once the problems relating to water reticulation were resolved (Graham-Leigh, 2000). The engineering of water supply and sanitation has been a major feat of humankind, providing the very foundation on which human civilization has been able to develop.

In the development of technological systems such as those found in hydraulic engineering, 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) who first described new methods of inquiry into the Natural Sciences. In this context, Bacon said that we can use what he called "noble discoveries" that will come from the new method of inquiry to "renew and enlarge the power of the human race itself over the Universe" (Kitchen, 1855: 129). Bacon's thesis was supported in the subsequent work of René Descartes (1637) where he said,

> "[I] saw that one may reach conclusions of great usefulness in life, an[d] discover a practical philosophy [i.e., the Natural Sciences] … which would show us the energy and action of fire, air, and stars, the heavens, and all other bodies in our environment and [we] could apply them … and thus *make ourselves masters an[d] owners of nature*" (emphasis added)(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 man constructs knowledge, which in turn impacts on the way that he interprets 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. To this Homer-Dixon (2000:83) comments as follows:

> "Seduced by our extraordinary technological prowess, many of us come to believe that external reality - the reality outside our constructed world - is unimportant and needs little attention because, if we ever have to, we can manage any problem that might arise there."

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.

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 km^3 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.

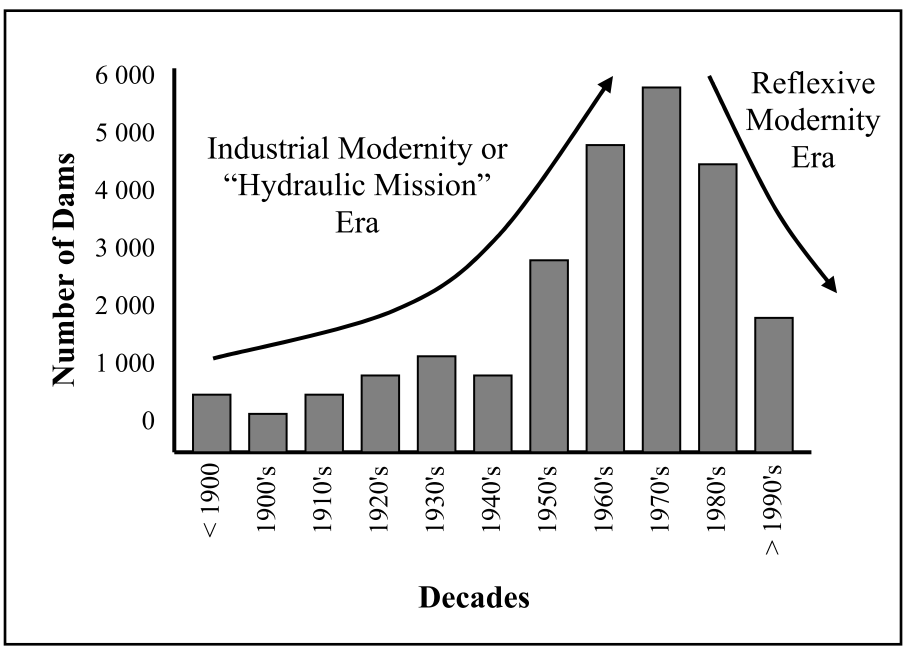

Figure 1. Global Construction of Dams by Decade (1900-2000) (WCD, 2000:9). The Industrial Modernity and Reflexive Modernity Era are clearly evident.

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. This in turn saw a mushrooming of dam construction, with a number of large dams such as Kariba and the Aswan High Dam coming shortly thereafter. This can be called the start of the golden age of Supply-Sided Management in which most water-scarcity problems were solved by developing infrastructure and relying on engineering-type human ingenuity; or what Homer-Dixon (1994:16; 2000:22) calls "technical ingenuity". Some authors refer to this as being the "hydraulic mission" period of water resource development (Allan, 2000:28-29; Reisner, 1993:112-114; Swyngedouw, 199a; 1999b).

- 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". 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 saying that,

> "Environmental concerns over rivers and watersheds in the United States began in the early 1900's with John Muir's opposition to the Hetch Hetchy Dam in the mountains of California. ***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 one of the most astounding proposals of all, the U.S. government announced plans in the 1960's to build a series of massive dams in the Grand Canyon, one of the most natural symbols of America. These dams provoked such an enormous outcry of dismay from environmental groups - and then from the broad American public itself - that the plans were halted: the first time such a major project had been stopped. 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" (emphasis added).

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 bias at that time was towards industrialized nations, so the problems of the developing world were largely ignored, but the issue of water pollution had been introduced onto the international agenda for the first time.

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. This

Conference was the origin of the notion of "basic needs" (Lundqvist & Gleick, 1997:21). Significant in this context is the statement that,

> "… all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs" (United Nations, 1978 – quoted in Lundqvist & Gleick, 1997:21).

While the initial response to Mar del Plata was mild – the 1987 Bruntland 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 (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.

Building onto the earlier notion of "basic needs" that was introduced at Mar del Plata, the 1992 International Conference on Water and Environment in Dublin expanded on this notion by including the principle that,

> "… it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price" (ICWE, 1992 – quoted in Lundqvist & Gleick, 1997:21).

The Dublin Conference resulted in the so-called Dublin Statement, 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.

> "In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems" (UNCED, 1992 – quoted in Lundqvist & Gleick, 1997:21).

Implicit within this statement 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). Significantly, the role of international organizations and NGOs is also alluded to in ensuring that this is the case. In short, the notion of "basic needs" (inclusive of the needs of the environment), can now be considered to be part of the international normative order.

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, 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,

> "The proposed [new World Bank] approach to managing water resources builds on the lessons of experience. At its core is the adoption of a comprehensive policy framework and ***the treatment of water as an economic good***, combined with ***decentralized management and delivery structures***, greater reliance on pricing, and ***fuller participation by stakeholders***. ... The adoption of a comprehensive framework for analyzing policies and options would help guide decisions about managing water resources in countries where significant problems exist, or are emerging, concerning the scarcity of water, the efficiency of service, the allocation of water, or environmental damage" (emphasis added) (World Bank, 1993).

In 1994, the OECD's Development Assistant Committee endorsed the Dublin Principles. During the same year, the Commission for Sustainable Development (CSD) urged international agencies such as UNEP, FAO, INIDO, WHO, WMO, UNESCO, UNDP, the World Bank etc., to strengthen their efforts towards developing a comprehensive assessment of the global freshwater resources (Lundqvist & Gleick, 1997: 30). This assessment was presented at the CSD in 1997, and subsequently again to a UN General Assembly Special Session. At this point the Swedish Government took on the responsibility of developing the research capacity further by commissioning the Stockholm Environment Institute (SEI).

The Global Water Partnership (GWP) and World Water Council (WWC) are recent examples of global water sector initiatives (Lundqvist & Gleick, 1997:29). Both organizations were officially launched in 1996 after extensive consultations. 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. Originally initiated by the World Bank, UNDP and SIDA, the GWP is an international network committed to the translation of the newly emerging international consensus on water resource management into comprehensive and coherent services. The major emphasis is on achieving sustainable water resource management in developing countries. The emphasis within GWP activities is on the facilitation of projects that emanate from locally defined needs. It will coordinate activities and provide leadership, rather than run the project as such. Encapsulated within this is the concern for ecosystem health as this forms the foundation of livelihood security and population health. The WWC is aimed at promoting awareness of critical water-related issues whilst facilitating long-term efficiency in planning and managing water resources. A strong element of this is the development of an analytical “think tank” capability, focussing on broad issues such as the “World Water Vision” that was announced in The Hague in March 2000.

Documentation available from the World Water Council shows that six major drivers have been identified in the global water scenario (World Water Council, 1999: 17). These are (1) economic growth; (2) population pressure: (3) technological change; (4) social performance; (5) environmental quality; and (6) governance and institutions. This whole range of issues will again be placed on the negotiating agenda during the forthcoming World Summit on Sustainable Development (WSSD) which will take place in Johannesburg during 2002, raising the issue of sustainable development once again, this time within the context of globalization, risk society and the post September 11'th world political economy.

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.

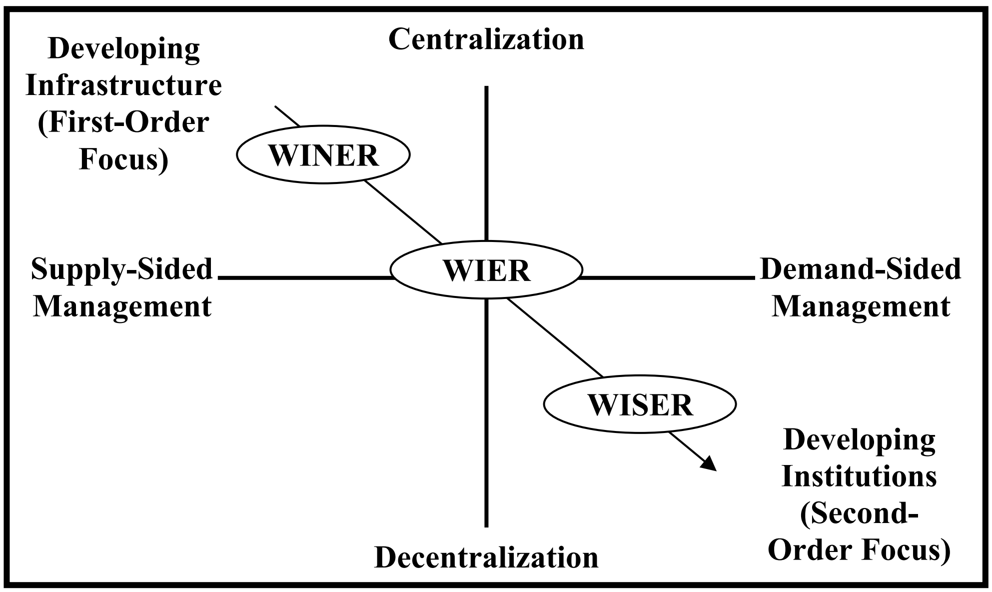

Figure 2. Integrated model showing the interaction between the two major competing international paradigms currently at work within the Water Sector (Turton & Meissner, 2000).

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.

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-facetted and does not readily fit any overly-simplistic classification such as either WINER or WIER.

The relevance a First Order and Second-Order Focus will be explained later in this Analytical Paper, under the section entitled “Theoretical Distinction between First and Second-Order Resources” (Section 3.3). In essence however, 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 (inter-sectoral allocation of water versus intra-sectoral allocation of water, which will be analyzed in more detail in the section entitled “Components of a Potential Model” in Paragraph 3.4). 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 that 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.,* 2000:9-10). 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

Having established the fact that the water sector is being influenced by a changing management paradigm, away from a predominantly supply-sided focus with a highly centralized management structure, towards an increasingly demand-sided approach with a decentralized management structure (Figure 2), it now becomes instructive to dwell for a few moments on what we mean by the concept of a "resource".

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; 1989; 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 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 9).

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.

From this conceptual differentiation, it now becomes possible to develop a whole range of unique concepts by means of a matrix showing different levels of first and second-order resources within any given social entity. This is illustrated in Figure 3.

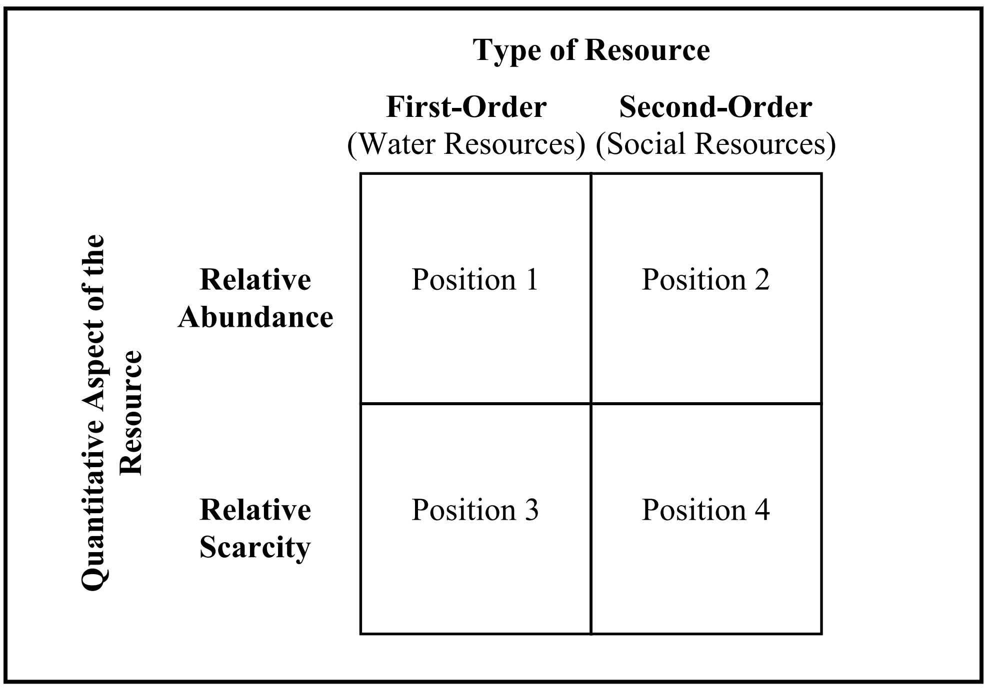

Figure 3. Matrix Showing Possible Combinations of First and Second-Order Resources (Turton & Warner, 2001:129).

A number of combinations of first and second-order resource are possible. Examples of these combinations are Positions 1 and 2, Positions 3 and 4, Positions 1 and 4, and Positions 3 and 2 in conjunction with one another. For purposes of this Analytical Paper, only the last three of these combinations are relevant (Turton & Warner, 2001).

- A combination that consists of a relatively high level of first-order resource availability (Position 1) in conjunction with a relatively low level of second-order resource availability (Position 4) 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 (Position 3) in conjunction with a relatively high level of second-order resource availability (Position 2) 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 (Position 3) in conjunction with a relatively low level of second-order resource availability (Position 4) 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.

If one assumes that water resources are relatively finite within any given country, then it is logical to conclude that if a population doubles, then there will be half the volume of water available per capita. It is this type of logic that underpins the work that has been done by Falkenmark (1984; 1986; 1989b; 1990; Falkenmark *et al.,* 1990) for example. This logic is seductively simple, so let us don the eyeglasses of first-order analysis and look at some African countries. Table 1 shows the population data for Southern African countries in Columns 2 - 6. The population growth over that time period (38 years) is shown as a factor in Column 7, whereas Column 8 shows the water availability expressed in cubic meters per capita in 1998. The World Bank Atlas (2000:30) defines water availability per capita as being the total renewable water resources of a given country, which includes river flows, divided by the population and expressed in cubic meters.

Table 1. Population Growth (Millions) and Water Availability Data for Southern Africa (SADC Member States) (after Turton & Warner, 2001).

Country	**1961**	**1970**	**1980**	**1990**	**1999**	**Growth** since 1961	**Avail** m3/cap 1998
<u>Angola</u>	4.8	5.5	7.0	9.2	12.4	2.58	**15 783**
<u>Botswana</u>	.49	.63	.90	1.2	1.5	**3.06**	9 413
<u>Congo (DR)</u>	15.7	20.2	27.0	37.3	50.3	**3.20**	**21 134**
Lesotho	.88	1.06	1.3	1.7	2.1	2.38	2 527
Malawi	3.6	4.5	6.1	9.3	10.6	2.94	1 775
Mauritius	.67	.82	.96	1.0	1.1	1.64	1 897
<u>Mozambique</u>	7.6	9.3	12.0	14.1	19.2	2.52	**12 746**
<u>Namibia</u>	.63	.79	1.0	1.3	1.6	2.53	**27 373**
Seychelles	.43	.53	.63	.70	.77	1.79	n/a
South Africa	17.8	22.0	27.5	34.0	39.9	2.24	1 208
Swaziland	.33	.41	.56	.75	.98	2.96	4 552
<u>Tanzania</u>	10.4	13.6	18.5	25.4	32.7	**3.14**	2 770
<u>Zambia</u>	3.2	4.1	5.7	7.2	8.9	2.78	**12 001**
Zimbabwe	3.9	5.2	7.1	9.8	11.5	2.94	1 711

Sources of data:
Population growth data (Columns 2 - 6) - FAO (2000).
Population growth since 1961 - Calculation (Column 6 / Column 2).
Water availability per capita m^3 in 1998 (Column 8) - World Bank Atlas (2000: 34-35).

For purposes of analysis, let us now make two assumptions, both of which are strictly of a first-order nature (Turton & Warner, 2001). Firstly, let us assume that a three-fold growth in population over a 38-year period is high. All of the countries that have a population growth in excess of this have been underlined and the respective figure in Column 7 has been highlighted. Secondly, let us assume that in terms of availability of freshwater, anything above 10 000 m^3/cap/ yr^{-1} is high. Here too the countries concerned have been underlined and the respective figure in Column 8 has been highlighted. Clearly, these assumptions are rather arbitrary and they can be challenged, but for purposes of debate, let us assume that they are valid. It should also be emphasized that these assumptions are relative and not absolute, and have been made merely to establish a clear split in order that basic trends can be detected.

From this rather crude assessment an interesting picture starts to emerge (Turton & Warner, 2001). The countries that have a relatively low population growth (i.e. less than a threefold increase in 38-years) in conjunction with a relatively high availability of freshwater include Angola, Mozambique, Namibia and Zambia. Conversely, countries that have a relatively high population growth rate in conjunction with relatively low water availability include Botswana and Tanzania. One country stands out alone in terms of this assessment - the Democratic Republic of the Congo (DRC) - displaying a relatively high population growth rate in conjunction with a relatively high water availability.

The picture that emerges from this admittedly rather crude analysis suggests that the countries in the first group (low population growth and high water availability) - Angola, Mozambique, Namibia and Zambia - have population and water resource fundamentals that ought to predispose them to a degree of prosperity, yet we know that this is not the case. While Angola is richly blessed with a wide range of first-order resources, it remains embroiled in a debilitating civil war, and if anything those resources (particularly oil and diamonds) are continuing to fuel the conflict. Mozambique seemingly has a high volume of water resources available to it, yet in reality it too has been debilitated from a quarter century of civil war and is in fact a downstream riparian on almost all of the river basins passing through it, making it vulnerable to the whims of upstream states. While Namibia is relatively prosperous and politically stable, it has a small population and therefore a small tax base. This is debilitating in light of the fact that the physical size of the country is massive and the population is far removed from water resources, meaning that any infrastructure projects actually have a low number of taxpayers per kilometer of pipeline. Zambia is politically stable but economically stagnant, and even though it is richly endowed with water, it lacks the capacity to build infrastructure and reticulate the water to where it is needed.

The second group of countries (high population growth and low water availability) suggests a future Malthusian catastrophe but it includes Botswana, which is actually one of the most politically stable countries in Africa with a functioning multiparty democracy, and the high population growth rate is off a low original population base. Significantly Botswana is also adopting progressive water policy options that include the preference for food security rather than national self-sufficiency, so Malthusian collapse seems unlikely indeed. Tanzania has had a history of economic stagnation, although this is changing (Turton & Warner, 2001).

First-order types of analysis are clearly superficial and can be downright dangerous. It is from this type of analysis that the so-called "Water Wars" literature derives its empirical basis. The argument that is used suggests that as uncontrolled population growth erodes into available water resources, then the conflict potential will increase to the point where war over water is inevitable (Turton, 2000d:39). By relying on so-called "hard" primary data (population and water availability), a linkage is made that results ultimately in a teleological argument being developed.

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 2 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 developed in Column 7 of Table 1. 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 as noted in the previous section (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 in Column 8 of Table 1. Column 3b shows this data as a High/Low split using the criterion that was discussed in the previous section (>10 000 m^3/cap/ yr^{-1} is High, <10 000 m^3/cap/ 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. (The issues raised in the section entitled "Methodological and Epistemological Concerns" in Paragraph 2 are relevant here).

Table 2. Comparison of First and Second-Order Resources in Southern Africa (SADC Member States) (after Turton & Warner, 2001).								
Country	**First-Order Indicators**				**Second-Order Indicators**			
	Population Growth since 1961		**Water Availability** $m^3/cap/yr^{-1}$ 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) - Column 7 of Table 1.
High/Low population growth split (Column 2b) - Arbitrarily defined as >3.0 is High, <2.9 is Low.
Water availability $m^3/cap/ yr^{-1}$ 1998 (Column 3a) - World Bank Atlas (2000:34-35) and Column 8 of Table 1.
High/Low water availability (Column 3b) - Arbitrarily defined as > 10 000 $m^3/cap/ yr^{-1}$ is High, < 9 999 $m^3/cap/ yr^{-1}$ 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 2 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. A cursory glance at

Table 2 will show 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 2, 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 3.

Table 3. 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

It is evident from Table 3 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, being embroiled in seemingly endless 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 in 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 Table 3, 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 simplicity will be summarized here. Homer-Dixon starts off his analysis by stating that an element of modern capitalism is what is known as "creative destruction" in which rapidly changing technologies compress time and space, thereby creating more economic opportunities – examples are planned redundancy and an increased dependence on technology (Homer-Dixon, 2000:101). Increased complexity is the result. This arises when discreet elements such as new technologies combine to produce unanticipated effects. A classic study by Juliet Schor entitled "*The Overworked American*" found that technology reduced the amount of time taken for any given task, but it also results in an increase in what people are expected to do (Homer-Dixon, 2000:102). Both as individuals and as societies we must deal with more issues simultaneously and make more decisions more often about increasingly complex issues. To do this we rely more on sophisticated time and decision management tools (Homer-Dixon, 2000:103).

There is an emerging body of literature called Complexity Theory, of which the work by W. Brian Arthur (1994) is an authoritative example according to Homer-Dixon (2000:103). According to Arthur's work, three critical processes combine to make systems more complex:

- <u>Growth in coevolutionary diversity</u>. The entities that make up the systems - organisms, corporations - compete fiercely. While some survive others fail, but not all compete. Some find symbiotic relationships too, much the same as occurs in natural ecosystems. Over time an increasingly complex web of relationships cause new niches to open and others to collapse. Complexity tends to bootstrap itself over time as entities start to feed on themselves. Diversity thus spawns new diversity in an increasingly complex fashion, not unlike the processes found in ecosystems. Diversity begets diversity and complexity begets complexity. For example, there is more complexity in 1 km^2 of the Amazon jungle than in 1 km^2 of the Sahara Desert.
    - Virtuous circles take hold in some societies and they experience an explosion of creativity, but this is not uniform (Homer-Dixon, 2000:104).
    - Some societies do not develop the same degree of creativity. We thus see the birth of an ingenuity gap where highly adaptive societies generate immense

amounts of ingenuity, while other societies start to lag behind (Homer-Dixon, 2000:105).

- Structural deepening. This occurs not within the whole system but within single entities that make up that system. There is a natural tendency for an organism, technology, or a corporation to become steadily more sophisticated in order to improve its performance over time. This is driven by fierce competition.
    - Introduction of radically new and simpler systems sweep away more complex systems that have become encrusted with additions and complications. For example, the piston engine got so complex in order to power an aircraft at altitude, but rapidly became redundant once a simple jet engine had been invented. In turn, the jet engine became increasingly complex over time (Homer-Dixon, 2000:105).
    - In evolving systems, bursts of simplicity cut through complexity and establish a new basis upon which complication again starts to grow.

- Capturing Software. Sometimes systems take over the task of simpler systems, exploiting the entities that make up those systems and also the rules or grammar that governs interaction between entities.
    - Human societies and electricity offer an interesting example. We have learned the physics of electricity so we can increasingly exploit it and make it subject to our bidding (Homer-Dixon, 2000:106). More electricity is consumed in developed societies than in developing societies as a result.
    - We have invented new economic instruments as well. In the beginning simple shares led to futures, which in turn led to derivatives, each inventing a new and increasingly complex language. Each becoming the domain of a specialist and each started to feed off the previous in a vicious spiral (Homer-Dixon, 2000:106).

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 1637 quotation by Descartes in the section entitled "The Changing Water Management Paradigm" (paragraph 3.1), where the main driving force of science was 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.

Complexity Theory (Arthur, 1994) identifies six key features of how the propensity towards complexity in turn places demands on the need to generate solutions to ever-more complex problems (Homer-Dixon, 2000:111). These can be summarized as follows:

- Multiplicity. Complex systems consist of a large number of entities.

- Causal connections. The individual components of complex systems are linked by complicated webs that affect each other in a variety of ways. The greater the connections, the greater the complexity. Feedback is thus a key element:
    - Positive feedback. This form of feedback reinforces or amplifies the changes already taking place. For example, rising share prices on the stock market feed an optimistic air, which inspires investors to invest, which drives up share prices (Homer-Dixon, 2000:111). This ultimately makes the system unstable and subject to wild swings at certain moments in time (Homer-Dixon, 2000:112), such as occurred after the September 11'th attack on the World Trade Centre in New York and the Pentagon in Washington.
    - Negative feedback. This form of feedback helps maintain stability by counteracting the initial forces. For example, experienced investors will start to sell off shares when they feel that the market is unrealistic, thereby dampening the upward spiral (Homer-Dixon, 2000:112).
    - Tightly coupled. This means that a change in one component has rapid and multiple effects on the rest of the system. For example, cars tailgating each other on a highway at speed mean that one accident will result in a multi-car pileup (Homer-Dixon, 2000:112).

- Interdependence. A way to measure interdependence is to divide a system into pieces and see how the changes affect the overall properties of the system. The human body is an example. By severing a limb, the body functions less well than when left whole (Homer-Dixon, 2000:112).
    - The larger the part that can be removed from a complex system without effecting the overall functioning of the system, the more resilient the system is said to be (Homer-Dixon, 2000:112-113).

- Openness. Systems are affected by outside events. It is therefore often hard to define system boundaries (Homer-Dixon, 2000:113).
    - The breakfast cereal you eat links you to soil health in a remote part of the globe.
    - Radioactive fallout from Chernobyl effected the grazing for cattle, so when condensed milk was produced from those cows, it too was radioactive.

- Synergy. The whole is more than the sum of its parts (Homer-Dixon, 2000:113).
    - The increased prevalence of deformed legs on frogs is an example of synergy where a complex set of factors combine to produce an unpredictable but severe outcome.

- Nonlinearity. Change in a system can produce an effect that is not proportional to its size (Homer-Dixon, 2000:113-114).
    - This is known as the proverbial straw that breaks the camels back.
    - Stratospheric ozone depletion is now feeding on itself. Ozone destruction has been found to occur at lightening speed, stripping ozone from the high atmosphere over the Antarctic in weeks despite attempts to reduce CFC

emission (Homer-Dixon, 2000:114-115; Toon & Turco, 1991; Stolarski, 1988).

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).

The science writer and historian Edward Tenner (1996) labeled such behavior as the "pathology of intensity" which is the single-minded over-extension of a good thing (Homer-Dixon, 2000:175). A classic example of this is found in the story of antibiotics. We widely used these as miracle drugs not only to cure, but also to prevent illness. In 1977 the treatment of livestock with antibiotics for purposes of nutrition, therapy and prophylaxis consumed half of the global production of antibiotics. Today, as a result, we are facing crises of antibiotic resistance from common strains of *salmonella* to lethal *staphylococcus aureus* and *mycobacterium tuberculosis*. The saga of mad cow disease and foot and mouth disease in England is another interesting example where science is seemingly unable to predict the unknown unknowns. So we not only need more biomedical ingenuity to deliver new antibiotics at a faster pace than before, but we also need social ingenuity to develop new institutions, often international in reach, for disease control and tracking purposes (Homer-Dixon, 2000:176). Tenner's (1996) pathology of intensity often magnifies unknown unknowns, but it also produces the narrowing of expertise with the resultant inability to provide insight into complex phenomena such as the management of water demand, which involves a myriad of crosscutting relationships and dynamics ranging from the human psychological to the engineering-based pressure management and the institutional capacity to collect revenue aspects.

Tenner (1996) also 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 word 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), *Simulum 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 it will be shown that 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). Central to this model, are a number of key concepts that need to be understood. These are as follows:

- The renewable water resource within a given river basin consists of the total volume of water flowing into that specific geographic area. This comes from a variety of sources such as precipitation, ground water discharge and surface water flows, and is represented in Figure 4 as a horizontal line labeled "Renewable". In essence, this represents the total water resource-base that exists within any given river basin.

- The potentially available water is less than the renewable water resource-base, and consists of the water that is available for depletive use within the given river basin. From a purely technical perspective this consists of the gross inflow into the river basin, minus non-utilizable flows (such as those needed for Instream Flow Requirements - IFR - in order to maintain the ecological integrity of the river) minus any agreed water commitments that must be met such as for downstream users. This is represented as a horizontal line in Figure 4 labeled "Potentially Available", below the renewable water resource line.

- Available water is a function of the existing hydraulic infrastructure within a given river basin at any moment in time. In purely technical terms this consists of the nett inflow, minus the amount of water that has been set-aside for committed uses, minus the non-utilizable uncommitted outflow. In essence, this is the amount of water that is available for use within the river basin in terms of the various assurances of supply design parameters, which have been determined by the hydraulic mission of the state.

This changes over time as the water resources are developed, and is represented as a stepped line in Figure 4 labeled "Available".

- Depleted water is the use or removal of water from a given river basin that renders it unavailable for further use within that basin. Water is not really consumed, which is one of the unique characteristics of this particular resource, because it is usually returned to the hydrological cycle in some form or other after having been used. This can be in the form of useable return flows from irrigation systems, industrial or domestic return flows, or returns to the atmosphere as water vapour via the stomata of plants, which are not useable in an immediate sense of the word, but which are available elsewhere as part of the global hydrological cycle. Consequently, Molden *et al.,* (2001) prefer to use the term "depleted water" in their specific model, as this indicates water that is no longer directly available for economic use. This is represented as an "S" shaped curve in Figure 4 labeled "Depleted".

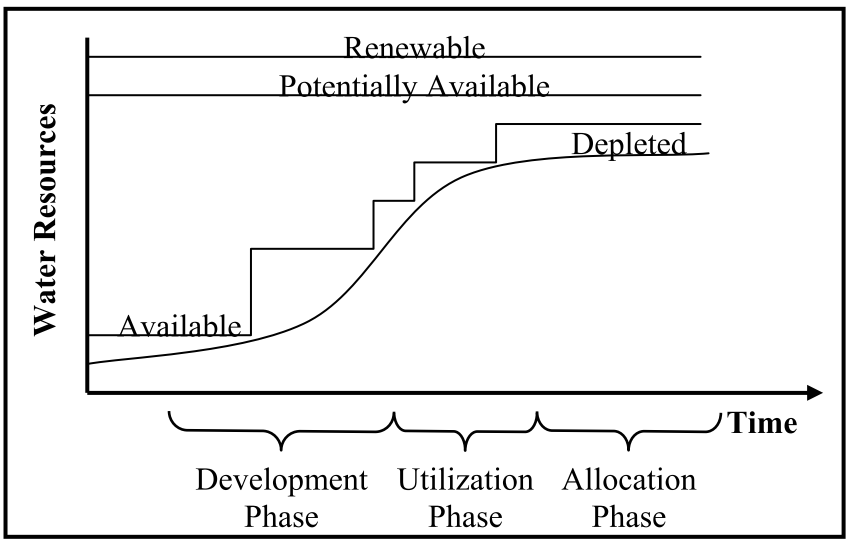

Figure 4. Phases of river basin development as envisaged by Molden *et al.,* (2001:77).

As water demand increases, there is an impulse to develop more of the available water resource-base within any given river basin. As more water is made available however, more water is also depleted. There is consequently a correlation between available water and depleted water, with the former being represented as a series of steps, which increase as each new dam comes on line. The latter is represented as an "S" shaped curve. Over time, as more of the water resources are developed in response to the growing demand, the depleted water curve approaches the available water curve, necessitating the development of a new hydraulic structure such as a dam. In highly developed river basins, the depletion curve approaches the potentially available supplies. In a closed river basin, the depleted curve approaches (or even exceeds) the potentially available curve. The potentially available water represents the maximum water resource-base that can be mobilized in a sustainable manner, unless other water is brought into the system by means of an IBT. This condition is equivalent to a frontier production function in the field of economics (Molden *et al.,* 2001:77).

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 are shown on Figure 4 and consist of the following:

- <u>The Development Phase.</u> 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.

- <u>The Utilization Phase.</u> 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.

- <u>The Allocation Phase.</u> 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, the one author has engaged in some research work (Turton, 1999a; Turton & Ohlsson, 1999; Lundqvist & Turton, 2001) with the purpose of developing a more comprehensive model. 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).

The starting point of this refined model 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. In order to achieve this, it was necessary to construct the simple model that is presented in Figure 5.

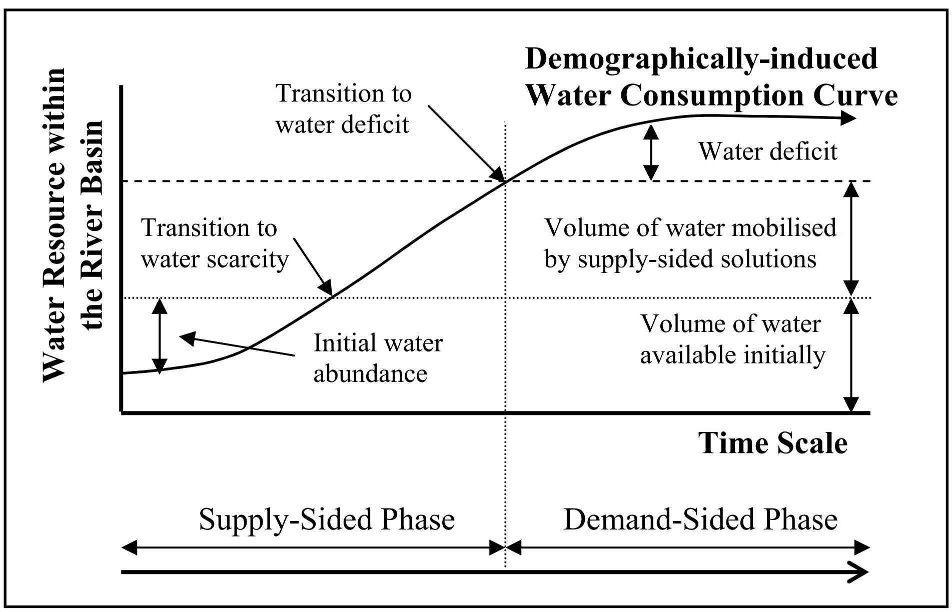

Figure 5. Simplistic model showing transition from Supply-Sided Phase to Demand Management Phase within a given river basin (Turton, 1999a).

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 in Figure 5.

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 corresponds to the "Potentially Available" line on Molden *et al's.,* (2001) model shown in Figure 4. 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. This corresponds with the stepped "Available" curve on Molden *et al's.,* (2001) model shown in Figure 4. 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 Figure 4. 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 implications. 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. As Horta (2000:196) notes,

> "Ultimately, the internal dynamics of institutions determine to a large degree how institutions will pursue a new set of goals and how these will become incorporated into institutional practice. … [T]hese theories make an important distinction between organizational adaptation and learning. While the latter leads to the adoption of qualitatively new objectives and priorities, the former involves changes brought about by new pressures or incentives, but without adjustments in the organization's underlying goals and priorities."

So 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). Focusing on environmental scarcity as a potential cause of conflict, Ohlsson (1999:47-48) notes that there are five conditions that may result in open violence. These are as follows:

- Trapped development occurs when depleted resources cannot be substituted in the foreseeable future, which place social groups that are dependent on that resource-base for their survival in a desperate situation. In this case the road to conflict is mapped out by the lack of viable options and the polarization of society.

- The lack of social regulatory mechanisms is a sign of the social and political powerlessness of both traditional and modern institutions of the State and civil society. In this regard the “powerlessness of power” occurs when a political system is unable to detract itself from certain social and political conditions, and developmental goals such as sustainability become impossible to attain. Open conflict becomes more endemic as social institutions fail to manage the rising levels of discord. Seen in this light, sustainability becomes intimately linked with the adaptive capacity of society.

- The environment becomes instrumentalized when certain powerful groups in society manage to manipulate the environmental scarcity in such a way that the resource scarcity becomes transformed into a group identity issue. In this regard cross-boundary rivers are easy to instrumentalize as a means of applying political pressure. Opposition groups start to use ecological crises to articulate their criticism of the state, and marginalized groups are used to attain specific political objectives. This is the case in the Jordan River Basin, particularly over the so-called Palestinian question (Turton, 2002a:56-98).

- The organizational ability, and opportunity to become armed, increases as the environmental conflict escalates. This on its own does not precipitate violence, but when it coincides with social and political cleavage lines, it enhances the conflict potential that is inherent within such societies.

- The overlay of historic conflict patterns becomes more relevant as environmental scarcities become a factor. For violence to occur, the adaptive capacity of society in general, and the State in particular, becomes highly relevant under these conditions. This is the case in the Jordan River Basin, particularly over the so-called Palestinian question (Turton, 2002a:56-98).

It must be noted that social adaptation - or more accurately stated, the lack of appropriate social adaptation - is a central feature of many of these conflict patterns. Reviewing the Rwanda genocide as a case study of environmentally-induced conflict, Ohlsson (1999:148) concludes that,

> "Now, judging from the developments in the field, the time for such a reconceptualization is ripe, whether practitioners are clear about what they are really doing, and whether social scientists studying the process recognize what is happening or not. As an example, water managers in water scarce countries have gone through an early phase of scrambling for more water, mainly with technical and engineering means (attempting to *overcome* scarcity), only to be forced into learning how to live with scarcity; first by saving water (attempting to *manage* scarcity); then increasingly by finding better uses for the limited available resource (attempting *adaptation* to scarcity); in the process being forced to deal with a number of difficult problems occasioned by the social and economic structural change necessitated (thus encountering the *social resource scarcity* sought for here (emphasis in original text)."

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 central to the rest of the argument being developed by the authors and are as follows:

- <u>A First-Order Resource</u>: 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:

    - <u>Non-Renewable Resources</u>: 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. Seen in this light, 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.

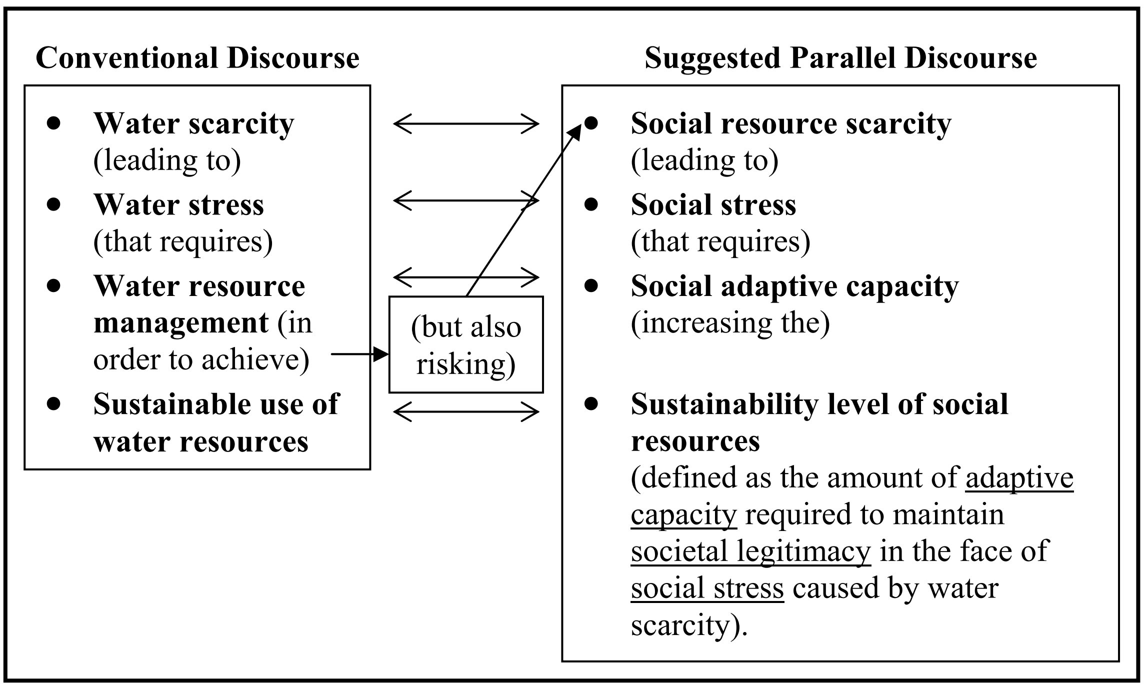

Figure 6. The parallel discourse of First-Order Natural Resource and Second-Order Social Resource Scarcity as depicted by Ohlsson (1999:164).

Seen in this light, Ohlsson (1999) has identified two different discourses on resource scarcity, which he presents graphically as shown in Figure 6. This work represented a substantial shift forward in the way that water resource management could be explained and understood, prompting one 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 5. 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.

Using the same concepts as those inherent in Figure 5, 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 (Baer, personal communication). Consequently, if water demand continues above the level of water mobilized by supply-sided solutions (roughly equivalent to the Available curve in Figure 4), 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 7. This would change the shape of the "S" curve, and would split the water demand curve from the population growth curve (Ashton & Haasbroek, 2002).

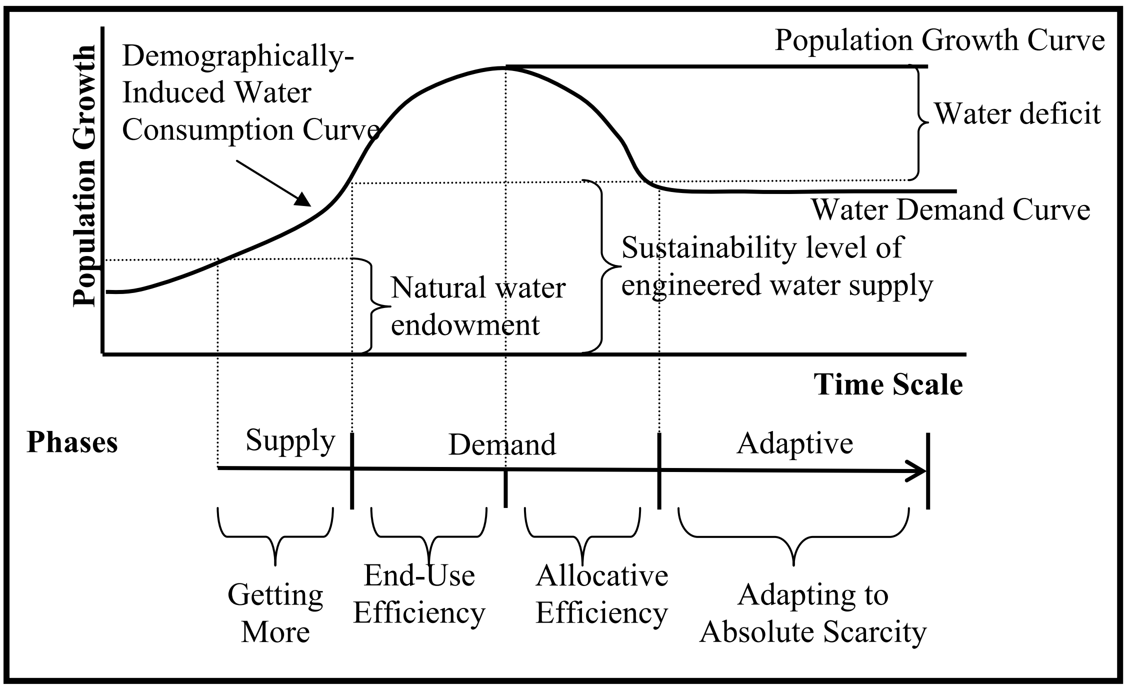

Figure 7. Schematic representation showing how reflexivity is needed to realign population-induced demand for water with the maximum level of sustainable supply (Turton, 2000b; 2002a:175).

As noted earlier in the section entitled "The Changing Water Management Paradigm (paragraph 3.1), this is called reflexivity (Giddens, 1990; Beck, 1992; 1995; 1996a; 1996b; Allan, 2000:29) in technical terms. ***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. Using the economic analogy previously alluded to, 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.***

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 (arising from the threshold effect) would need to become part of the institutional objectives (refer to the section entitled "Complexity and its Implications for Water Managers" in paragraph 3.4). 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).

It is therefore evident that adaptation, which involves institutional learning, is really a key concern for sustainable water resource management, as suggested by the simple model that has been developed by Molden *et al.,* (2001) and shown in Figure 4. 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 8. 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.

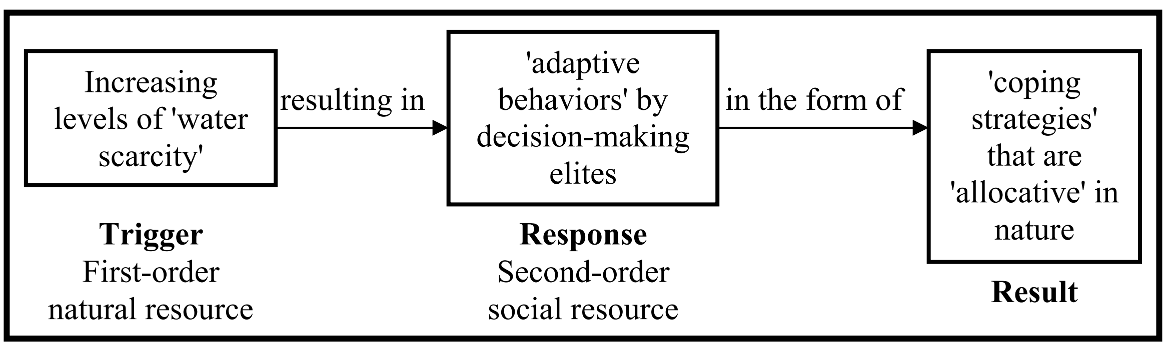

Figure 8. Schematic representation showing how water scarcity generates an adaptive response that results in some form of allocative measure such as WDM being introduced (Turton & Ohlsson, 1999; Turton, 2002a:177).

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 4. ***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). (The reader is referred back to Figure 2 in order to contextualize the relevance of this in the overall context of this Analytical Paper).

Table 4.
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 has resulted in research (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000), which has shown that it is best understood in terms of a series of bottlenecks or oscillations between first-order and second-order resources. 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 (refer to the section entitled "Complexity and its Relevance to Water Managers" in Paragraph 3.4). 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. (The issue of legitimacy will be discussed in more detail in the section entitled "Legitimacy and WDM Policies" in Paragraph 6.4 as it is an extremely important element of sustainable water resource management).

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 7. Details of some of these issues are as follows (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000):

- <u>During the Supply-Sided Phase</u>: 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 (Paragraph 3.1 entitled "Changing Water Management Paradigm). 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).

- <u>During the Demand Management Phase</u>: 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 (Paragraph 3.1 entitled "Changing Water Management Paradigm"). 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 (water as a first-order resource issue), to the management of demand (institutional measures such as WDM as a second-order resource issue) (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" (refer to the heading "Complexity and its Relevance to Water Managers" in Paragraph 3.4) - 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.

- <u>During the Adaptive Phase</u>: the problem is extremely complex (refer to the heading "Complexity and its Relevance to Water Managers" in Paragraph 3.4), 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.

The oscillations within the turning of the screw model (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000) can be visually depicted as shown in Figure 9. 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.

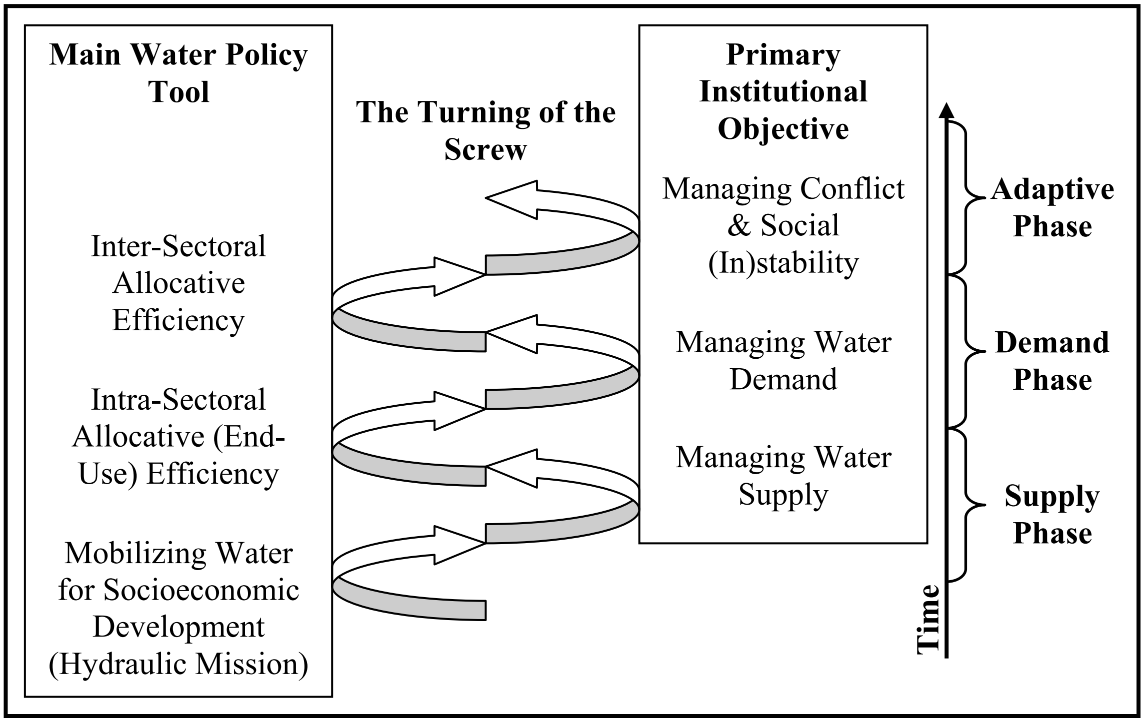

Figure 9. The Turning of the Screw Model showing the oscillations between First-Order and Second-Order Resources (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Turton, 2002a:183).

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 first-order and second-order resources, with an oscillation in emphasis between these two types of resource in a way that is more complex that 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) has taken note of the importance of second-order resources, and has said the following about their role in water management:

> "Another body of theory developed by Ohlsson & Turton (1999) is useful in explaining why water policy reform is difficult. The theory is also useful in

> gaining an understanding of the social and political dynamics of water policy reform. … Ohlsson (1999) drew attention to a very important feature of water scarcity. He pointed out that water scarcity has two dimensions. He identified first-order water scarcity. This is the physical shortage of water. Second-order scarcity he argues is the lack of capacity to ameliorate the shortage. Ohlsson called the second-order scarcity the lack of 'social adaptive capacity'. Both first-order and second-order scarcity can change over time. First-order scarcity can occur and worsen when demand rises to outstrip supply. Second-order scarcity can vary according to the pace at which social adaptive capacity can be strengthened. An improvement in social adaptive capacity can compensate for a physical water shortage. An improvement in the volume and quality of water cannot compensate for a shortage in social adaptive capacity in the same measure. … Only when low social adaptive capacity is combined with water deficits is there an intractable situation. An economy need not be significantly hampered by water deficit. … The achievement of a high level of social adaptive capacity is not determined by water availability (Allan, 2000:322-323)."

In the preface to the same work, Allan (2000:xvi) also notes that "his (Turton's) work with Leif Ohlsson … is the most cited in the book".

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 are consequently the determining variable (Turton, 1999a; Turton & Ohlsson, 1999; Allan, 2000:322-325; Turton & Warner, 2001).

4.4 Ingenuity as a Second-Order Resource

> "The water crisis is often a crisis of governance: a failure to integrate policies and practices related to the management of water resources. Good water governance exists where government bodies responsible for water establish an effective policy and legal framework to allocate and manage water in ways responsive to national social and economic needs, and to [ensure] the long-term sustainability of the resource base" (GWP, 2000).

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 will be argued is nothing more than a second-order resource or a form of social capital.

Homer-Dixon develops his argument along the following lines. He starts off by analyzing the concept of a resource, much the same as Ohlsson (1999) did, but with a different emphasis. With respect to environmental resources, and in particular scarcities of those resources, Homer-Dixon (1996:360) identifies three generic forms of scarcity.

- <u>Supply-Sided Scarcity</u>: occurs when the actual resource-base diminishes over time. This can be thought of as being a smaller sized resource pie.

    - Causes could be periodic drought, which is a natural event.
    - Global climate change could have an impact on precipitation levels reducing the total volume of water within a river basin.
    - Hydrocide (Lundqvist, 1998) reduces the availability of water through pollution and abuse of the resource. This is a form of induced-scarcity that is typically the plight of developing countries using dirty technologies to drive economic growth (Ohlsson & Lundqvist, 2000).
    - Mobilization and use of water upstream can cause a physical reduction in volumes available downstream, which typically results from basin closure.

- <u>Demand-Induced Scarcity</u>: occurs when a growing population remains dependent on a finite resource such as land, with a resultant decrease in resource availability per capita. This can be thought of as a smaller slice of the overall resource pie.

    - This is based on the notion of a finite resource-base such as land. In the water literature, this type of argument is called the "numbers game" (Ohlsson & Lundqvist, 2000), which can be traced back to the pioneering work by Falkenmark (1986; 1989b), as well as other more recent literature (Falkenmark, 1994; Falkenmark & Lundqvist, 1995). Postel (1997; 1999) also bases much of her work on this logic.
    - Ohlsson (1999: 80-144) has found that this form of scarcity (in this case land) acted as a driver for the Rwanda genocide, so it is something to be taken seriously by policy-makers.

- <u>Distributional Scarcity</u>: arises from a growing imbalance between wealth and poverty.

    - This is also known as structural scarcity after resource capture has occurred by powerful elites in society.
    - The so-called pipelines of power thesis (Turton, 2000a) can be used to explain this phenomenon.
    - The case of Apartheid South Africa also falls into this category (Homer-Dixon, 1996:365; Percival & Homer-Dixon, 1995; 1998).

Building on this conceptualization, Homer-Dixon (1996:361) notes that environmental scarcity is not only a consequence of institutions and policy - it can also influence these in a reciprocal manner. The cause-effect linkage is not linear and unidirectional. Therefore, explanations for environmental scarcity should not be subordinated to institutions and policies alone, because it is also partly a result of the physical context in which society is embedded. Consequently, once environmental scarcity becomes irreversible, say through the destruction of topsoil by erosion and poor agricultural practices, and the resultant siltation of dams, then the scarcity becomes an external influence on society. Seen in this light, both institutions and policies are a product of the second-order resources in society. Yet again this indicates greater complexity than has been attributed to water sector reform in the mainstream literature on that subject.

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 things that are needed to develop effective WDM strategies and to negotiate and maintain water-sharing regimes in closing river basins. The significant aspects of social capital (Putnam, 1993:168-170) are that:

- A reputation for honesty and reliability is an important asset for a would-be participant in a communal venture.
- The reliance on a reputation reduces the uncertainty in the absence of collateral and therefore induces compliant behavior.
- Social networks allow this trust to be spread, and thereby result in confidence-building. Trust is an essential component of social capital.
- Unlike financial capital, social capital increases the more it is used. As such, once it exists, it need never be depleted over time; and if well managed will grow.
- Social capital can therefore be regarded as being a moral resource.
- Like all public goods, social capital is undervalued and under-supplied by private agents.
- Unlike other forms of capital, social capital must be produced as a byproduct of other social activities such as in an institution.

Percival & Homer-Dixon (1998:281) state that environmental scarcity forces groups to focus on narrow survival strategies, which in turn reduce the interactions of civil society within the state. Putnam (1993:173) notes that networks of civic engagement are needed to create social capital, so environmental scarcity reduces the density of that engagement, thereby eroding the cohesiveness of society and reducing the stock of social capital. This in turn fosters group segmentation with a concomitant increase in group identity (Percival & Homer-Dixon, 1998:281). Civil society retreats in the face of this dynamic and is thus unable to articulate its changing demands on the State. More significantly however, this fragmentation reduces the density of social capital, which in turn creates gaps that are open to exploitation by powerful social groups. In this regard, 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, which will be discussed in the section entitled "Legitimacy and WDM Policies" in Paragraph 4.6.

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). Violence and conflict *per se* cannot arise from environmental scarcity alone. These scarcities need to combine with other factors such as the failure of institutions or government in order to result in open conflict. This consequently supports the conclusion that has been reached by Turton (1999a), Turton & Ohlsson (1999), Turton & Warner (2001) and Allan (2000:323) that second-order resources are the key determining factors in water resource management.

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 (refer to the section entitled "Complexity and its Implications for Water Managers" in Paragraph 3.4). 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:

- <u>Technical Ingenuity</u>: 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 on Figure 2.
    - It is also evident as one component of the so-called Paradox of Perception noted in Paragraph 3.1 ("Changing Water Management Paradigm).

- <u>Social Ingenuity</u>: 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 in keeping with the adaptive management that is central to models such as those developed by Molden *et al.,* (2001) (Figure 4), Turton (1999a), Turton & Ohlsson (1999) and Ohlsson & Turton (1999) (Figures 5, 7 & 9).
- This can be likened to the Second-Order Focus shown on Figure 2.
- It is also evident as the other component of the so-called Paradox of Perception noted in Paragraph 3.1 ("Changing Water Management Paradigm).

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.

Taking this further, Homer-Dixon (2000:173) notes that broadly speaking there are three kinds of system that humans interact with:

- <u>Natural Systems</u>. These have existed since before *Homo Sapiens* evolved into the dominant species that it is today. These natural systems, such as river basins, have taken billions of years to form and have a dynamic that works over these long periods of geological time.

- <u>Social Systems</u>. These are relatively modern creations, having evolved as products of evolution and endeavor, but are not exclusively human in their relevance, although they are generally ascribed to human development. The time-scale in these systems is thus relatively short when compared to geological timeframes.

- Technological Systems. These are entirely man-made with the purpose of interfacing between natural and social systems. As such they can be traced back to early hominid development and are in fact an important element in the ultimate evolution of humans, having enabled them to become masters of their respective environments.

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) that was quoted in Paragraph 3.1 (Changing Water Management Paradigm). 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 (refer to Paragraph 3.4 entitled "Complexity and its Implications for Water Managers"). 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. To this Homer-Dixon (2000:83) comments as follows:

> "Seduced by our extraordinary technological prowess, many of us come to believe that external reality - the reality outside our constructed world - is unimportant and needs little attention because, if we ever have to, we can manage any problem that might arise there."

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 (refer to Paragraph 3.4 entitled "Complexity and its Implications for Water Managers"). 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), in which the benchmark was defined as the amount of ingenuity needed to compensate for any aggregate social disutility caused by environmental stress. Stated differently, this is the minimum amount of ingenuity that a society needs to maintain its current aggregate level of satisfaction, despite the stress caused by environmental scarcity (Homer-Dixon, 2000:23).

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, 2000:6, in Perret), 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 referred to in the Changing Water Paradigm in Paragraph 3.1 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 (refer to the section entitled "Legitimacy and WDM Policies" in Paragraph 4.6).

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. In this regard, Ostrom (1990:21) suggests a model for negotiation:

> "Success in starting small-scale initial institutions enables a group of individuals to build on the social capital thus created to solve larger problems with larger and more complex institutional arrangements. Current theories of collective action do not stress the process of accretion of institutional capital. Thus one problem in using them as foundations for policy analysis is that they do not focus on the incremental self-transformations that frequently are involved in the process of supplying institutions. Learning is an incremental, self-transforming process" (Ostrom, 1990:190).

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. Such complexity has prompted Merrett (1997: 63) to say, "the concept of demand for water is a many-headed beast".

In order to understand why legitimacy is so important, we need to examine two key concepts in more detail. Figure 10 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 (Lichtenthäler, 1996). Allan (1998c: 170) notes that agriculture can consume as much as 90% of the national water budget of certain political economies. Figure 10 uses conservative figures for illustrative purposes.

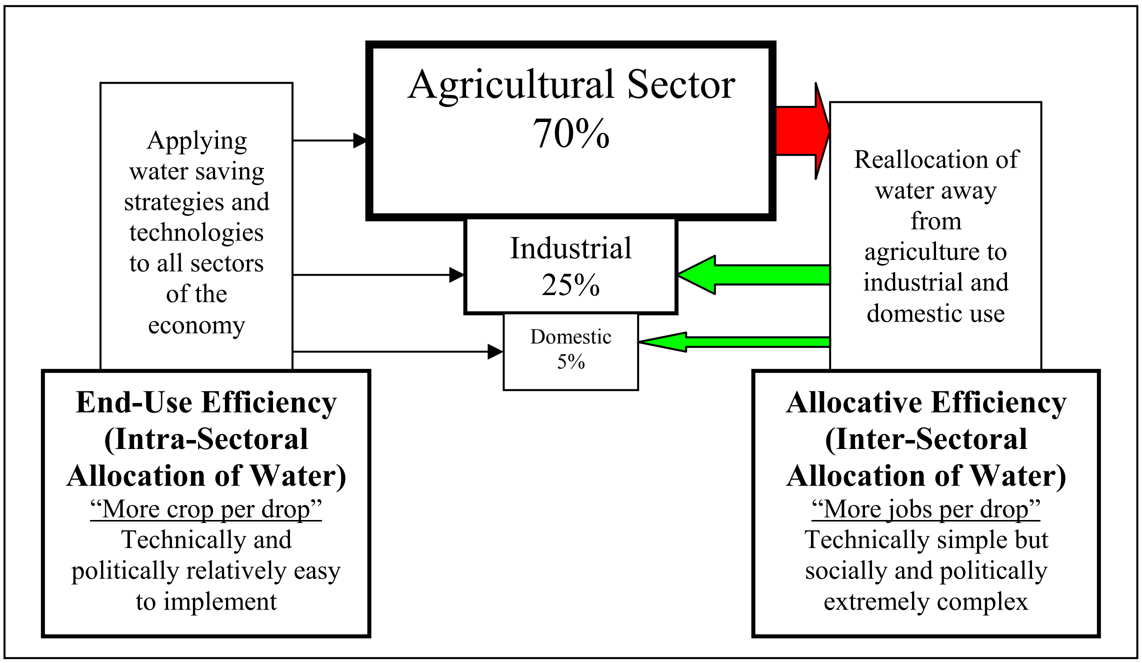

Figure 10: Schematic representation of two different policy instruments typically found in WDM strategies (after Turton, 1999a).

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.

- <u>Allocative Efficiency</u>: (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 (Figure 7 & 9) 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 11, 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.

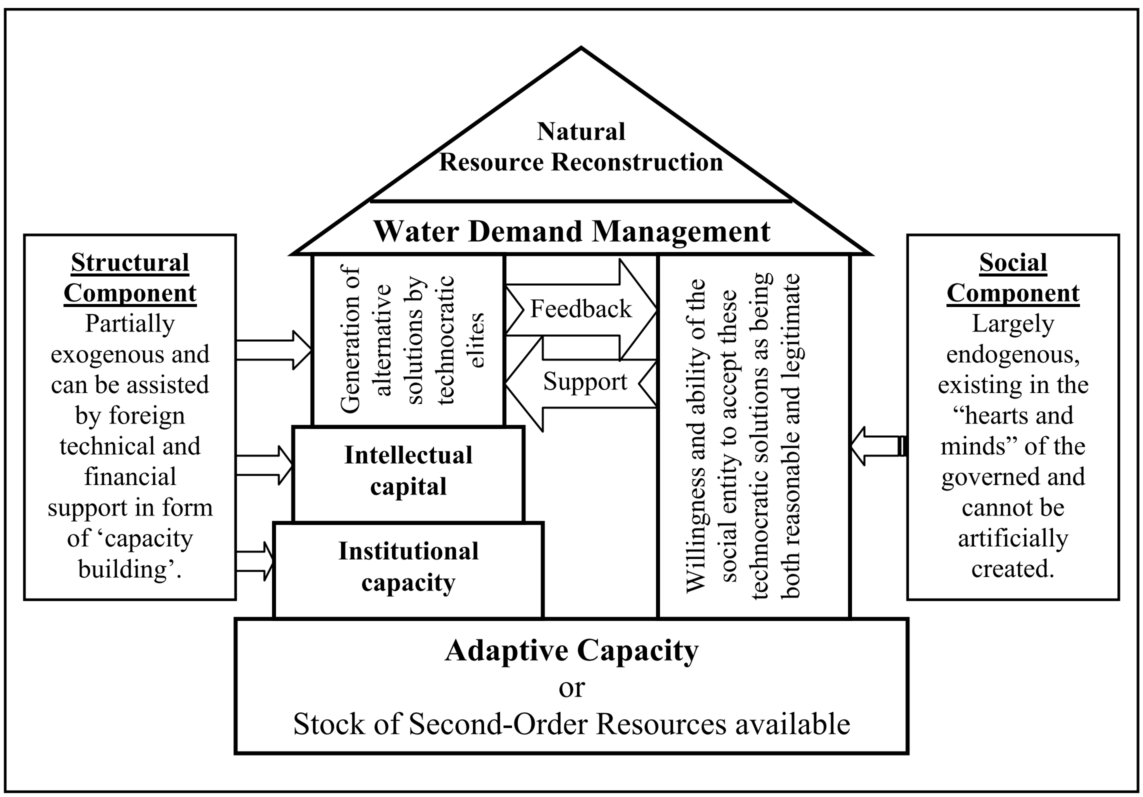

Figure 11. Model linking Natural Resource Reconstruction via Water Demand Management to the Second-Order Resource base of a given social entity.

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 in Paragraph 3.4, 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?

The UNDP and the World Bank now promote the concept of Integrated Water Resource Management (IWRM), which is essentially based on the French model (Ohlsson, 1999:189). This is an administrative approach based on treating the entire river basin as a unit of management, and focuses on the establishment of various technical administrative units (River Basin Commissions) combined with user groups (River Basin Authorities) where stakeholders discuss, and reach agreement on, the appropriate goals. This approach places great demands on the administrative capacity of states, which are exactly the type of resources that are scarce in many developing countries (Ohlsson, 1999:190).

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) (Figure 4) and Turton & Ohlsson (1999) (Figures 7 & 9).

Is the concept of ingenuity helpful? In answering this question, Ohlsson (1999:151) has the following critique about Homer-Dixon's theory:

> "Yet, opting for the terms "ingenuity" and "ingenuity gap", Homer-Dixon never takes the last step. I can but speculate about the reasons, since the parallel seems so obviously fruitful: i) the resources societies need to mobilize in order to deal with challenges posed by scarcities of natural resources are distinctly social in character; ii) a failure to mobilize enough such social resources rightly ought to be termed a social resource scarcity; iii) highlighting the social resource scarcity aspect of a perceived natural

> resource scarcity shifts the attention from attempts of "getting more" of the scarce resource (often frustrating and conflict-creating), to concentrating on efforts to adapt" (Ohlsson, 1999:151).

So what is missing from this conceptualization is the ability to change the nature of the underlying paradigm that informs water resource management. Yet again the so-called Paradox of Perception enters into the equation. While this paradigm is changing at present, it is still generally about seeing water as a problem (Ohlsson & Lundqvist, 2000), and as such it is still predominantly first-order in focus, even if it has introduced some second-order dimensions (refer to Figure 2).

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 (refer to Paragraph 2 entitled “Methodological and Epistemological Concerns”). 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 in Figure 3 and in the section of this Analytical Paper entitled “Theoretical Distinction Between First and Second-Order Resources” (Paragraph 3.3), 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 12, which 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. (Refer to the discussion on "Methodological and Epistemological Concerns" in Paragraph 2.)
    - 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 12) it can be shown that the four hypotheses that have been presented in the section of this Analytical Paper entitled "Theoretical Distinction between First and Second-Order Resources" (Paragraph 3.3 below Table 3) are valid (Turton & Warner, 2001).

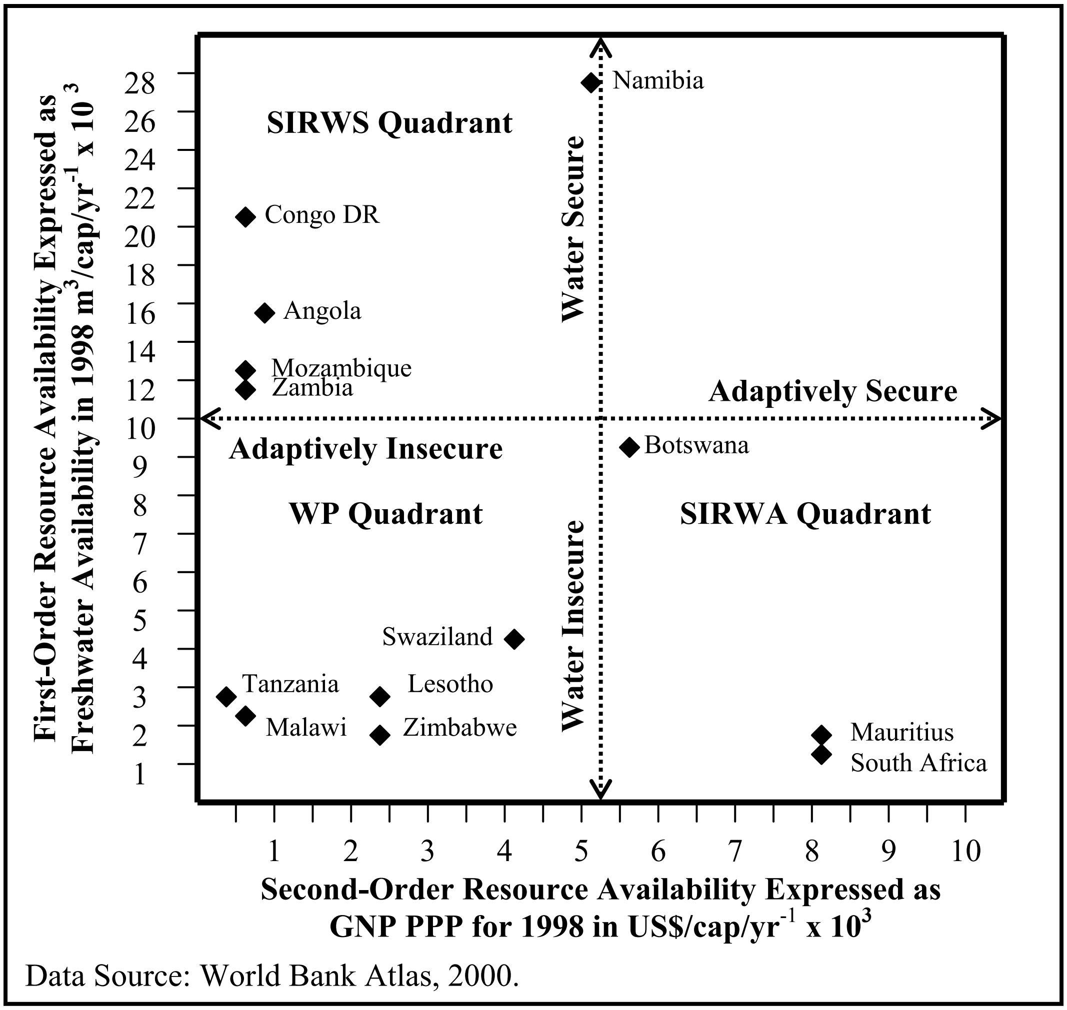

Figure 12. Matrix showing the relationship of both First and Second-Order Resources in Southern Africa (Turton & Warner, 2001; Turton 2002a:199).

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. With respect to institutional development in international river basins, the following key questions can be considered to be indicators:

- Is there hydrological data that has been institutionalized?

- Is this data uncontested and therefore seen as a legitimate basis for future agreements between the respective riparian states?

- Are there agreed-upon rules and procedures?
    - If so, have they been formalized, or do they exist only as a loose arrangement?
- Is there a dedicated conflict resolution mechanism as part of the overall institutional arrangement?
    - If so, has it been used and what has been the outcome?
- Has there been a re-definition of the core management problem away from perceiving water scarcity in an absolute sense, to perceiving water scarcity in a relative sense?
    - To what extent has WDM become one of the institutional objectives?
    - Is there any evidence of Inter-Sectoral Allocative Efficiency being a policy objective?
- Is there a mechanism to sanction non-compliant actors?
    - If so, has it been used and what has been the outcome?
- Has there been any redistribution of water resources between the various riparian states directly as the result of the regime, and if so what has been the outcome?
- Is there any evidence of regime resilience?
- Is there any evidence of regime robustness?
- Is there any evidence of regime effectiveness?
- Is there any evidence of the growth and development of institutional knowledge or institutional learning as the result of the regime?
    - If so, to what extent has this become a confidence-building and unifying factor?
- Can the existing water management arrangements within the international river basin in question be called a regime?

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. Quite the contrary is true. The current IUCN initiative is highly 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. It can be said that the IUCN is promoting institutional learning and the conversion of information into knowledge, which was shown in the section entitled “Ingenuity and Institutional Learning” (Paragraph 4.5) to be of great importance. For this opportunity the authors are extremely grateful.

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 authors, 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:

- <u>Strategic Issue-Area No. 1: Accept that Diversity is the Norm</u>. 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.

- <u>Strategic Issue-Area No. 2: Focus on Institutional Development</u>. 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 document 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 detain 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

This Analytical Paper has been prepared in order to synthesize the research work that has been done in a number of different venues in order that the people responsible for managing the water sector in Southern Africa can benefit from this new knowledge. As far as the authors know, this new knowledge is not yet in the mainstream water sector literature in anything more than fragmented forms, so the intention has been to make this Analytical Paper as comprehensive as possible. 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!

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Turton *et al.,* 2000b; Turton *et al.,* 2001; Mucheleng'anga, 2001; Musonda, 2001). This has improved the epistemological basis of the concepts under development.

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