WATER AND SUSTAINABLE DEVELOPMENT: A SOUTHERN PERSPECTIVE

Brief address of author

A.R. Turton, African Water Issues Research Unit (AWIRU), Department of Political Sciences, Pretoria University, Pretoria 0002, South Africa awiru@postino.up.ac.za

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Short contents list

Glossary of terms, abbreviations, symbols

Discursive Elite. The discursive elite comprises those persons who are in a dominant position within bureaucratic entities and who can determine the nature, form and content of the prevailing discourse, also known as the sanctioned discourse. The discursive elite legitimizes or sanctions the prevailing discourse.

Hydro-Social Contract. The hydro-social contract is the unwritten contract that exists between the public and the government (Turton & Ohlsson, 1999), that comes into existence when the individual is no longer capable of mobilizing sufficient water for their own personal survival, and that acts as the mandate by which government ultimately takes on and executes this responsibility. This hydro-social contract thus acts as the basis for institutional development, and also determines what the public deems to be fair and legitimate practice such as the desire for ecological sustainability, to which politicians react.

Reflexivity. Reflexivity is said to exist when a social grouping becomes concerned by the undesirable and unintended consequences of their actions (Giddens 1990), such as environmental degradation caused by industrialization, and actively seek to limit these consequences by developing coherent strategies, policies and regimes to effect these desires.

Sanctioned Discourse. The sanctioned discourse is the prevailing or dominant discourse that has been legitimized by the discursive elite within the water sector at any one moment in time. It represents what may be said, who may say it is and how it may be interpreted, thereby leading to the creation of a dominant belief system or paradigm.

Second-Order Resource. A second order resource is the level of social adaptive capacity available for a social entity (Ohlsson, 1998; 1999) to confront and effectively manage increasing levels of water deficit.

Structurally-Induced Relative Water Abundance (SIRWA). Structurally-induced relative water abundance is said to exist when a social entity that is confronted by an increasing level of water scarcity, manages to mobilize sufficient social resources with which to effectively adapt to absolute scarcity (Turton & Ohlsson, 1999). Due to the existence of high levels of social capital, such an entity will have artificially managed or induced a degree of relative water abundance and will practice sustainable development within environmentally acceptable parameters.

Virtual Water. Virtual water is the volume of water needed to produce a commodity or service (Allan, 1996a). This enables trade in commodities that have a high virtual water content such as wheat in order to balance a water budget. Trade in virtual water is thus an environmentally sustainable strategy for coping with water deficit with the added advantage of being politically silent (Allan, 1997).

Water Deficit. Water deficit refers to the prevailing condition that exists when the consumption of freshwater within a given social entity exceeds the level of sustainable supply (Turton & Ohlsson, 1999).

Water Demand Management. Water Demand Management (WDM) refers to a set of reflexive coping strategies that water resource managers develop that are designed specifically to reduce the demand of water, as opposed to the augmentation of supply. The existence of an effective WDM strategy is an indicator of the existence of second-order social resources (Turton & Ohlsson, 1999).

Water Poverty. Water poverty is said to exist when a social entity that is confronted by an increasing level of water scarcity, fails to mobilize sufficient social resources with which to make the adaptation effectively (Turton & Ohlsson, 1999). Due to the lack of social capital, such an entity will be confronted by the consequences of the collapse of aquatic ecosystems, which will further exacerbate their existing developmental problems.

Body of the contribution

Introduction

The concept of "sustainable development" sounds so tantalizingly nice that it flows off the tongue as if it has real meaning. In reality, it is extremely difficult to define what sustainable development actually is, or more accurately, how to achieve it as a coherent policy strategy, especially for a developing country. This contribution will explore some of these contradictions and nuances, and will attempt what the author has just said is almost impossible to achieve - a reasonable definition of sustainable development within the context of water and aquatic ecosystems from the perspective of a developing country.

Defining sustainability in dynamic political economies

For developing countries, mostly found in the South, the concept of "sustainable development" is as elusive as the proverbial mirage in a desert. An example serves to illustrate this. Namibia is an extremely arid country with a large surface area, low precipitation levels and a relatively small population relative to geographic size. Yet water sector officials there acknowledge that,

> "For a number of reasons the call for sustainable development and the need to increase the use of water in Namibia seems almost incompatible. … Can Namibia afford sustainable development? The answer for the short-term may be no! This year and next year it may be cheaper and more expedient to supply whatever water is wanted, wherever it is wanted, to whoever is demanding it. " (Heyns *et al.,* 1998:3-12).

Such is the dilemma for developing countries in arid regions. Two empirical examples illustrate the point precisely. Figure 1 shows the demographically-induced water consumption curve for the city of Windhoek in Namibia. From this it is evident that there is a close correlation between water consumption and population growth, hence the most appropriate name for the phenomenon being the demographically-induced water consumption curve. As population grows, so too does water demand. Yet this data set only shows a small part of the problem. The heart of the problem being confronted by developing countries in arid areas lies in the population factor, and this is where it starts to get complicated. The population factor consists of a number of issues that are difficult to do much about in the short-term, at least for many governments in the developing world.

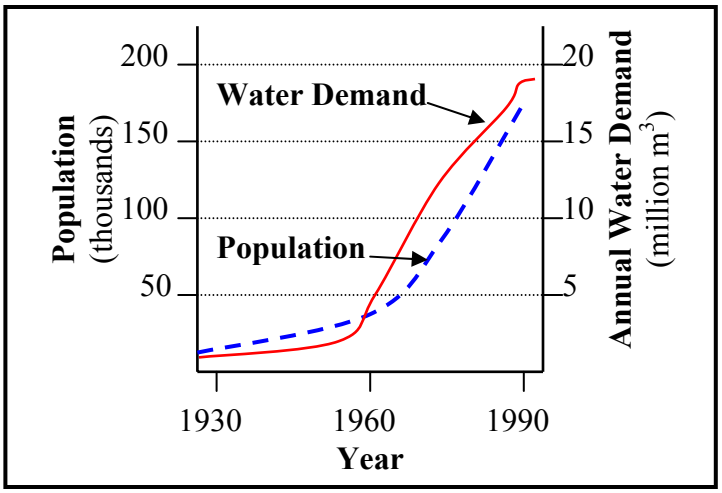

Figure 1. Example of Demographically Induced Water Consumption for the City of Windhoek (after Jacobson *et al.*, 1995:57).

Firstly, there is the population migration factor. It is this factor that is evident in the Windhoek case presented in Figure 1. People are migrating to the urban centres in response to at least two stimuli. Population-push factors include aspects such as a complex interaction between ecological marginalization, which is a political and economic factor, and resource degradation, which is an ecological factor caused from over-exploitation and the resultant collapse of aquatic ecosystems.

Secondly, there is the population-pull factor. This is what serves as an attractant to urban centres and it is driven by the interaction of the existence of better opportunities for employment in urban centres, which is a political and economic factor, and the perception that people have about a better life, which is a social or psychological factor. In reality there may not be a better life in the urban centres, but this is not a deterrent. People are driven largely by perceptions of reality, rather than by reality itself. This is what makes the problem complex.

These two factors interact and cause the next phenomenon, which lies at the heart of the dilemma. Because people aspire to a better life, they want to experience a degree of upward mobility. This is logical and indeed morally justifiable. People ought to be able to live better lives in the future than they did in the past. Yet for large parts of the developing world this is not the case and is manifest as a set of slums around urban centres. The problem is that the developing world is trying to model itself on the developed world, but the latter only achieved development at the cost of severe ecological degradation. Northern-based consumption patterns are thus not the ideal model to follow, but there is no viable alternative.

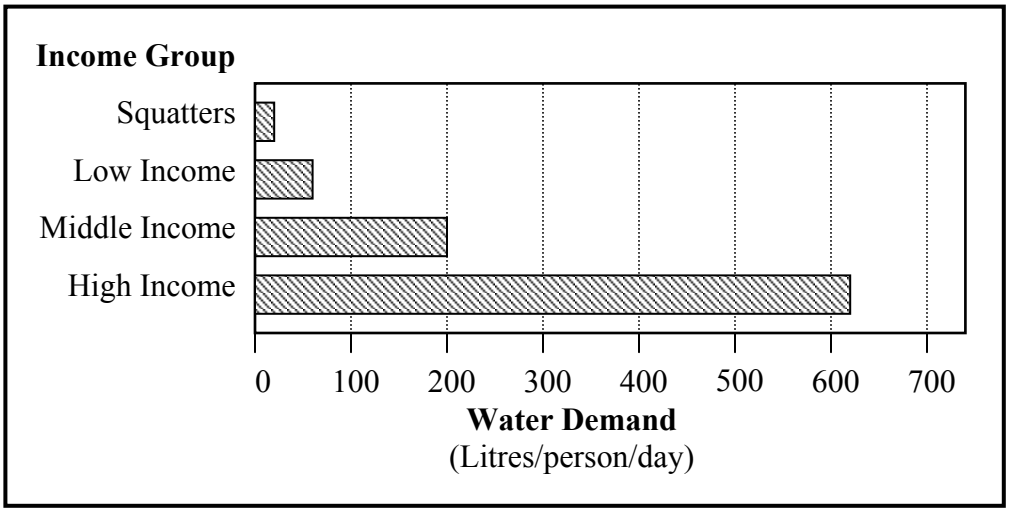

Figure 2. Graph Showing Daily Water Consumption per Person Expressed as a Function of Income for the City of Windhoek (after Jacobson *et al*., 1995:57).

Figure 2 shows what happens to water consumption as the result of urbanization. Again this data set comes from Windhoek, Namibia as it illustrates the point being made. Squatters, or those unfortunate people who live in informal settlements around the urban centres, consume a minute volume of water per capita per day. There is a naturally occurring limiting factor at work here. The absence of piped water in each house acts as a physical deterrent. It is arduous to carry water in a bucket on your head for great distances under the blazing sun, so water consumption is limited. But people aspire to more stability and a better quality of life, and rightly so. Squatters move into low-income houses when they can afford it, and the impact on their daily life is enormous. Security of tenure and the existence of running water on the property itself is a major milestone of development. The social impact is better political stability, which is clearly a desirable state of affairs. This manifests as an increase in demand for water. It is easier to open a tap than to carry a bucket, so more water is consumed. For many, this is a tangible manifestation that their quality of life has improved and they relish it. The same thing happens as people become upwardly mobile, but with each jump in income group, an exponential growth in water consumption occurs. The result is that the water consumption per capita in Windhoek is about one order of magnitude more for a person living in a high-income neighborhood than for a person living in an informal settlement.

This is the dilemma. Government must provide basic services like water and sanitation and it must meet the minimum level of expectations that the electorate has, or else political instability is imminently likely. The latter is clearly an undesirable condition so government seeks to avoid this, even if this means long-term ecosystem collapse. This is perceived as less immediate a danger than the very real problem of widespread social or political instability that can occur in the short-term. In effect, the environmental endowment of a future generation is sold off cheaply in order to satisfy the needs of the current generation. The problems of the here and now are more pressing than those of tomorrow. This is the crux of the matter when it comes to water and sustainable

development form the perspective of a developing country. It is a vicious spiral that is difficult to break.

Some theory: The environmental Karshenas Curve

So much for the facts as illustrated in the Namibian example. What do theoreticians say about it? Probably one of the most useful sets of environmental theory that serve to explain aspects of the above-mentioned phenomenon is that known as the Karshenas Curve.

Dr. Masoud Karshenas is a resource economist, who worked in conjunction with Prof. Tony Allan at the School of Oriental and African Studies (SOAS) in London, and they set out to explain linkages between the environment and economic development (Allan & Karshenas, 1996:127). They isolated what they considered to be two key variables. The independent variable consists of the stock of environmental resources such as water that is available to a political economy. This is plotted on the horizontal axis, with a critical threshold being the minimum beyond which development would become unsustainable. This is evident as the vertical dotted line on Figure 3, with the area to the left of that representing ecological catastrophe. The dependent variable is the standard of living, and this is plotted on the vertical axis. A critical threshold in this regard being a minimum standard of living, shown as a horizontal dotted line in Figure 3, with the area beneath that representing a Malthusian catastrophe. The concept of water and sustainable development can thus be represented graphically as coinciding with the area on the graph above these two minimum threshold points. In other words, sustainable development would exist in the upper right-hand portion of the graph.

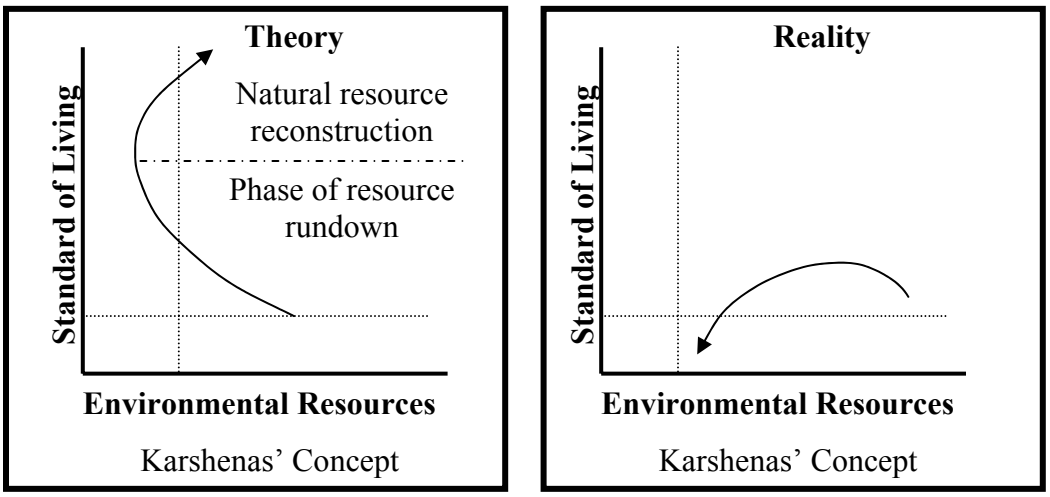

Figure 3. A rendition of the Karshenas Curve showing phases of resource rundown and subsequent natural resource construction (After Allan & Karshenas, 1996). The change in trajectory is known as "reflexivity".

The Karshenas curve shows that in theory, as a political economy starts to develop, it initially reduces its stock of environmental capital (water). This developmental trajectory may cross the threshold into unsustainability, but then through a series of policy interventions, the government can change this trajectory sufficiently to bring the curve back into the area of sustainability. This is shown in the left-hand graph of Figure 3. The portion before the trajectory change can be called the phase of resource rundown, with the portion after the trajectory change being called the phase of natural resource reconstruction. In reality, the political economy concerned may not show evidence of crossing the threshold that is represented in the left-hand graph. This is shown merely to illustrate the point being made - that a government can change the developmental trajectory if it chooses to adopt the so-called "precautionary principle" that is central to an understanding of the concept of "sustainable development". The graph on the right-hand side shows what happens in reality in many developing countries found in sub-Saharan Africa. As the country tries to develop, it consumes its stock of environmental resources such as water, but fails to translate this into an improvement in the standard of living for its citizens. The Namibian case mentioned in the beginning of this article is indicative of the early phases of this phenomenon. As more natural resources are consumed, the resultant ecosystem degradation does not effectively translate into an improved standard of living. This in turn means that government is impoverished and rendered incapable of making the policy interventions that are needed to change from the phase of resource rundown to a phase of natural resource reconstruction. As ecosystems collapse, this triggers a series of events that can result ultimately in social and political collapse if left unchecked. Under such conditions, the government is rendered incapable of rectifying the problem, so political decay and social instability set in and become increasingly manifest over time.

Thus from a theoretical point of view, the Karshenas curve shows that a country tends to initially run down its stock of environmental resources in the quest for development. While this is clearly undesirable from an ecological point of view, it is what happens in reality and therefore needs to be understood as such. If this development is successful, then the developmental trajectory will translate this resource consumption into an improvement in the standard of living for its citizens without compromising ecosystem integrity. The early phases of this process represent resource rundown, but at a point when the government has sufficient capacity to do something about it, a series of policy interventions alter the developmental trajectory and make it move into the portion of sustainability. This second portion becomes sustainable and a phase of natural resource reconstruction is launched during which degraded ecosystems are rehabilitated and environmentally friendly development practices become the norm.

In technical terms, the phenomenon of "turning the curve" is known as reflexivity. Social theorists Beck (1992) and Giddens (1990) argue that the late twentieth century is increasingly characterized by a new phase of modernity, which they call "reflexive modernity". The popularization of environmental principles represents a reflexive response to the problems that are associated with a risk society. This has a direct implication for the notion of sustainable development. Before development can be considered to be sustainable, reflexivity has to take place. In other words, sustainable

development can be considered to be the dependent variable, with reflexivity being a necessary pre-condition (or interceding variable) for it to exist. If there is no reflexivity, then consumption of environmental capital will continue until such time as the ecological catastrophe that Karshenas predicts occurs.

Significantly, endeavors such as the EOLSS can be categorized as being evidence of reflexivity. The central theme of the EOLSS project is to change perceptions about the environment and the relationship that people have with organisms that co-inhabit the environment.

Central to the notion of reflexivity is the whole North/South development debate. Stated simplistically, the developed North has become reflexive and hence concerned with the unintended outcomes of industrial modernity. They wish to reduce the consumption of natural resources, limit carbon emissions and restore ecosystem health on a global scale. The best example of this is the United Nations Framework Convention on Climate Change (UNFCCC). An analysis of the cleavage lines that exist in this complex series of negotiations reveals this North/South debate dramatically. The issue is that they can afford to do this in the North, because they have reached population stability, and therefore have a reasonable standard of living per capita with which to achieve this objective. The developing countries of the South are not so fortunate. They are confronted with large population growth levels and increasingly complex problems that need to be solved, all of which needs to be done with an ever diminishing budget in human, financial and environmental terms. One therefore needs to understand this aspect more if one tries to understand the complexities of water and sustainable development from the perspective of a developing country, such as the Namibian case quoted in the beginning of this contribution.

Perceptions of water and water landscapes

What drives the consumption of water and the consequent destruction of aquatic ecosystems? The key to this question lies with the perception that people have of the environment in general, and water in particular. This is a major study in its own right, so only a brief overview can be presented here. What does sustainability actually mean? Is it a useful concept in any way? How does one attain it and how do we know how far we are from the goal? These are vexing questions that are almost impossible to answer. They sound intuitively easy, but are in fact extremely difficult. They are also vitally important for the governments of developing countries to understand. Jacobson *et al.,* (1995:11-12) note that there are three elements of sustainability. These are economic sustainability or the effective planning of resource use; environmental sustainability or the use of resources effectively; and social sustainability involving the rights and responsibilities of human beings. Intuitively this sounds good, but it does not help us with a crisp definition of the concept. Hjort-af-Ornäs & Lundqvist (1994:4) define environmental sustainability as,

> "a condition which guarantees that the functioning of ecosystems is not impaired, and that the quality of goods and services that emanate from the

> natural capital [endowment of the social entity] is not reduced or changed so as to increase the risk for human life and well-being".

Sustainability can also be linked with equity in terms of the social, economic and inter-generational dimension. In this form, sustainability can be expressed as inter-generational equity, or a reflexive response that inhibits the consumption by one generation at the expense of another. While this is good from an academic perspective, how does it help a developing country like Namibia that has a relatively limited range of options and is thus forced to degrade ecosystems in an attempt to achieve economic development?

The problem with any attempt at defining the notion of sustainable development is that it consists of two concepts that are mutually exclusive of one another. If the emphasis is placed on the "development" aspect of the concept, then it implies the need for economic growth, expansion of markets and therefore the accelerated consumption of environmental capital. This is the perspective of the developing world. They need to grow rapidly in order to meet basic aspirations and generate sufficient wealth to distribute to a burgeoning population. This translates into a contradiction of the concept of "sustainability". If the emphasis is placed on the former aspect of the concept - "sustainability" rather than "development " - then the classic "Tragedy of the Commons" (Hardin, 1968); "An Inquiry into the Human Prospect" (Heilbronner, 1974); the Club of Rome's "Limits to Growth"; and the Ecologist Magazine's "Blueprint for Survival" argument comes into the picture, implying that aggressive development needs to be curtailed. This whole debate is encapsulated in the political ecology discourse such as the work of Eckersley (1997:11-12), Bryant & Bailey (1997), Leach & Mearns (1996) and Turton (2000).

The bottom line is that perceptions drive human behavior, and it is human behavior that is responsible for ecosystem health. This can be illustrated by an example from another country in an extremely arid area. The Yemen provides an excellent case study of perceptions (Lichtenthäler & Turton, 1999). The Sa'dah basin of Yemen is extremely dry. It is occupied by a number of tribes, many of which are in conflict with one another. This conflict has a long history, and can be said to be deeply ingrained in the fabric of society there. The dominant normative order is determined by Islam and the Quranic principles central to this belief system. One of these central Quranic principles is that "with respect to sustenance, Allah has favoured some over others" (translation of Surat 16:71 [*Al-nahl*] by Lichtenthäler, 1999). This accounts for the amazing lack of conflict over water, because perceptions are that if one person has more water than another, then that is the will of God and should not be questioned. Large volumes of water were discovered in an alluvial aquifer and this started a race to harness the resource. Here another Islamic principle is involved. Landowners have the right to utilize and abstract groundwater on their own property as long as they do not waste this God-given resource, but wasteful practices are not clearly defined. This fuelled the desire to develop irrigated agriculture. As wells were sunk, so the water table dropped, necessitating subsequent deepening of the wells. When some people could no longer afford to deepen their wells, there was still no conflict over water, even in the face of a long history of internecine strife, because "Allah had favoured some over others" (Lichtenthäler, 1999). However, when the long-

term environmental consequences of the fall in groundwater tables by 4-6 metres a year were explained to Islamic scholars, the usual reply was "everything is all ordered by God" (Lichtenthäler, 1999). In short, the threat of environmental collapse has no impact under these cultural conditions, and will not induce a change in human behavior, because the prevailing perception is that when the ecosystems fail, then it is the will of God and He will provide the solution at that time. This is a fatalistic view of the future in which it is accepted that current actions need not be modified, so reflexive responses are unlikely emerge until after the event.

The perceptions of water are not only confined to social systems that have a deeply traditional orientation. In the West perceptions of water also impact on the way that aquatic ecosystems are treated. This occurs through the mechanism known as the "sanctioned discourse" that forms a type of paradigm, defining the problem on hand and the type of solutions that are acceptable. 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. Of even greater importance, the sanctioned discourse defines the relationship of the individual technocratic elite within an institutional hierarchy as it is logical to assume that an individual who challenges the prevailing conventional wisdom would find themselves running out of career advancement opportunities. For example, if the sanctioned discourse is based on irrigation, then the discursive elites would be from an irrigation background and the dominant jargon in use would reflect this. This would find its way into regimes and be reflected in their rules and procedures. The American hydraulic mission was based on the Land Reclamation Act, which gave rise in turn to the Bureau of Reclamation as the dominant bureaucratic entity. Within this bureaucracy, the jargon used was based on a notion of "conserving" the freshwater that flowed to the sea (which was perceived as being wasted), by building dams and piping it to "reclaim" the desert from nature. In terms of this sanctioned discourse, wild rivers were thus in need of being tamed, and they had little intrinsic value by just being wild. This in turn gave rise to a technocratic elite with a specific profile. Reisner (1993:114) notes that, "the engineers who staffed the Reclamation Service [at that time] tended to view themselves as a Godlike class performing hydraulic miracles for grateful simpletons who were content to sit in the desert and raise fruit". In Spain, the Corps of Engineers is highly elitist, intellectualist, 'high cultured', male dominated, socially homogenous and an exclusive organization that has taken a leading role in Spanish politics and development over the centuries (Mateu Belles, 1995 in Swyngedouw, 1999). Waterbury (1979:101) eloquently describes the sanctioned discourse at the time that the decision was made to construct the Aswan High Dam by quoting from the *Rubayyat of Omar Khayyam*: "When the King says it is midnight at noon, the wise man says behold the moon". The sanctioned discourse is thus a critically important concept to grasp when seeking to understand the social stability aspects of water, as it in effect provides the key to the code with which the researcher can decipher what is actually happening in society.

In some social entities, rivers are the source of danger and are therefore feared by the public. This gives rise to the desire to subjugate such rivers by encasing them in concrete and steel. There are many examples of this, including Los Angeles in California, Laingsburg in South Africa and many of the Mediterranean countries such as Greece and

Spain. Significantly these regions have rivers that are extremely variable, with the ability of changing from a dry riverbed to a raging torrent in the matter of minutes. The Dutch have a history of flooding, so they have a hydraulic culture that seeks to control and straighten these rivers, reinforcing their banks, building dykes and generally managing water at the level of the flood. The Israeli's have a history of drought, so they have a hydraulic culture that seeks to recycle, measure, apportion and control water at the level of the individual drop. In other social entities, rivers are a source of pleasure and tranquility and are therefore loved by the public. This in turn gives rise to the desire to sustain ecosystem health along the riparian fringe of such rivers because this is perceived by the public to be correct. English rivers generally fall into this category, but the public in cities such as Toronto share this perception of their own rivers. In these cases, the rivers are mellow and less variable, so they are not regarded as being a source of danger and therefore are left in a more natural (but still controlled) state. Consequently, it can be accepted that a specific hydraulic culture exists in specific social entities, and this culture is driven by historic experience that in turn determines the perceptions that people have of rivers and aquatic ecosystems in general.

The Sa'dah basin in Yemen also provides some excellent examples of the different notions of "value" with regard to returns to water (Lichtenthäler & Turton, 1999). The economic value alone does not explain the actions or responses of a Yemeni farmer with respect to water (Lichtenthäler, 1996). Great social importance continues to be attached to the cultivation of land and to the production of homegrown foods, whether economically viable or not. To a certain extent, some evidence exists that farmers have responded in an economically rational way by meeting the demands for certain cash crops, but this is limited. These returns are combined with income from other activities and often subsidize those agricultural activities, which are perceived to have a high social and political value. Cereals are not only central but also absolutely essential to Yemeni cuisine. Importantly, the perceived social and cultural values of some home grown varieties – of which 25 are known for sorghum alone – and their distinct place and function within Yemeni daily life, explains the strong preference for local grains over foreign imports. Moreover, homegrown cereal foods, especially at lunch, are believed to enhance the daily and socially significant *qat* chewing experience in the afternoon. *Qat* is a mild stimulant chewed by the majority of Yemeni men in the company of friends and relatives. The production and consumption of homegrown cereals strengthens social values and notions of identity. These are more significant than economic and environmental rationality when it comes to making a decision about allocative efficiency and returns to water (Lichtenthäler & Turton, 1999).

The Sa'dah farmers have chosen to grow fruit trees, partly due to political and economic incentives, but also partly because of the notions of prestige attached to such production (Lichtenthäler & Turton, 1999). Unlike the farmers in the Amran basin, who grow mainly seasonal vegetables and are thus able to respond quickly to changing market conditions (Handley, 1996), the Sa'dah farmers are locked into a long production cycle spanning a number of years from planting to first harvest (Lichtenthäler, 1999). Alfalfa for livestock production is a major consumer of groundwater (Lichtenthäler, 1999) and irrational in the

context of water scarce conditions, yet it persists for social reasons such as the status of owning livestock.

Such is the power of perception - it drives human behavior in all cultural settings from America to the Yemen and from Spain to Namibia.

Water poverty and water scarcity: two useful concepts

What has been shown above is the fact that sustainable development within the context of aquatic ecosystems is a nebulous concept indeed, especially when examined from the perspective of policy options for a developing country. What is needed to change the phase of resource rundown into natural resource reconstruction as suggested by Karshenas? A hint as to the answer is found in the aspects of perceptions. It is the human perception of themselves in relation to ecosystems that holds the key. As long as humans perceive themselves to be separate from their life support systems, then reflexivity is unlikely to occur. It is only at the point when a social entity consciously decides that their own wellbeing is dependent on the wellbeing of the ecosystems of which they are part, that reflexivity starts to occur.

The burning question is therefore, how can reflexivity be achieved? This gives us a hint as to the existence of another form of resource that has hitherto been ignored in the environmental discourse. Dr. Leif Ohlsson (1998; 1999) has done some pioneering work into the existence of what he calls a second-order resource. He builds up his argument as follows. Natural resources such as water can exist in various quantities within a geographic entity, ranging from relative abundance to relative scarcity. It is the existence of these resources that determines the natural endowment of a country or region. These natural resources are what Ohlsson (1999) calls a first-order resource. Whilst these are important from a developmental perspective, what is likely to become the critical determinant of social stability in future is the way that social entities adapt to increasing scarcities of these first-order resources such as water (Ohlsson & Turton, 1999). Ohlsson (1998; 1999) defines these second-order resources as being the capacity of a social entity to make the necessary adaptations in order to successfully cope with rising levels of first-order scarcity. This conceptual difference enables a whole new research focus to be developed.

Let us recap on the argument as it has been presented thus far. It has been shown that a necessary pre-condition for environmentally sustainable policies to exist is reflexivity. Reflexivity in turn is dependent on perceptions. Perceptions cause a change in human behavior that is manifest as a shift from resource rundown to a phase of natural resource reconstruction as visualized by Karshenas and Allan. Perceptions are culture bound and can be regarded as social resources. Therefore, for a change in the consumption patterns of a first-order resource such as water to occur, a second-order resource known as social adaptive capacity must also exist. If no social adaptive capacity exists, then no reflexivity will be unleashed and a change in the developmental trajectory will fail to materialize, resulting in the environmental catastrophe that Karshenas' model shows.

Armed with Ohlsson's (1998; 1999) concept of second-order resources, a whole new dimension is thus added to the environmental discourse. Clearly not all countries that are faced with water scarcity have this impact negatively on their economic growth potential. Israel is a case in question. Despite being beyond what Prof. Malin Falkenmark (1989) defines as the "water barrier", Israel seems to be able to survive and indeed prosper. According to Dr. Eran Feitelson (1999), Israel can be regarded as being water scarce but not water poor. This prompted hydropolitical researchers (Turton & Ohlsson, 1999) to develop a new set of concepts that are capable of making the conceptual distinction between "water scarcity" and "water poverty".

By presenting the different possible combinations of first and second-order resources within a social entity, Turton & Ohlsson (1999) were able to show that water poverty is indeed different from water scarcity as originally suggested by Feitelson (1999). The Turton/Ohlsson matrix is presented as Figure 4.

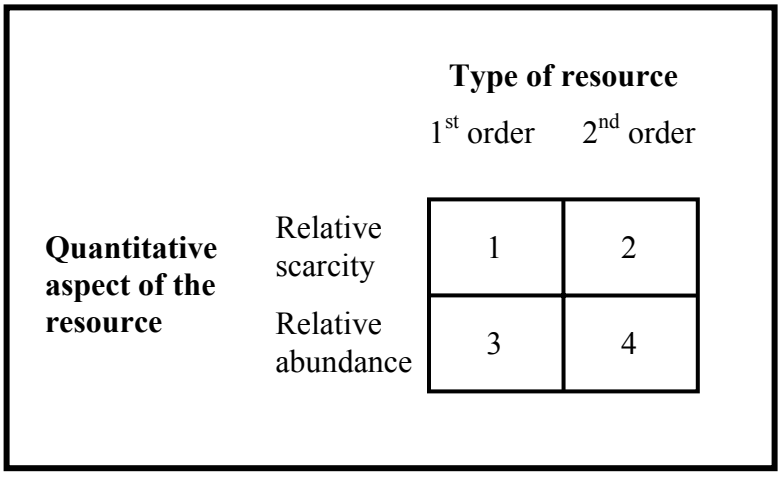

Figure 4. Matrix showing possible variations of type of resource and quantitative aspects of the resource (Turton & Ohlsson, 1999).

The type of resource is shown on the horizontal axis, with a distinction between first and second-order. Thus a first-order resource such as water exists in different combinations with a second-order resource such as social adaptive capacity in this model. On the vertical axis, degrees of availability are plotted, ranging from relative scarcity to relative abundance. This enables two key concepts to be developed. "Water poverty" is defined as being the combination of a first-order resource scarcity (block 1) and second-order resource scarcity (block 2) simultaneously (Turton & Ohlsson, 1999). Under such conditions, the social entity concerned will be unable to make the adaptation to absolute water scarcity successfully, resulting in ecosystem collapse, political decay and social instability. "Structurally-induced relative water abundance" (SIRWA) is defined as being the combination of a first-order resource scarcity (block 1) and a second-order resource abundance (block 4) simultaneously (Turton & Ohlsson, 1999). Under such conditions, the social entity concerned will be capable of making the necessary adaptation to absolute water scarcity, and will be able to prevent ecosystem collapse by engaging in natural

resource reconstruction. In short, such an entity will have induced a relative abundance of water by effectively mobilizing social resources, in the correct volume and at the correct time, in order to develop a set of coping strategies with which to effectively manage the problem.

Adaptive capacity and water resource management

This enables us to develop a better understanding of water and sustainable development. We can now start to generate a model that will show what sustainable development actually means in the context of water and aquatic ecosystems. Figure 5 shows a number of these concepts in a coherent model.

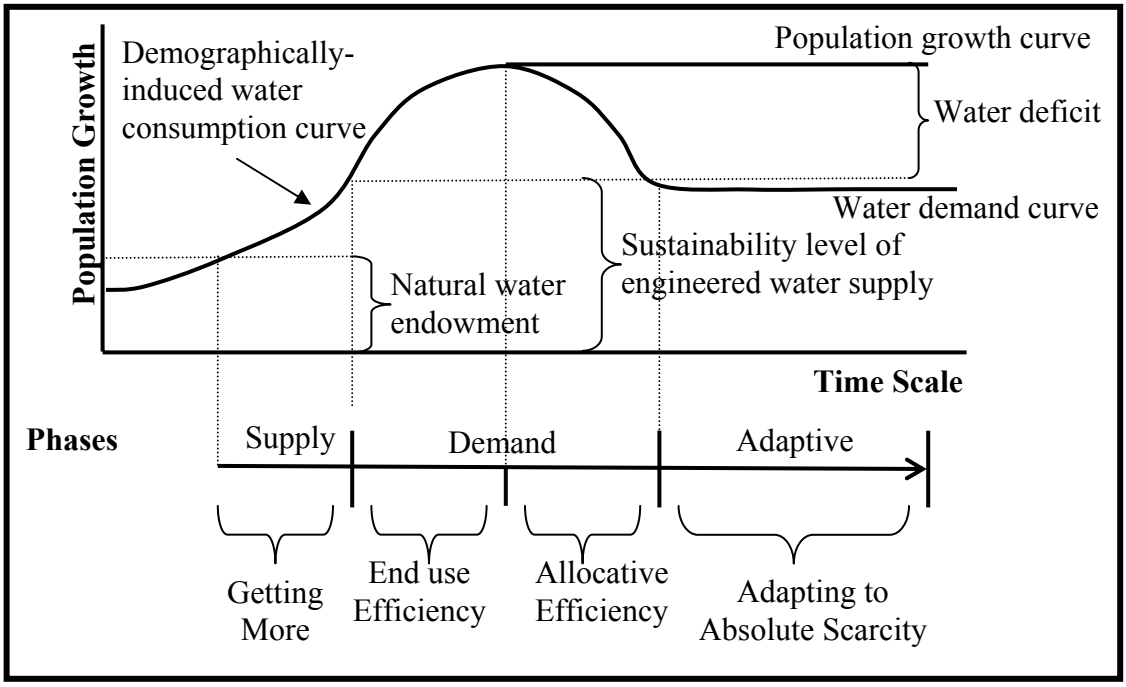

Figure 5. Schematic representation showing how reflexivity is needed to realign population-induced demand with maximum level of sustainable supplies (Turton & Ohlsson, 1999).

Firstly, the demographically-induced water consumption curve moves dramatically upwards in an exponential manner in response to population growth and changes in the overall demographic profile. At a point in time, it passes the limit of the natural endowment of the social entity concerned into a condition of water scarcity. This gives birth to what has become known as the "hydraulic mission" (Reisner, 1993) of society and gives rise to the Supply-Sided Phase of water resources management. A social response to this first transition is the origin of the "hydro-social contract" (Turton & Ohlsson, 1999) that defines the relationship between the public and water service providers such as government. Hydraulic engineers who seek to mobilize water from ever-distant river basins dominate this phase as discursive elites. These efforts improve

the security of supply and serve to enhance the natural endowment at the national, regional or city level, but increasingly alienate people from the resource itself. Hydraulic perceptions change from an intimate relationship with the resource when it was drawn from a private well, to a disjointed relationship when water is drawn from a tap at the end of a long pipeline far removed from the original point of abstraction. These perceptions impact negatively on attempts to conserve the resource, as people feel distant from it, making it an abstract concept.

Secondly, a point is reached where the demographically-induced consumption of water again exceeds the enhanced supply that was developed during the Supply-Sided Phase. Significantly though, due to the increased costs of these now major engineering projects, there is a limitation to the volume of water that can be appropriated by continued Supply-Sided options. Coinciding with this, is the birth of a new social conscience, usually in the form of environmentalism. This is sparked off by the reflexive concern for aquatic ecosystem health that is being negatively impacted on as almost all of the wild rivers are finally subdued by concrete and steel. This becomes part of the changing hydro-social contract, and a new discourse emerges in the public domain. Initially this discourse is hostile and dominated by ecologists and environmental activists, who challenge the exclusive stranglehold that hydraulic engineers have obtained as discursive elites (Turton 1999). This in turn changes the sanctioned discourse, and provided that the environmental activism receives the necessary support from the public in terms of the changing nature of the hydro-social contract, then reflexivity starts to kick in. Initially this is manifest as a new discourse that is characterized by conflict between dam builders and river rights activists, supported largely by reflexive NGOs from the North. Over time, the composition of the discursive elite changes and the Demand Management Phase emerges.

Thirdly, this Demand Management Phase sees the emergence of a series of rational policy changes being considered for the first time. These end the phase of resource rundown that Karshenas shows, and ushers in the phase of natural resource reconstruction. This is only possible if water poverty as defined by Turton & Ohlsson (1999) is not the prevailing condition. If structurally-induced relative water abundance (SIRWA) is achieved, then natural resource reconstruction leads to a set of sustainable development policies being considered and implemented by water resource managers. The immediate result of this is seen as a separation of the demographically-induced water consumption curve, and realignment of the water demand portion of it with the sustainability level of supply that supply-sided solutions can assure. Only once this has happened can one conclude that a condition of sustainable development has been attained, as this is the first tangible evidence that a social entity is living within the limits of its natural aquatic ecosystems.

Fourthly, it is evident that in order to attain the condition of sustainable development, an Adaptive Phase of water resource management has to be successfully entered into (Ohlsson & Turton, 1999). This Adaptive Phase will have as a primary function, the management of water deficit and the reduction in the social, political and economic tensions that this will unleash.

Fifthly, elements of allocative efficiency are crucial in this Demand Management Phase. Typically the agricultural sector consumes as much as 75% of the overall water budget of a political economy, yet it only contributes a small percentage to the GDP, sometimes as low as 5%. This is a low sectoral water efficiency. Agriculture usually employs a large number of people though. The industrial sector typically consumes around 20% of the overall water budget, yet it contributes a major portion of the GDP in industrialized political economies, often in excess of 50%. In almost all cases, this has a much higher sectoral water efficiency, often by one or more orders of magnitude in extent. Rationality therefore suggests that an industrialized political economy is more water efficient than an agricultural one. In order to move from the one to the other, it will entail a major structural change to the economy however. This will impact severely on the social and political fabric of society as migration is induced from the rural areas to industrialized urban centres. Inter-sectoral allocative efficiency is therefore inevitable if sustainability is to be achieved, but this may induce political and social instability in the process, making the problem a complex one indeed. As a result of this complexity, politicians tend to avoid the issue until such time as the reflexive responses from the public at large change the hydro-social contract and therefore induce politicians to change. It is important to understand that politicians only tend to change in response to pressures from their constituencies (or potential constituencies), so it is naïve to believe that politicians will cause a change in public perception. The latter is a rare occurrence and involves a particularly charismatic form of politician capable of drumming up support, but even then, it is only possible if the public want the change in the first place.

Challenges to achieving sustainable development

The major challenge is therefore found in the management of water deficit. The operative word to describe this is the "effective" management of that deficit. It therefore becomes instructive to dwell for a moment on aspects of this. What is likely to constitute an effective management strategy?

Firstly, the problems inherent under conditions of water deficit are extremely complex. In fact, it can be expected that a direct relationship will exist between the level of water deficit and the range and complexity of the problems associated with it. Water deficit impacts negatively on economic growth potential, so this reduces the level of resources that are available to the technocratic elite with which to solve the problems. It is therefore reasonable to conclude that unless sufficient social resources are mobilized, then the problem will remain insoluble and ecosystem collapse will result. Second-order analysis will thus become more important for social scientists in the future when engaging in environmental research, and multidisciplinarity will increasingly become the norm.

Secondly, given the fact that ecosystems straddle international borders, if certain countries are unable to harness sufficient social resources to make the adaptive phase sustainable, then political decay in one country can trigger political problems in another. This can be likened to an environmentally induced domino effect, with ecosystems linking different political economies in a regional context. As such, security is likely to become increasingly linked with ecosystem integrity. Ecological collapse in parts of a

region can mobilize environmental refugees who will migrate to other parts of the region, thereby overloading existing resources in other countries. Environmental diplomacy is thus likely to become more important in the future as security complexes become increasingly defined in environmental terms. The existence of environmental dimensions to security and diplomatic interactions between states can thus be regarded as tangible evidence of reflexivity and attempts at achieving sustainability.

Thirdly, thorny issues such as population growth policies are going to have to be tackled. At present, in many developing countries, population growth mitigation is a taboo subject. It is simply too culturally sensitive and too politically risky for many politicians to try and confront, so they avoid it. If reflexivity is to exist, then a stabilization of population growth is a necessary pre-condition.

Fourthly, water deficit is going to have to be managed in such a way as to reduce the conflict potential inherent in this condition. In this regard, the role of "Virtual Water" is likely to be a key element. This concept was developed by Prof. Tony Allan (1996a), who noted that it takes about 1 000 tonnes of water to produce one tonne of wheat. Therefore, if a country in a water deficit condition imports a tonne of wheat, it is equivalent to importing 1 000 tonnes of water that was used to produce it. This represents the "virtual water" component of wheat. In other words, a country can manage its water deficit if it elevates the definition of the problem from the national political economy to the international one. As such, water scarcities may exist in certain watersheds, but they do not exist at the level of the global hydrological cycle. Therefore, to change the paradigm from a watershed-based understanding of the problem to a "problemshed" definition of the problem, allows politicians to manage the water deficit better by increasing the range of options available. This also acts in mitigation of water wars. Virtual Water is thus an environmentally sustainable component of a national coping strategy, with the added advantage of being politically silent (Allan, 1997). There are preconditions that need to exist before this can be viable however. A country like Japan can import its food because it has a strong economic base with which to finance this activity. A country like Namibia is in another category altogether. Therefore a sound economic base is a precondition of sustainable development.

Fifthly, large volumes of water are found in international river basins. This water becomes increasingly important as water deficits increase. Competition over this scarce water will thus increase in direct relation to its relative scarcity, so one can expect to see an increase in conflict potential within international river basins. International law as it currently stands is inadequate as a conflict regulating mechanism. A vital issue is going to be regime creation between countries within these international river basins. If regime creation is effective, then allocating mechanisms that are considered to be equitable and legitimate will be developed. This will reduce the conflict potential between countries and reduce the risk of water wars. Regime creation will only be possible once perceptions change, specifically regarding the policy choice of food security in preference to one of national self-sufficiency.

Sixthly, Water Demand Management is going to become an increasingly important aspect of water resource management. This is not an easy thing to do, as it is linked with human perceptions of water. There are many case studies that show just how complex this problem is. Demand management is not simply charging a tariff for water or detecting and repairing leaking pipes. These are components of the strategy, but not the entire strategy. Water is not a free good. This is encapsulated in the WINER (Water Is Not an Economic Resource) paradigm that is being developed by Prof. Tony Allan at present. Neither is it a purely economic good. This is encapsulated in the WIER (Water Is an Economic Resource) paradigm that Prof. Tony Allan is developing. In reality, water is both a social and an economic resource, plus more. This is encapsulated in the WISER (Water Is both a Social and Economic Resource) paradigm that the author is currently developing. The existence of the latter means that purely economic instruments will surely fail to meet the desired change in consumption patterns, and effective WDM strategies will have to embrace a range of instruments ranging from the economic to the social and physical. Inter-sectoral allocative efficiency measures will become an integral component of demand management strategies, but given the social disruption that this causes, it will have to be phased in over time and be carefully managed by government.

So what is sustainable development?

Having noted the subtle but important difference between a first and a second-order resource scarcity, and having used different combinations of these two types of resource to develop a set of fundamental concepts, one can now examine how these impact on the notion of 'sustainable development'.

What does sustainability actually mean? Is it a valuable concept? How do we know when we have found sustainability?

The author is of the view that a crisp definition of 'sustainable development' is necessary but probably impossible to achieve. This is unhelpful to both students and practitioners alike, so it becomes necessary to use the academic rules of epistemology to develop a definition. In this regard, the key aspect in achieving sustainable development, in the context of water in developing countries, which are facing water deficit as a limitation to their economic growth potential, lies in the notion of 'reflexivity'. Translated into water resources terminology, reflexivity can be said to exist when overall water consumption in a given social entity does not exceed the available supply that can be reasonably guaranteed without the threat of environmental collapse. This becomes useful as it enables one to develop the model that was presented in Figure 5.

If the key to sustainability lies in the ability of a social entity to become reflexive, then how do we know when reflexivity exists? In an empirical sense, sustainable development can be said to exist when the overall water demand is reduced to the extent that it coincides with the supply of water that engineered solutions can provide, without the risk of both environmental and social collapse. A useful definition of sustainable development in the context of water can now be developed. In this regard, the usefulness will be determined by its ability to be empirically verified. In the context of water resource

management, sustainable development can therefore be defined as the empirical evidence of reflexivity in overall water demand to the extent that the demographically-induced consumption curve is realigned with the maximum level of sustainable supply within a given social entity over time.

Therefore, for reflexivity to occur, the second issue is that effective coping strategies need to be developed and implemented. For these coping strategies to be effective, they will have to limit first-order resource consumption by reducing demand without impacting negatively on economic growth potential, which is a vital issue for developing countries. Thus, for coping strategies to be effective, second-order resources must be in existence in sufficient quantities. In this regard, the distinction between water poverty (an undesirable condition) and structurally-induced relative water abundance (SIRWA) (a desirable condition) is the existence of a high level of adaptive capacity in society. Second-order scarcities are thus the determining factors in the context of water and sustainable development. It is a second-order resource abundance that puts the notion of "sustainability" into the concept of "sustainable development". Analyses of this are largely lacking in the existing literature and it is for this reason that this contribution has been written.

This enables a simple model to be constructed that would give some form of indication of sustainable development. Clearly, if a coping strategy is ineffective then it will fail. One can therefore assume that coping strategy effectiveness (as measured by a reflexive water demand curve) is some form of empirical indicator of the existence of social adaptive capacity. In order for effectiveness to be attained however, there is the necessity for adaptive capacity to exist. In this regard, there are two distinct components of adaptive capacity (Turton, 1999). The first is what can be defined as the structural component that has as an output the generation of alternative solutions by technocratic elites. For this to occur, the pre-condition of institutional capacity and intellectual capital must be met. If the institutional capacity is hindered in terms of distributing financial or other resources, then clearly effectiveness will be impaired. Intellectual capital is also needed in order to effectively identify problems and then develop a range of coping strategies. Intellectual capital on its own is insufficient, as it needs data and other resources on which it can base decisions. The second component is what can be defined as the social one, consisting of the willingness and ability of the social entity concerned to accept the technocratic solutions as being both reasonable and legitimate. This is a dynamic component in which government legitimacy plays a vital role. Clearly legitimate governments will enjoy popular support, which in turn will enhance the chances of the coping strategies to become effective. There is a dynamic interaction between the structural and the social component. If the technocratic elite is too far removed from the broad population, then the coping strategies that they develop such as water demand management may not enjoy popular support and will therefore fail. A profound understanding of the dynamic changes that take place in the hydro-social contract over time is thus needed, as it impacts directly on legitimacy.

Adaptive capacity is a necessary but insufficient condition to make coping strategies effective however. Given the fact that coping strategies seek to manage water deficit by

allocating scarce water (Allan, 1996b:5) in the most efficient manner possible, it implies that a form of cooperation must exist. This cooperation may be between sectors of the economy, between social groupings, between upstream and downstream riparians and between countries that share an international river. Cooperation also allows water budgets to be balanced by trading in 'virtual water' (Allan, 1998:7). By importing products that take a large volume of water to produce, such as wheat, then an effective coping strategy can be developed. Such importation effectively moves water in virtual terms with relative ease and in a politically silent manner (Allan, 1997) without impacting negatively on ecosystem health. In order to trade in virtual water, a degree of economic development is needed, thereby giving a government sufficient leverage to allocate water away from agriculture (a traditionally heavy consumer of water) to industry and domestic consumption (traditionally more efficient users of water). This inter-sectoral water efficiency is therefore a component of an effective coping strategy that is based on a paradigm of cooperation rather than competition. Another important component is regime creation between countries within international river basins.

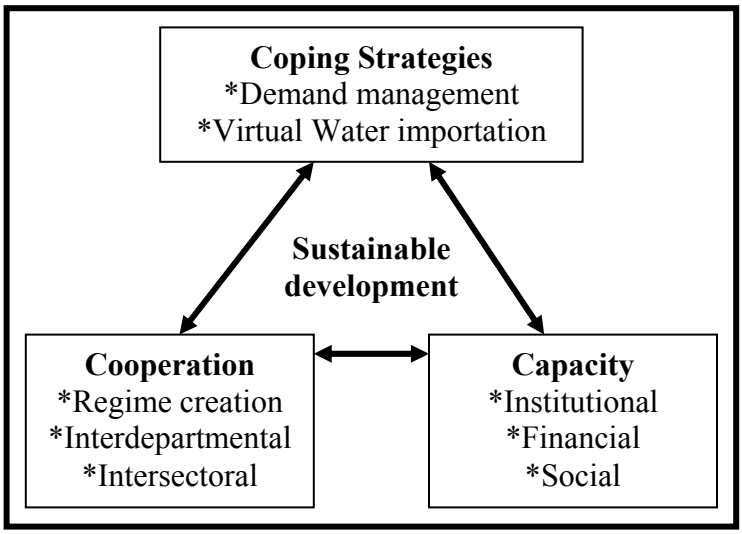

Figure 6. A simplistic model showing the "Three Cardinal C's of Sustainable Development" in a triangular configuration, with sustainable development being the center of the triangle where each of the components are in dynamic equilibrium.

This model can be illustrated graphically by means of a triangle as shown in Figure 6. The three corners consist of the "Three Cardinal C's of Sustainable Development"; coping strategies to reduce demand while maintaining economic viability; capacity in terms of institutional responses and social resources with which to legitimize the coping strategies; and cooperation which forms the basis of regime creation in international river basins. There is a dynamic interaction between these three elements, so sustainable development can be considered to exist when all three are in existence in relative balance to each other. In other words, sustainable development can be said to exist in the middle of the triangle.

Summary

The challenges confronting water resource managers are considerable, particularly in the developing world. Water deficit is a debilitating condition that results in ecosystem failure and economic stagnation. Social and political instability is therefore likely under these conditions. Water poverty is a unique condition that exists when a social entity is facing water scarcity and has limited social resources with which to manage this problem. Structurally-induced relative water abundance (SIRWA) is a condition whereby a social entity facing water scarcity can manage its way out of the problem due to the existence of sufficient social resources. A range of coping strategies are thus necessary if sustainable development is to be possible. These coping strategies will need to embrace aspects such as Water Demand Management, regime creation and Virtual Water importation in order to balance the water budget in a sustainable manner. If these strategies are implemented effectively, then natural resource reconstruction can be implemented. Before this happens though, reflexivity is necessary in society. Reflexivity is a response to changing perceptions of water and environmental impacts of development, so perceptions are the crucial variable in the overall equation. Changing public perceptions of water and hydraulic landscapes, as reflected in the hydro-social contract, ultimately induce politicians to embrace notions of sustainability. The focus for understanding this problem therefore shifts to second-order resources as these are the fundamental determinants of sustainability in the long-term.

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Bibliography

Allan, J.A. & Karshenas, M. 1996. Managing Environmental Capital: The Case of Water in Israel, Jordan, the West Bank and Gaza, 1947 to 1995, in Allan, J.A. & Court, J.H. (Eds.) *Water, Peace and the Middle East: Negotiating Resources in the Jordan Basin.* I.B. Taurus Publishers: London.

Allan, J.A. 1996(a). Personal interview with the author at the School of Oriental and African Studies (SOAS), University of London, Russell Square on 14 June.

Allan, J.A. 1996(b). Policy Responses to the Closure of Water Resources: Regional and Global Issues, in Howsam, P. & Carter, P. (Eds.) *Water Policy: Allocation and Management in Practice.* London: E & FN Spon/Chapman & Hall.

Allan, J.A. 1997. *'Virtual Water': A Long Term Solution for Water Short Middle Eastern Economies?* MEWREW Occasional Paper No. 3. SOAS Water Issues Study Group, University of London, available from Website http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html.

Allan, J.A. 1998. Moving Water to Satisfy Uneven Global Needs: 'Trading' Water as an Alternative to Engineering it, in *ICID Journal*, Vol. 47, No.2; 1-8

Beck, U. 1999. What is a Risk Society? In *Prometheus*, Vol. 1;74-79

Bryant, R. L. & Bailey, S. 1997. *Third World Political Ecology.* London: Routledge

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

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

Feitelson, E. 1999. "Is the Commodification of Water Commensurate with Sustainability Notions?" Paper presented at the Conference on Sustainability, Risk and Nature: The Political Ecology of Water in Advanced Societies, 15-17 April 1999, Oxford University, hosted by the School of Geography and the Oxford Centre for Water Research.

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

Handley, C. 1996. *Water Use Patterns in the Amran Valley, Yemen.* World Bank Report.

Hardin, G. 1968. The Tragedy of the Commons. In *Science*, No. 162; 1243-48. Reprinted in Environmental Ethics, 242-52. Edited by K.S. Shrader-Frechette. Pacific Grove, California: Boxwood, 1981.

Heyns, P., Montgomery, S., Pallett, J. & Seely, M. (Eds.) 1998. Namibia's Water: A Decision Maker's Guide. Department of Water Affairs, Ministry of Agriculture, Water and Rural Development & The Desert Research Foundation of Namibia: Windhoek

Hjort af Ornäs, A. & Lundqvist, J. 1999. Life, Livelihood, Resources and Security - Links, and a Call for a New Order. In Granfelt, T. (Ed.) 1999. *Managing the Globalized Environment: Local Strategies to Secure Livelihoods.* London: IT Publications

Jacobson, P.J., Jacobson, K.M. & Seely, M.K. 1995. *Ephemeral Rivers and their Catchments: Sustaining People and Development in Western Namibia*. Desert Research Foundation: Windhoek.

Leach, L. & Mearns, R. 1996. *The Lie of the Land. Challenging Received Wisdom on the African Environment.* Oxford: The International African Institute in association with James Currey

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

Lichtenthäler, G. 1999. *Environment, Society and Economy in the Sa'dah Basin of Yemen: The Role of Water.* Draft copy of a PhD Dissertation. Geography Department. School of Oriental and African Studies (SOAS), University of London.

Lichtenthäler, G. & Turton, A.R. 1999. *Water Demand management, Natural Resource Reconstruction and Traditional Value Systems: A Case Study from Yemen.* Paper presented in Workshop No. 4: Water and Social Stability of the 9th Stockholm Water Symposium "Urban Stability through Integrated Water-Related Management", hosted on 9-12 August by the Stockholm Water Institute (SIWI) in Stockholm, Sweden. Also available as Occasional Paper No. 14 from Website
http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html

Mateu Belles. 1995. "Planificacion Hidraulica de las Divisiones Hidrologicas", in *Planificacion Hidraulica en Espana*, Fundacion Caja del Mediterraneo, Murcia; 169-206. As quoted in Swyngedouw, 1999.

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

Ohlsson, L. 1999. *Environment, Scarcity and Conflict: A Study of Malthusian Concerns*. Department of Peace and Development Research. University of Göteborg.

Ohlsson, L & Turton, A.R. 1999. *The Turning of a Screw.* Paper presented in the Plenary Session of the 9th Stockholm Water Symposium "Urban Stability through Integrated Water-Related Management", hosted on 9-12 August by the Stockholm Water Institute (SIWI) in Stockholm, Sweden. Also available as MEWREW Occasional Paper No. 19 from Website
http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html

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

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

Turton, A.R. 1999. *Water Scarcity and Social Adaptive Capacity: Towards an Understanding of the Social Dynamics of Managing water Scarcity in Developing Countries*. MEWREW Occasional Paper No. 9, SOAS Water Issues Study Group. Refer to Website http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html

Turton, A.R. & Ohlsson, L. 1999. *Water Scarcity and Social Adaptive Capacity: Towards an Understanding of the Social Dynamics of Managing Water Scarcity in Developing Countries.* Paper presented in the Workshop No. 4: Water and Social Stability of the 9th Stockholm Water Symposium "Urban Stability through Integrated Water-Related Management", hosted on 9-12 August by the Stockholm Water Institute (SIWI) in Stockholm, Sweden. Also available as MEWREW Occasional Paper No. 18 from Website
http://www.soas.ac.uk/Geography/WaterIssues/OccasionalPapers/home.html

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

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