THE PROBLEM:

There is a critical need to develop a theoretical understanding of the way that various societies cope with water scarcity. This is especially true in light of the work that has recently been completed by Ohlsson (1999) which suggests that the ‘adaptive capacity’ of a society should also be regarded as a resource. If this is so, then a society with a low ‘adaptive capacity’ could be regarded as being resource poor. This poses the question as to what will happen to societies that are facing natural resource scarcity while at the same time having a scarcity of ‘adaptive capacity’. This paper will try and develop this concept a little further by attempting to develop a theoretical model that links natural resource scarcity (such as water), with the ‘adaptive capacity’ of a society, in the hope that this can contribute to a deeper understanding of the social dynamics of resource scarcity.

KARSHENAS’ BASIC MODEL:

There is a need for an understanding of the way that water is allocated in terms of optimum efficiency within the economies of arid regions. Since water is mostly regarded as a free commodity, especially within the sector that is traditionally the heaviest consumer - agriculture, vested interests for continuing the practice of free water provision are powerful (Allan, 1994: 88). The concepts of ‘returns to water’ and ‘sectoral water efficiency’ (SWE) therefore become significant in arid regions.

Allan draws heavily on the theoretical modeling of Karshenas, an economist from the School of Oriental and African Studies (SOAS) at the University of London. Karshenas has developed a model in which he shows the relationship between environmental capital and economic development. This is useful as it shows how a developing state uses, and sometimes even abuses, natural resources in an attempt to develop. The green movement of the 1980s has raised awareness of this factor to such an extent, that the concept of sustainability is now so well established as a political factor, that economists are beginning to provide an economic rationale for the concept (Allan & Karshenas 1996a:}
The concepts and processes relevant to sustainable resource use, especially the valuation of ‘environmental capital’ such as water, have proven difficult to define and operationalize however. This has resulted in what economists refer to as a ‘precautionary principle’, which generally recognizes the difficulty of establishing the cost of resource degradation. A sound principle is that economic development should not reduce the stock or value of environmental capital (such as water) for future generations.

The Middle East region has a rich history of sustainable economies from the past and provides a number of good examples of this precautionary approach. This is illustrated in the Karshenas model that is presented below. Figure 1a is an attempt to conceptualize the relationship between economic development and the use of environmental capital such as water. The portion on the top right hand corner of the graph is the space where development can take place in a sustainable manner. The area to the left and below this represents the depletion of resources in an unsustainable manner. The zones adjacent to the axes are those of ecological and Malthusian catastrophe, where environmental, and possibly even economic circumstances, become irreversibly degraded. The illustrated development trajectory is similar to that of poor countries in marginal circumstances as found in much of sub-Saharan Africa.

Figure 1a. Concept of ‘eco-environmental space’ showing the consequences of low environmental capacity and over-use of environmental capital (Allan & Karshenas, 1996a: 127).

Figure 1b shows the same model but with two differing development trajectories. The lower one is that of a conventional trajectory in the early phases of economic development. During this phase environmental capital is commonly degraded. The upper case is the trajectory typically advocated by ecologists and environmental economists, where economic development is achieved with no degradation of environmental capital.
Figure 1b. ‘Common’ and ‘precautionary’ development trajectories (Allan & Karshenas, 1996a: 127).

This model shows that in the early stages of development, a degree of over-exploitation may occur. This is not necessarily irreversible provided that policy interventions are made and implemented in time.

Figure 1c. Diversifying economy trajectory (Allan & Karshenas, 1996a: 127).
Figure 1c is the trajectory identified by Karshenas as reflecting a ‘normal’ pattern for the use of environmental capital in which there are phases of resource use. Initially, environmental capital is used to develop the economy and improve the welfare of the citizens. This may be beyond the threshold of sustainability in the short-term, resembling a degree of ‘over-exploitation’. As the economy develops via the adaptation of new technologies, as well as by the integration of the national economy with larger regional or global economies, a new series of resource options begin to become available. With the increasing strength and diversity of the developing economy, policy makers can begin to contemplate the introduction of politically costly ‘demand side management’ options, specifically by re-allocating water from one economic sector to another. This has been described by Karshenas as ‘natural resource reconstruction’ (Allan & Karshenas 1996a: 127-8) which is presented graphically in Figure 1c.

This diversifying economy trajectory has been found to exist within the Middle Eastern economies that have been studied by Allan & Karshenas (1996a: 128). The data recently gathered from Israel, the West Bank and Gaza is presented in Figure 1d below. Allan & Karshenas (1996a: 128) note that this evidence “powerfully confirms the relevance of the trajectory” depicted in Figure 1b. The Israeli trajectory conforms to that which would be expected of a diversified industrialized economy. By the second half of the 1980s it became evident that the water consumption policies within Israel were unsustainable and had to be modified. By this stage Israel had made the transition to an industrialized economy so the implementation of ‘demand side management’ strategies and policies were possible through a protracted period of dialogue between the principle stakeholders - government and agricultural interests.

Figure 1d. The situation regarding water in Israel, the West Bank and Gaza 1947-1995 (Allan & Karshenas, 1996a: 127).
It should be noted that economies relate to each other. In the above example, the stronger economy of Israel was able to make the transition from environmental over-exploitation, whereas the weaker and less diversified economies of Gaza and the West Bank were not. The latter are on a trajectory that indicates environmental catastrophe unless major policy intervention takes place. This in turn cannot be done unless Israel finally relinquishes control over the West Bank as it has recently done with Gaza. Israel is reluctant to do this in the case of the West Bank, because of the significance to the overall water supply of Israel of the groundwater aquifer located there.

Allan & Karshenas (1996a: 130) conclude that the Karshenas model shows the tendencies of economies to deplete their environmental capital during the pre-industrial phase of economic and social development. This places the water issue into perspective. In a political economy where agriculture is the dominant sector, ‘returns to water’ will be modest; however in an industrialised economy the ‘returns to water’ will be high and as a result, livelihoods will be more numerous. The sectoral water efficiency (SWE) therefore becomes highly relevant in water scarce economies. This also illustrates the need to bring economic principles to bear on matters affecting water policy, but at a rate that is consistent with the political acceptability of the approach. This again hints at the relevance of ‘adaptive capacity’. Policy makers that are negotiating access to shared international watercourses, should accept that their highest priority is the creation of livelihoods. This presents the additional virtue of enabling an economy that is expanding and diversifying to gain access to ‘virtual water’ on the international market.

APPLICATION TO SOUTHERN AFRICA:

Recent research (Turton, 1998: 95-176) within the context of the Zambezi Basin and South Africa resulted in a pattern similar to that noted by Allan in the Middle East (Allan & Karshenas, 1996a: 127). The research done by the author, indicates that there are three distinct sets of what may best be labelled as generic cases, in Southern Africa (Turton, 1997; 1998: 199-204). These are:

• The “Eastern Belt of Poverty” consisting of Malawi, Mozambique and Tanzania. These states have a high Hydropolitical Risk Profile (HPRP) in conjunction with a weak economy.

• The “Central Belt of Resource Scarcity” consisting of South Africa and Zimbabwe (which have a high HPRP in conjunction with a stronger and more diversified economy); & Botswana and Namibia (which have a medium HPRP in conjunction with a reasonably sound economy that is not plagued by a high foreign debt burden).

• The “Western Belt of Resource Abundance” consisting of Angola and Zambia. These states have a low HPRP in conjunction with a high agricultural potential (much of which is largely undeveloped) and a weak or faltering economy.
From the above analysis of the Southern African region, a set of conditions can be generated in terms of the Karshenas Model used by Allan. These are presented in Figure 2 below.

![Southern African Empirical Evidence]

**Figure 2. The situation regarding water in the Zambezi Basin and South Africa in terms of the Karshenas Model used by Allan (Turton, 1997; 1998: 220).**

From the above graphic representation it can be seen that four distinct sets of hydropolitical conditions are evident within the Zambezi Basin and South Africa (Turton, 1997; 1998: 220-222). These are as follows:

- Those sets of conditions where unsustainable development is currently the case, and where ecological catastrophe is likely to occur, if the current development trajectory is not altered. Given the prevailing level of population growth and resulting water scarcity, it is unlikely that the current trajectory can be altered even if the governments’ concerned wish to alter it. In other words, *policy intervention is unlikely to make an impact on the development trajectory of these states.* The letter “X.” on the graph represents this set of conditions. These states are those labeled as the “Eastern Belt of Poverty” (Malawi, Tanzania and Mozambique). Stated bluntly, the situation here is out of control, with effective solutions probably lying beyond the capacity of each state to implement alone.

- Those sets of conditions where unsustainable development is currently the prevailing condition, but where a policy choice can result in an adjustment to the development trajectory. These political economies are represented by the symbol “Z1.N.” on the graph representing Zimbabwe and Namibia. If a policy adjustment is not made then...
the current trajectory will probably lead to an ecological catastrophe at some time in the future, but a timely policy intervention can still alter the prevailing trajectory.

• Those sets of conditions where unsustainable development is, or has been, the prevailing condition, but where a policy choice has already been made, or is about to be made. In the case of Botswana, (represented by the symbol “B.”) the policy choice has already been made so the development trajectory is likely to move back into the area on the graph that represents sustainable development fairly soon, if it has not yet done so. In the case of South Africa, (represented by the symbol “S.”) the policy choice is currently being implemented and is likely to result in a change of trajectory. Given the “lag time” between policy making and the benefits of such a policy, the new development trajectory can be expected to lie within the unsustainable portion of the graph for a period of time. The long-term development trajectory is likely to move ultimately back into the area of sustainability however.

• Those sets of conditions where resource abundance has not yet resulted in a major environmental impact. Under these conditions sustainability is not an issue, so consequently policies relating to resource efficiency are not yet being considered. Under these conditions policy choices can probably only be effected in a regional context by means of the intervention of an outside hegemonic power. Examples are South Africa and Zimbabwe, with a possibility of Botswana if supported by the USA. These major actors may offer a series of incentives in order to induce a co-operative policy choice. This trajectory is indicated by the symbol “Z2.A.” on the graph which represent the position of the states within the “Western Belt of Resource Abundance” (Angola and Zambia).

THE CONCEPT OF ADAPTIVE CAPACITY:

The theory provided by Karshenas is certainly useful to the scientist seeking to understand water within the context of political economies in water-scarce regions. The generation of two data sets, that of the Middle East by Allan & Karshenas (1996a) and that of Southern Africa by the author (Turton, 1997; 1998) serves to show that the concept is valid in at least two regional settings. What Karshenas’ concept does not explain however, is why the different states or social entities are on different development trajectories. In places, there was a hint of the relevance of ‘adaptive capacity’ however. It therefore becomes necessary to search for a concept that would be useful in this regard.

Recently completed work by Ohlsson (1998; 1999) suggests that a vital component of the overall resource base of a society is what he describes as ‘adaptive capacity’. Ohlsson builds up his argument as follows:

• Adapting to natural resource scarcities entails the mobilisation of an increased level of social resources. These social resources can be called the ‘adaptive capacity’ of a given society.
The existence of a natural resource scarcity can be regarded as being a ‘first-order scarcity’ (Ohlsson, 1999:161).

A society that does not have sufficient ‘adaptive capacity’ to make the relevant adjustments needed to cope with increased resource scarcity can be regarded as having a ‘second-order scarcity’, namely the lack of ‘adaptive capacity’ (Ohlsson, 1999:161). It is therefore the inability of a social entity to find the social tools with which to deal with the consequences of the ‘first-order scarcity’ that in fact becomes important to understand.

Social resources are embodied in institutions or within an institutional framework, including actors and “rules”. These institutional actors are therefore plagued by the same sorts of social costs that are associated with institutions (Ohlsson, 1999: 161).

Social resources have a sustainability aspect to them. Thus for every level of adaptation to the increasing scarcities of natural resources, a corresponding level of input of an increased amount of social resources will be necessary (Ohlsson, 1999: 162).

There is thus a point where what can be regarded as a ‘sustainability level of social resources’ must be achieved and maintained, for social adaptation to take place in the event of natural resource scarcity (Ohlsson, 1999: 162). A failure to meet and sustain this level means a failure of a society to adapt to those resource scarcities, with severe social consequences. Ohlsson (1999: 80-144) cites the case of Rwanda as an example.

It can be concluded from Ohlsson’s work that existing scientific endeavors are focusing on ‘first-order scarcity’. This is certainly the case of the Karshenas model, which relates directly to natural resource depletion and reconstruction. The Karshenas model fails to explain why societies such as those found in Gaza, Mozambique, Tanzania and Malawi are set on the developmental trajectory that they are on, whereas entities such as Israel, South Africa and Botswana seem to be on an entirely different trajectory. The reason for this, if one takes Ohlsson’s concept of ‘adaptive capacity’ into consideration, is that some societies have a scarcity of ‘adaptive capacity’, whereas others seem to be able to muster the resources needed. What is therefore needed is to shift the analysis onto ‘second-order scarcity’ instead, if one is to develop an understanding of why (or how) certain social entities seem to cope with resource scarcity better than others do.

The discourse on natural resource scarcity identifies a deficit of the supply of a particular resource in relation to the demand for that resource. The scarcity that results from these two forces is known as ‘stress’ - such as ‘water stress’- for example. In order to overcome this ‘stress’, societies attempt to manage the resource with the overall objective of achieving ‘sustainability’ of that specific resource use. The capacity for managing resource stress is what we have already called ‘adaptive capacity’, but this too has both supply and a demand side aspects. ‘Adaptive capacity’ can be in short supply relative to demand in a given situation of social need for change. This is what Ohlsson (1999:163) calls a ‘second-order scarcity’ or a ‘social resource scarcity’. This in turn can lead to
‘social stress’, which is usually incorrectly identified by the prevailing discourse as the stress related to the ‘first-order’ of analysis. First-order methodology can be misleading.

If we can think in terms of two variables, the ‘adaptive capacity’ of a social entity and ‘natural resource scarcity’, we can start to link the first and second-order scarcities together. It is to this endeavour that we now turn our attention.

![Figure 3. Hypothetical response curves indicating the way that various societies adapt to natural resource scarcity.](image)

In Figure 3(a) a hypothetical response curve is shown. This curve shows that in the face of increasing natural resource scarcity, this given social entity is able to mobilise the necessary social ‘capital’ to make the adaptations required. In this case there is unlikely to be a long-term problem, as the society concerned seems capable of making the necessary adaptations in a linear fashion. In Figure 3(b) we have the type of response curve that would be expected to result from a society that has reached the level of its ‘sustainability levels of social resources’ and is unable to make the adjustments that increased natural resource scarcity demand. In this case, increased natural resource scarcity can no longer be met by the social entity and some form of social disruption
would be likely. This is the type of curve that one would intuitively expect to see from social entities such as Gaza, Malawi, Mozambique and Tanzania. Figure 3(c) depicts a society that is highly responsive to the increasing levels of natural resource scarcity. As these natural resource scarcities become more pronounced, such an entity is able to mobilise increasing levels of ‘social capital’ with which to address the social adjustments needed. Typically such an entity would be expected to commit large sums of money and intellectual capital into the establishment of both institutional and intellectual capacity. This will increasingly develop the unique set of ‘adaptive capacities’ that would be needed. Such a curve could be intuitively expected to exist for Israel, South Africa and Botswana. In fact, in highly responsive societies, the response curve could even go back on itself as such societies begin what Karshenas would describe as ‘natural resource reconstruction’. This would suggest therefore, that ‘natural resource reconstruction’ depends on the degree of ‘adaptive capacity’ in existence within society at that time. The curve represented in Figure 3(d) would represent a society that is not coping with the adaptive needs and which has exhausted its level of adaptive capacity. In such a case, the dotted line would represent the ‘sustainability levels of social resources’. The trajectory could only be altered in these cases by means of foreign aid, which would ideally be focused on creating the capacity needed. Such a condition could be used to describe what would be needed by social entities such as Gaza, Malawi, Mozambique and Tanzania, if they were to avert the ecological catastrophe that the Karshenas model seems to predict for them.

Thus we have a linkage between Karshenas’ model, which focuses on a first-order scarcity only, and the second-order scarcity as suggested by Ohlsson (1999). It becomes instructive to view two cases side by side, each generated from the respective models.

Figure 4. Schematic examples of social entities that are unable to adapt to natural resource scarcity as depicted by Ohlsson’s (a) and Karshenas’ (b) concepts.

Figure 4(a) shows the response curve that is generated by using the variable ‘adaptive capacity’ and ‘natural resource scarcity’, which is best understood in terms of Ohlsson’s
thinking as a ‘second-order scarcity’. There is a marked similarity between this response curve and that generated in terms of Karshenas’ model (Figure 4b) that focuses on a ‘first-order scarcity’.

When comparing the trajectories of social entities that are highly adaptive to natural resource scarcity, the ‘adaptive capacity’ curve can even fold back on itself as depicted between the dotted lines in Figure 4(c). This indicates that if sufficient social resources can be mobilised, it may even be possible to perform what Karshenas describes as ‘natural resource reconstruction’, which is depicted in Figure 4(d). There seems to be a correlation between the response curves of the first and second-order scarcity.

This now enables the development of a more profound understanding of the relationship between the transition from supply-sided management to demand-sided solutions in the face of increasing water scarcities within developing countries.

Attention is now drawn to the fact that Allan and Karshenas (1996a) accept that demand management becomes an option once societies have developed their political economies to a point where alternatives may be considered. This suggests that more developed political economies are able to mobilise a higher level of ‘adaptive capacity’ with which to meet the rising challenge of increased natural resource scarcity. However, if this logic is correct, then it also suggests that certain social entities would not be capable of mobilising the necessary ‘adaptive capacity’ with which to implement demand management policies effectively. It therefore becomes instructive to place the notion of ‘adaptive capacity’ into the broader context of water demand management (WDM).
Evans (1997: 53) is explicit when he says that “before a national water policy can be prepared, the future water availability and the future demands need to be determined with a reasonable degree of accuracy”. This would require a reasonably sophisticated institutional capacity as well as the intellectual capital needed to effectively manage that capacity. Judging from the rest of what he says, this may well be beyond the capability of certain social entities to mobilise. Regarding the existence of effective water-related decision-support structures within developing countries in Africa, Evans (1997: 55) notes that there are “data collection agencies struggling with unrealistic budgets and totally inadequate resources … [which means that] … many agencies are barely able to function and few function efficiently”. Evans (1997: 59) concludes that “in many developing countries data collection has almost been abandoned. Water resource assessment agencies are invariably small units within large sectoral ministries and perceived to be of little value”. Against this background, is it reasonable to assume that effective WDM policies will be developed or implemented with any degree of success in such environments?

Winpenny (1997: 297) notes that “demand management is a policy for the water sector that stresses making better use of existing supplies, rather than developing new ones”. This suggests that ‘adaptive capacity’ is needed in order to generate the WDM options in the first place and then to ultimately implement them. These seem unlikely to emerge from the institutional setting that Evans (1997) has already identified as being in existence. Meinzen-Dick and Rosegrant (1997: 312) allude to the fact that “incentives [such as raising user fees, efficiency pricing and water markets require] infrastructure … to make them effective”. This again hints at the relevance of ‘adaptive capacity’, as presumably a society with a higher level of such capacity would be able to develop the institutional support needed for such a venture. Briscoe (1997: 339) urges water managers to “pay attention to general principles, but [to] be sensitive and innovative in adapting these in different institutional settings and environmental contexts”. In this case, the necessity of adaptation is clearly spelled out, but how will this be possible if there is a blatant lack of ‘adaptive capacity’ in many developing states that are already water scarce?

Morris (1997: 230) alludes to the fact that “sustainable development involves a switch in emphasis from supply management (which attempts to meet rising demands by withdrawing more water from a depleted resource base) to demand management (which attempts to reduce consumption by increasing efficiency in use). Furthermore, this switch encourages both suppliers and users to think of water as an economic commodity, and policy-makers to use economic instruments to achieve water use efficiency”. In fact, Morris (1997:228) goes on to say, “economic principles and market processes are unlikely in themselves to deliver sustainable water management, without regulation and direct action by Government and its agents. Water policy can benefit from the discipline of economics, but it is no substitute for capability in political systems”. Without using the actual words, Morris is talking of nothing more than ‘adaptive capacity’. Allan (1996b: 8) supports this train of thought when he says, “what is required for sound policy is the existence of a political will to implement environmental policy inspired by an
integration of economic and environmental principles. However, to insist that a principle’s environmental policy, in this case on water, could have come early in the process of industrialisation rather than late appears to fly in the face of the evidence. … It also contradicts basic notions of how policy determining scientific and political discourses evolve. It is evident that approaches inspired by sound economic demand management principles and sustainable environmental principles [come] after supply management approaches [are] no longer tenable”. In short, there is a need for a crisis in order that the supply phase may give rise to a national debate on the notion of demand management. This also means that social and political stresses occur as a result, while the government deals with the crisis. What becomes important then is to understand how the social entities concerned deal with and accommodate these social stresses. In political science terminology, this is broadly linked to the concept of ‘legitimacy’. A popularly supported legitimate government will be able to introduce such measures, whereas an unpopular government will not, and may come under further pressure as a result.

What these authors have in common is the fact that they all allude to the need for changes to take place within a social entity in order to meet the challenge of increased water scarcity. This series of changes is generally spelled out as being some form of second phase of water management, namely demand-side management. This second phase comes into play at a point in time when the first phase of supply-sided management faces a crisis and is unable to mobilise more water by the application of traditional supply-sided solutions. Thus a simple model illustrating this could be developed as shown in Figure 5.

![Figure 5. Simplistic model showing transition from Supply-Sided Phase to Demand Management Phase within a political economy.](image)

This is a simplistic rendition of reality. It therefore becomes instructive to see how this model holds up against reality. This is best accomplished in the form of a short case study in order to gain a better perspective of the transition from supply-sided to demand
management solutions. The purpose of this case study is to determine firstly if the simple model depicted in Figure 5 has any validity, and secondly to see where and how the model can be improved.

CASE STUDY: THE AMERICAN HYDRAULIC MISSION:

In order to gain a deeper insight into the socio-economic intricacies of water, it is necessary to make some very clear distinctions. Water, it seems, and the politics that goes with it, is not as simple to understand as it first seems. Reisner (1993) offers an imminently readable rendition of this. Using the example of the American West, Reisner traces the history of water back to the days of the first settlers. To this end he notes that “in the West, of course, where water is concerned, logic and reason have never figured prominently in the scheme of things. As long as we maintain a civilisation in a semi-desert with a desert heart, the yearning to civilise more of it will always be there. It is an instinct that follows close on the heels of food, sleep and sex, predating the Bible by thousands of years. The instinct, if nothing else, is bound to persist” (Reisner, 1993:14)(emphasis added).

Late in the 1870s, the boundary of the Great American Desert appeared to have retreated westward across the Rockies to the threshold of the Great Basin, in the face of a heavy drive to settle the land. Such a spectacular climatic transformation was not about to be dismissed as a fluke by a people who “thought themselves handpicked by God to occupy a wild continent” (Reisner, 1993: 35). Thus a new school of meteorology was founded to explain this phenomenon. The unspoken principle of this New Meteorology was Divine Intervention and its motto was “rain follows the plough”. Since the great rains of the 1860s and 1870s coincided with the headlong westward advance of settlers, the two must somehow be connected, so the argument went. Prof. Cyrus Thomas, a noted Climatologist at the time, was a leading proponent of the New Meteorology, linking a gradual increase in moisture to human activity, which to his mind was now permanent due to the settlement. Thomas concluded that moisture levels would increase in a direct relationship with human settlement. Ferdinand V. Hayden, a noted Geographer and Geologist supported this notion. Dynamiting the air, according to Hayden, improved rainfall by inducing cloud formation (Reisner, 1993: 36). Merchants in St. Louis and other railhead cities, dreaming of expanding markets, welcomed the new settlers and actively embraced the New Meteorology. The railroad companies also had a vested interest in settling the west so they too embraced this New Meteorology. J.J. Hill, the founder of the Great Northern Railroad Company said, “you can lay track through the Garden of Eden, but why bother if the only inhabitants are Adam and Eve?” (Reisner, 1993: 37). Thus the New Meteorology, based on bad science, was embraced as a form of ideology, thereby giving birth to the American Hydraulic Mission.

John Wesley Powell, the first man to ever take a boat down the Colorado River (as this was the only means of exploring it at the time), wrote a document in 1876 entitled A Report on the Lands of the Arid regions of the United States, with a More Detailed Account of the Lands of Utah. This report stated that two fifths of the USA had a climate that could not support unirrigated agriculture (Reisner, 1993:45). Irrigation in turn could
claim only a small fraction\(^{10}\). Furthermore, the logical unit of management was the watershed. Powell had thought that the Western farmers would stand behind him because what he was articulating was a policy of sustained use of the scarce water. History unfortunately shows that he was like Don Quixote, tilting at windmills and ultimately being labelled as an eccentric.

Congress opposed Powell’s report (Reisner, 1993: 49). Stegner\(^{11}\) wrote that “apparently he (Powell) underestimated the capacity of the plains dirt farmer to continue to believe in myths even while his nose was being rubbed in unpleasant fact – the press and a good part of the public in the West was against him more than he knew. … The American yeoman might clamour for government assistance in his trouble, but he did not want any [information] that would make him change his thinking...”. Powell wrote scientific fact, but the public and its elected officers wanted instead to believe in myth\(^{12}\) (Reisner, 1993: 50). For example, on hearing of Powell’s report on the sustainable\(^{13}\) use of artesian wells in the Dakota’s, Senator Moody of South Dakota said, “we ask you … your opinion of artesian wells. You think they are unimportant. All right, the hell with you. We’ll ask somebody else who will give us the answer we want\(^{14}\). Nothing personal.” (Emphasis added.) One century later, the folly of the pseudo-scientific New Meteorology has been revealed with two major cyclical droughts - in the late 1800s and again in the 1930s (Reisner, 1993: 51). In the third year of the Great Drought of 1890, it became obvious that the theory of rain following the plough was a preposterous fraud (Reisner, 1993: 107). Later statistics showed that of the original one million homesteading families who had settled, only 400,000 remained. The rest either died or left, mostly to Oklahoma\(^{15}\).

The above historic rendition can be regarded as the birth of Supply Management in the American West. It is interesting to note however, that even during this phase, Demand Management was introduced on occasion, but never maintained for long\(^{16}\). For example, in 1917, due to the existence of drought and the fact that a storage dam\(^{17}\) could not be built at that time, William Mulholland\(^{18}\) (the father of the Los Angeles Aqueduct) introduced restrictions for the use of irrigation water for alfalfa in the San Fernando Valley, and he prohibited winter planting (Reisner, 1993: 89). This was only a temporary measure however, and the construction of the Los Angeles Aqueduct went ahead. This started to inflame local passions, especially of farmers who believed that inter-basin transfers of this scale would rob them of their entitlement to water. On 21 May 1924, the Los Angeles Aqueduct was dynamited (Reisner, 1993: 93) and one week later the No Name Syphon across the Mojave Hill was also dynamited. The first shoot to kill order was given to those who were charged with protecting the Aqueduct after this incident (Reisner, 1993:95).

The birth of the American Hydraulic Mission as an official bureaucratic\(^{19}\) entity can be traced back officially to the Land Reclamation Act, which was signed by Roosevelt on 17 June 1902. In a speech prior to the launching of this piece of legislation, Roosevelt said that, “the western half of the United States would sustain a population greater than that of our whole country today if the waters that now run to waste\(^{20}\) were saved and used for irrigation” (Reisner, 1993: 112) (emphasis added). This Hydraulic Mission would have all of the river water “conserved” by damming and piping it in order to “make the desert
bloom”. Reisner (1993: 114) notes in this regard that, “the engineers who staffed the Reclamation Service 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”.

The age of the modern Engineer\(^{21}\) had come, and with it the official birth of the modern Supply-Sided Phase of water development. Reisner (1993: 121) notes in this regard that “one could almost say, then, that the history of the Colorado River contains a metaphor for our time. One could say that the age of Great Expectations was inaugurated at Hoover Dam\(^{22}\) - a fifty year flowering of hopes when all these things appeared possible. And one could even say that, amid the salt-encrusted sands of the river’s dried up delta, we began to flounder in the Era of Limits”. The Hoover Dam was the largest structure\(^{23}\) at that time to be erected in the USA. What is significant about it is that it took only three years to complete at a time when the economy was being ravaged by the Great Depression. This is why the Hydraulic Mission, which entrenches supply-sided solutions as the most appropriate options, became so powerful. People, both voters and politicians, began to equate their existence with the security of the success of dam building projects. In the Bureau for Reclamation, Franklin D. Roosevelt had found a vast job-creating engine in an agency that eagerly set about remaking the Western landscape\(^{24}\) into a place where the dispossessed could be resettled (Reisner, 1993: 138). Symbolic achievements mattered a lot in the 1930s, and the Federal dams that were being constructed in the Western USA were the reigning symbols of the era (Reisner, 1993: 159). Ecological sustainability\(^{25}\) seemed not to matter at the time.

Jimmy Carter decided to counter this tendency and he started off his term of office with a “hit list” of water-related projects that he considered were either unsustainable or uneconomic. He lost the momentum of his presidency, and a chance at a second term in office\(^{26}\), through a hapless effort to bring the Bureau for Reclamation and the Corps of Engineers under control. Eisenhower, Johnson and Nixon had all tried to dump or delay a number of water projects, and failed in almost every case (Reisner, 1993: 227). Such is the power of the ‘sanctioned discourse’\(^{27}\). The politics of water in the USA worked as follows (Reisner, 1993: 227): The West was settled because of the water that the Bureau for Reclamation provided. The population in the West then grew eightfold, because of these supply-sided solutions. This in turn placed more members of Congress in important gate-keeping positions, and this changed the character of congressional leadership. As Reisner (1993: 308) notes, “to a degree that is impossible for most people to fathom, water projects are the grease gun that lubricates the nation’s legislative machinery. Congress without water projects would be like an engine without oil. It would simply seize up.”

These supply-sided solutions came to an end with time however. The start of this demise was heralded by the birth of the ecology movement in the 1960s. David Brower, the Executive Director of the Sierra Club, succeeded in denying funds to build Echo Park Dam, even though they were forced to compromise at that time. In order to save Echo Park from inundation, the Sierra Club had to agree to leave the Glen Canyon Dam project unchallenged (Reisner, 1993: 284). This unleashed a powerful response as history has subsequently revealed. Brower, in the foreword to a Sierra Club book entitled *The Place*
no one Knew, wrote that “Glen Canyon died in 1963, and I was partly responsible for its needless death. So were you. Neither you, nor I, nor anyone else, knew it well enough to insist that at all costs it should endure” (Reisner, 1993: 285). This mobilised considerable public support, and so the hydraulic social conscience was officially born.

Brower vowed then to never compromise in his opposition to the construction of any dams in future. The battle for the Grand Canyon’s Dams was the Conservation Movement’s coming of age (Reisner, 1993: 298). The National Environmental Policy Act of 1969 required an Environmental Impact Assessment to be conducted before any dams could be constructed for the first time in history. This was followed shortly thereafter by the Endangered Species Act28 of 1973 (Reisner, 1993: 325). Thus, what had started as an Olympian diversion of the Colorado River’s water emerged, after half a century of tinkering and tweaking, according to the dictates of political reality, as an ultimate testament to the West’s cardinal law that “water flows [uphill] towards power and money” (Reisner, 1993: 296).

An economist named William Martin did some of the groundwork to the demand-management era that was being born. In 1973, Martin and Robert Young co-authored a book under the title of Water Supplies and Economic Growth in an Arid Environment. This book went against the ‘sanctioned discourse’ and was vociferously opposed to such an extent that Young was forced to leave town (Reisner, 1993: 298). What this study did achieve was to show for the first time, that as the cost of water rose, farmers would start doing more with less. This was a form of natural WDM, which dictated that farmers would switch to higher value crops and increased irrigation efficiency, as water became scarcer. In fact this study challenged the conventional wisdom to the extent that it showed that if a farmer was to take the so-called “cheap” irrigation water that was being offered as a bailout, it would almost certainly lead to his ultimate bankruptcy (Reisner, 1993: 299). When Jimmy Carter tried to introduce a water reform program based on the concept of “realistic water pricing” it failed (Reisner, 1993: 323). When Carter decided that the golden age of supply-sided management had come to an end, his “hit list” of irrigation projects – some of which would only return 5 cents on every taxpayer dollar - alienated almost 200 Western Congressmen. This is one of the reasons why Carter failed to make it to a second term of office (Reisner, 1993: 11). The politics of water are dangerous for the uninitiated and naive it seems!

A major lesson for WDM can be learned from what happened in California. The Central Valley Project (CVP) was ostensibly designed to relieve pressure on the groundwater aquifer. In one test well in Tulare County, the aquifer dropped by almost 20 metres between 1920 and 1960, the first year that the CVP water flowed. The water table then rose by almost 6 metres during the first 9-year period of the CVP as surface water percolated down and recharged the aquifer again. Then three years later it dropped again by almost another 10 metres. Reisner (1993: 341) concludes that “the CVP had delivered a lot of surface water throughout the valley, but [this] had encouraged so much agricultural expansion that they had not relieved the pressure on the aquifer at all. For a while they made things better, then the projects actually made things worse. Half of the agricultural water in the state was still coming out of the ground – even farmers who got
cheap [Federal] water continued to pump from their own wells in order to irrigate as much land as possible. ... The big projects ... were just encouraging more pumping” (emphasis in original text). Yet farmers fiercely resisted attempts to regulate groundwater abstraction. “When you added a couple of lanes to a freeway or built a new bridge, cars came out of nowhere to fill them. It was the same with water: the more you developed, the more growth occurred, and the faster demand grew” (Reisner, 1993: 348).

Pat Brown is on the record as saying, “I don’t think [cost] has any validity because you need water. Whatever it costs, you have to pay for it. It’s like oil today. If you have to have oil, you’ve got to pay for it. What’s the value of oil? What’s the value of water? If you’re crossing the desert and you haven’t got a bottle of water, and there’s no water anyplace in sight and someone comes to you and says, ‘I’ll give you two spoonful’s of water for ten dollars’, you’ll pay for it. The same is true for California” (Reisner, 1993: 348).

What emerges from this brief case study is the following:

• 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.

• 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. 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. For
this reason, there is a natural social dynamic at work, which acts as a disincentive\textsuperscript{37} to implement long-term WDM strategies. Politicians are therefore hesitant to act.

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”. 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 are capable of illustrating. Such complexity has prompted Merrett (1997: 63) to say, “the concept of demand for water is a many-headed beast”. This aspect will be explored in more detail in the next part of this paper. It is to a development of a more sophisticated model that this paper now turns.

**TOWARDS A DEEPER UNDERSTANDING OF WDM:**

One would intuitively expect that the USA would not be accurately described as being scarce of ‘adaptive capacity’, yet the above case study suggests the social and political stresses that accompanied WDM efforts were of such a magnitude, that rational water-use strategies tended to be avoided. If this is so, in what is arguably a developed society not lacking in ‘adaptive capacity’, then surely it can be more stressful in developing societies which still have a critical scarcity of social resources. The reasons for this need to be explored further, because this suggests that the so-called Second Phase of Water Management – Demand-Sided Management – consists in fact of two distinct categories. These can best be described as sub-phases. To this end, Ohlsson (1999: 189) notes that there are essentially three policy-related goals for dealing with water scarcity. These are:

- Managing the competing water demands from different societal sectors and population groups in order to achieve a distribution of the scarce resource that is perceived to be equitable. This involves conflict management and resolution.

- Facilitating technological changes to achieve greater end-use efficiency. This can be encapsulated in the concept of ‘doing more with the water’.

- Facilitating socio-economic changes to achieve greater allocative efficiency. This can be encapsulated in the concept of ‘doing other things with the water’.

Thus, the poles of the WDM phase of water management can be better understood as revolving around two broad options, namely “doing more with what you have”, or “doing better things with what you have”. The former suggests that socio-economic adjustments are kept to the minimum with a lower level of political stress, and can be termed ‘end-user efficiency’ options. The latter suggests a fundamental re-allocation of water between different sectors of the economy based on inherent “gearing ratios” that are to be found within the concept of ‘sectoral water efficiency’, and can be termed ‘allocative’ options. In keeping with the theme of this paper, these can be illustrated by means of the concepts and models already introduced. Table 6 is a model that shows the greater detail involved in the Demand Management Phase. For illustrative purposes, the model used in Figure 5
will be reproduced, but the horizontal axis will be extended for ease of explanation, and combined with Figure 3.

**Figure 6. Schematic representation indicating how ‘adaptive capacity’ is needed to realign population-induced demand with maximum level of sustainable supply.**

From this diagram it can be seen that as population-induced demand for water increases, there is an accompanying increase in the need for engineering (supply-sided) solutions. There is a finite limit to this supply-sided management, represented by the intersection of the population growth curve and the upper value of the amount of water that can be mobilised by traditional engineering options. This brings the social entity concerned into a period of water deficit and is usually accompanied by an event such as a drought. This in turn involves a degree of social stress, but it also provides the ‘window of opportunity’
that is needed to challenge the prevailing ‘sanctioned discourse’. The outcome of this is the introduction of various WDM measures, which are seen in the eyes of the consuming public as being acceptable. This acceptability is short-termed however, and as soon as the crisis (drought) is over, the popular support for WDM is reduced, placing pressure on politicians to reduce the demand management to “acceptable levels”. This is important, as there is a strong transitionary period that is encountered at this time. This transition is between the early phases of WDM that are based on end user efficiency and the more radical allocative efficiency forms of demand management. Allan (1996b) refers to this as the ‘closure of a water resource’. Due to the fact that this closure of the resource is so stressful in socio-political terms, two factors now become relevant:

• There is a corresponding need at this transitionary moment in time to have a high level of ‘adaptive capacity’ within the social entity concerned. Without this ‘adaptive capacity’ the stresses become too great and the society begins to fail. For this reason, politicians tend to avoid having to deal with this reality and fall back instead onto the prevailing ‘sanctioned discourse’ that there is no crisis, which the engineering community cannot solve. This becomes one of the ‘necessary lies’ that need to be told in order to keep the political integrity of the given social entity.

• The softer option of ‘virtual water’ becomes increasingly attractive at this time. This option involves the importation of grain. Because it takes 1 000 tonnes of water to produce one tonne of wheat, importing the tonne of wheat is equivalent to importing 1 000 tonnes of water. This enables water scarce countries to balance their water deficits in a way that is not politically stressful, so the ‘essential lie’ that there is no water scarcity threatening the state can be maintained. This allows the political leadership to de-emphasise the water predicament (Allan, 1996b: 5).

In order for this to be successful however, there is the need to develop the ‘adaptive capacity’ that will be required. The need for ‘adaptive capacity’ therefore peaks out as this transition is made. This explains why certain social entities are unable to start ‘natural resource reconstruction’ to use Karshenas’ terminology. The reason for this is that there are two distinct components of ‘adaptive capacity’ - structural and social - both of which need to be present if ‘natural resource reconstruction’ is to take place. This also supports the notion espoused by Ohlsson (1999) that a second-order of resource scarcity exists, namely the lack of ‘adaptive capacity’ or a ‘scarcity of social resources’. If the social entity concerned manages to mobilise sufficient ‘adaptive capacity’ they can successfully manage the transition to a stable water demand regime. This involves the aggressive application of the second sub-phase of WDM, ‘allocative efficiency’, which starts freeing up significant quantities of water due to sectoral reallocation and economic gearing. If successfully applied, this in turn enables the total demand curve to be realigned with the upper limit of water mobilised by means of supply-sided solutions in a sustainable manner. The volume of water that is represented by the label “water competition compensated for by adaptation or ‘natural resource reconstruction’” results from the interaction between two different variables:
‘End-user efficiency’ or “doing more with the water”. This can be described as the “more crop per drop option” as visualised (IIMI: 1996) by the International Irrigation Management Institute (IIMI) in Colombo.

‘Allocative efficiency’ or “doing better things with the water”. This can be described as the “more jobs per drop option” as visualised by Allan (1999).

The former is relatively easy to apply, but the latter is socially stressful and therefore avoided. Each of these, on their own, are necessary but insufficient conditions for ‘natural resource reconstruction’ to take place.

THE DYNAMICS OF ALLOCATIVE EFFICIENCY:

Because ‘allocative efficiency’ is socially stressful, but has also been shown to be a virtually inevitable end result for developing states in arid regions, there is a need to understand this concept well. Lundqvist & Gleick (1997: 20) note that “achieving allocative efficiency is difficult and should involve more than purely economic considerations. If the highest valued users are allowed to purchase all water in a purely free market, some groups … are going to lose their economic base of support. This requires that the economy and the political system be able to provide alternative livelihoods, compensate third parties affected by market transactions, and judge between diverse claims for allocation” (emphasis added). What this implies is nothing other than a higher level of social adaptation, the (second-order) scarcity of which opens the door to ‘resource capture’ and the imposition of structural scarcity within society. This in turn creates an inherent conflict-generating dynamic, fuelled by unequal resource access, making it undesirable if the social entity is to be able to ultimately manage the final transition into the adaptive phase as illustrated in Figure 6.

Figure 7 is a schematic representation of ‘end-user 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 consumes 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 rational choices between water allocation 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 consumed 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 (1998a: 170) notes that agriculture can consume as much as 90% of the national water budget of certain political economies. Figure 7 uses conservative figures for illustrative purposes.

![Figure 7. Schematic representation of the two alternative strategies of ‘end-user efficiency’ and ‘allocative efficiency’ at work.](image)

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\(\textsuperscript{42}\). 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 WDM strategies, in support of Figure 6.
‘End-user efficiency’ aims at developing a series of water saving strategies and technologies, which can be applied to all economic sectors. 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, retrofitting using low volume devices, alternative irrigation hardware and regimes 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 ‘adaptive capacity’ of a 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. These negative aspects are mostly offset by the rewards to the consumer in the form of reduced expenditure as evidenced in their monthly water bill.

‘Allocative efficiency’ is something quite different however. 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. 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. This is especially true if the regime concerned is unpopular or facing some form of legitimacy crisis (Turton, 1999a). The rewards for successfully managing this transition 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 4 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. 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.

• 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 of water management entails.

Figure 8. Model linking ‘natural resource reconstruction’ via ‘water demand management’ to the ‘adaptive capacity’ of a social entity.

The logical choice of WDM strategies would therefore be to initially launch ‘end-user efficiency’ projects, and then to gradually phase in the ‘allocative efficiency’ strategies at
a rate that is socially and politically acceptable. Both strategies have a legitimate role to play and each require a specific set of social pre-conditions.

As can be seen in Figure 8, the author visualises an interconnection between ‘adaptive capacity’ and ‘natural resource reconstruction’. In fact, both of these are the flip side of the same coin. The former is regarded as a type of social foundation upon which the series of strategies are subsequently built. This can be likened to the construction of a major monument for example. If the foundations are solid (sufficient ‘adaptive capacity’) then the construction can proceed upwards. Two pillars take the weight of the superstructure, which consists of two distinct components. The bottom portion, forming a sound lintel (to continue with the construction metaphor), consists of WDM strategies and policies. The end stage of the construction consists of placing the apex of the roof onto this lintel. The apex is ‘natural resource reconstruction’ which is the final phase of the construction. Once this has been reached, it can be said that the social entity is stable and balanced, with sustainability of water use being the prevailing condition. In order to reach this point of completion, careful consideration needs to be given to the design of the pillars that will ultimately hold the superstructure up. These pillars can be likened to the two components of ‘adaptive capacity’. In the illustration, each pillar is constructed differently. In the final analysis, each pillar is vitally important if the construction is to be sound. Let us examine these in greater detail.

The left-hand pillar represents the structural component of ‘adaptive capacity’ and it can be engineered to a certain extent. External role-players such as donor agencies or NGOs can play an active role in creating the capacity that is needed in developing countries. In this sense they could advise on institutional arrangements, IT systems, data flow and processing, training of skilled personnel, etc. The following are unique aspects about this:

- This can largely be constructed as part of a conscious effort. It can even be regarded as an exogenous element in the sense that each of the major constituent parts can be sourced from outside of the social entity concerned.

- The basis of this component is an institutional setting of sorts. It is imperative that such an institutional arrangement is effective, which in turn assumes that it is rationally constructed with a sound financial position. There may be more than one institutional arrangement, but the important thing is that they must all be effective. In this sense they need to have free communication with one another, and data generation and sharing becomes critical. Data generation, capture and processing become one of the critical variables of the ‘sustainability levels of social resources’ in this model.

- Housed within this institutional setting is the intellectual capital that is needed to interpret the data in order to generate viable strategies or policy options. This intellectual capital should be regarded as a critical element as it represents one of the variables of the ‘sustainability levels of social resources’. Significantly, this intellectual capital will have to be multidisciplinary due to the increased complexity
of their domain of interest. The section on ‘discursive elites’ in Figure 9 illustrates how the composition of the technocratic elite changes with time.

- Whatever the arrangement, whether staffed by locals or foreigners, the main output of this structural component is a range of strategies or policy options. In other words, these technocratic elites design the WDM policies by integrating data and knowledge of both foreign and local conditions.

The right-hand pillar is the difficult one to come to terms with however. Unlike the other pillar, this one cannot be engineered to any significant extent. This represents the social component of ‘adaptive capacity’. It is important to the overall success of the WDM strategies because it contains two unique elements:

- The willingness and ability of the people who are being governed to accept the WDM measures.
- The ability of the regime to generate WDM strategies that are perceived as being both reasonable and legitimate by those people being governed.

The first variable - the willingness of the people to accept the WDM strategies - in turn depends on the legitimacy of the political regime. If a government is popular, and if the prevailing policies are perceived to be reasonably fair, then WDM can be implemented without too many social disruptions. If inequity exists, such as large scale ‘resource capture’ which has led to structural scarcity and ‘ecological marginalization’, then WDM policies would be viewed with scepticism and would thus be undermined by the people being governed. The second variable - the ability of the regime to generate WDM strategies - in turn depends on the quality and makeup of the structural component. These two components cannot be developed in isolation from one another. If the structural component is developed largely with foreign support, then it needs to pay close attention to the development of a mechanism to adapt foreign strategies to local conditions. A WDM policy that has been successful in Britain for example, may be wholly inappropriate in Southern Africa, but elements may be valuable. For this reason there is a need for feedback to take place between the structural and social component. This is in the form of consultation with special interest groups which is designed to make them part of the process and to bring them on board. Support is either given or withheld as the result of this feedback in a dynamic manner. This can be understood as being a process whereby the government gains legitimacy for its intended actions, and is thus a vital component in the overall WDM chain.

Perceptions are therefore very important, especially given the fact that the support aspect is dynamic. What is supported by those being governed today may be opposed tomorrow. These perceptions constitute one of those intangible aspects that the social sciences try to come to grips with in the field of WDM. For this reason perspectives on water need to be understood and where appropriate, to be changed (refer to Figure 9). Heyns (1997: 83) notes that “inhabitants of this desert country [Namibia] have traditionally viewed rainfall and water supplies as a gift from God. In the past authorities have supplied water without
charge as a social good. People are now resisting paying for water”. The introduction of pre-paid water meters in Zwelithle (Hermanus) was viewed with suspicion and the meters were smashed (Turton, 1999c), even though this political demonstration of frustration or outrage disadvantaged the community as a result. Prior to the 1994 democratic elections in South Africa, an illegitimate regime needed to retain the support of white commercial farmers who owned most of the land, which led to the serious undervaluation of water (Abrams, 1996: 27). In Yemen, increased water scarcity is having a social effect in the form of reduced sexual activity between married couples, because water is needed to bathe in after sexual contact prior to the next prayer session (Lichtenthäler, 1996) in terms of Islamic culture. These are all based on perceptions of water. Therefore for effective WDM policies to be introduced, perceptions of water need to be understood and managed, because such perceptions can mitigate against strategies, which may be well thought out, but which ultimately fail.

Figure 9 shows how different perceptions of water are linked to different phases of water management.

![Figure 9. Schematic representation of the different phases of water management showing how perceptions, policies, the resource base and makeup of the discursive elites change accordingly.](image)

From this it is evident that each phase of water management has an accompanying perception of water. In order for the management strategies to be successful, the
perception of water needs to be shifted accordingly. This is no easy task, as perceptions are culture bound, and normally take considerable time to change. Innovation is thus called for. ‘Adaptive capacity’ could be linked in this regard to two key variables; the ability of the technocratic elites in the structural component to innovate, and the willingness of those people being governed to accept these innovations as reasonable and legitimate. This establishes a clear causal linkage between perceptions of water and the type of ‘sanctioned discourse’. For this reason it is possible to show how the ‘sanctioned discourse’ changes along with the configuration of the technocratic or discursive elite, defined as those persons in gate-keeping positions who allow new ideas to be introduced. It therefore becomes clear that in the supply-sided phase, the discursive elites are engineers, hydrologists and politicians. As water scarcity develops and the resource base becomes increasingly burdened in environmental terms, the ecologists come into the picture. Only once the demand management phase is looming, are economists and social scientists welcomed into the technocratic elite. With each new addition, the incoming specialists are faced with a strong body of previously formed opinions, so their ideas are likely to be regarded with some scepticism at first. This is what Aston (1999) refers to as the ‘ego barrier’.

From the argument, it becomes evident that the social aspects of water management are extremely important and not yet fully understood. For this reason Allan (1996: 5) is only partly correct regarding the economic development of a political economy as being most important. Economic development is obviously important, but only insofar as it allows three critical things to happen. These are to:

• Allow structural changes to take place within the political economy of the country (or region) in question.

• Enable the transition to be managed from the “more crop per drop” option to the “more jobs per drop” option with minimal disruption.

• Provide the support base for the structural component of ‘adaptive capacity’ (institutional capacity and intellectual capital) to become effective.

These three aspects on their own cannot be effective if the second (social) component of ‘adaptive capacity’ is flawed or missing. Therefore, economic development on its own is a necessary, but not a sufficient condition for the transition in water management to be made.

CONCLUSION:

This paper has been an attempt to make a contribution to the state of the art regarding aspects of the socio-cycle of water use and management. It has sought to take the work of different authors, who are each at the cutting edge of social research, and then to combine their respective contributions into an overall framework. This could be considered as a model for the construction of new knowledge in this specialised field and is represented diagrammatically as an appendix. Allan has made a major contribution with his insight
into discourse analysis and the concept of ‘virtual water’. The latter provides a viable policy option for water scarce political economies. Karshenas has generated a model which shows how a political economy initially depletes, but can ultimately reconstruct its natural resource base. Ohlsson differentiates between a first-order scarcity of natural resources and a second-order scarcity of social resources. Homer-Dixon’s concept of ‘resource capture’ is valuable in explaining how and why certain social entities are unlikely to manage a transition in water management. The author has tried to combine these all in a rational and logical way.

The water sectors within a number of developing countries are currently undergoing significant degrees of reform, generated in part from the changes taking place in the global arena. The fact that reform is taking place shows that the existing policies are inadequate. There is a paucity of information regarding the processes that are driving these reforms. There are major gaps in the knowledge regarding the social, institutional, and hydropolitical dynamics of water sector reform. It is unknown, for example, exactly how reform is generated and how policy is actually made or impacted on by various actors in the water sector. The construction of such new knowledge, specifically regarding the social dynamics at work, is likely to increasingly become of strategic significance to the governments of developing countries. It is hoped that some of the ideas that have been articulated in this paper will make a constructive contribution to the construction of this new knowledge that is relevant to the water sector of such political economies.

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The Socio-Cycle of Water Use and Management

- The need for economic development
  - Depletes available water resources
  - Needing hydraulic engineering solutions
  - Resulting in water scarcity or unsustainable resource use which is a first-order scarcity
  - That mobilise all possible water resources
  - Resulting in a ‘window of opportunity’
  - Enabling water sector reform to be initiated
  - In order to ultimately achieve ‘allocative efficiency’
    - More Jobs per Drop
    - Which enables ‘natural resource reconstruction’ to take place
  - By supplementing local water scarcity by importing ‘virtual water’ from the global political economy

- Human population growth in developing countries
  - Exacerbates this
  - Causing a convergence in ideas between the public, politicians and technocrats
  - Resulting in water demand management strategies being developed
  - Enabling water sector reform to be initiated

- If sufficient ‘social resources’ exist which can be a second-order scarcity
  - Initially resulting in ‘end-use efficiency’
    - More Crop per Drop
  - Buying time to make structural adjustments in society
END NOTES:

1 This would require ‘adaptive capacity’ to implement however.
2 This is where the concept of ‘adaptive capacity’ really starts to become relevant. A state with a scarcity of ‘social resources’ would not be able to generate a range of viable options, which in turn would limit their range of strategic choices.
3 Feitelson (1998) gives a good insight into the way that this process worked in the case of Israel. Essentially what happened was that agriculture became increasingly unimportant to the politics of Israel. By 1990 only 4.2% of the labor force was employed in agriculture, compared with 17.3% in 1960. In 1980 agriculture was contributing only 3% to the GDP which reflected a shift in the Israeli economy away from agriculture. This allowed pricing of water to be used as a demand management instrument after the droughts of 1990/1 without fear of political repercussions. This also represents a classic example of a ‘window of opportunity’ during which water sector reform could be implemented.
4 This suggests that there are at least two forms of social resources. Firstly, the ability to develop alternative options, and secondly the ability of society to accept these options as being legitimate.
5 Refer to Turton (1997; 1998: 197-248) for more details regarding the reasons for the selection of these states.
6 This is a strong indication that the second component of ‘adaptive capacity’ – the willingness or ability of a social entity to accept WDM options as being legitimate and therefore to support these governmental initiatives – is extremely important.
7 This case study is a short summary of Reisner (1993). This book is extremely well researched and is essential reading material for any scholar or practitioner of WDM in the opinion of the author. The website is http://www.pbs.org/kteh/cadillacdesert/home.html. The case study presented here is a very brief summary of the book due to space constraints, so the reader is urged to consult the original text for a deeper insight.
8 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. 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 the “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, and 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 and owners of nature” (Anscombe & Geach, 1954: 46). The control of nature aspect is still relevant today within the natural sciences and is particularly manifest in hydraulic engineering. 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. The efforts of Nomi Lazar (1999) of the University of Toronto at drawing the author’s attention to these philosophical nuances are gratefully acknowledged.
9 This is possibly the birth of what is now known as “cloud seeding”.
10 When all river waters are conducted onto the land, Powell noted that only 3% of the country would be redeemed (Reisner, 1993: 45).
11 As quoted in Reisner (1993: 50).
12 Refer again to endnote number 8 and the conclusion by Giddens (1984: 335) regarding the social barriers that exist with respect to the reception of scientific knowledge.
13 Powell concluded that the artesian wells would dry up if over-exploited on the scale that irrigation would require. History has shown him to be correct in this prediction even if his advice was not taken seriously at the time. Such is the power of the ‘sanctioned discourse’ that it blocks out new knowledge and ideas that go contrary to the prevailing conventional wisdom.
14 This is an interesting and common feature about water politics. It is what is known as the ‘sanctioned discourse’, which becomes an extremely powerful ‘filter’ between the facts generated by science, and the actions taken by decision-makers. It appears as if human beings, by their very nature, seem to be more confident with science when hearing something which is apparently scientifically based that supports their original unscientific instincts. When science goes contrary to these deeply held convictions, then it is
science that is to blame, rather than the validity of the deeply held conviction. Galileo was a classic example, who after proving that the earth was not the centre of the universe, was branded as a heretic and almost lost his life as a result. Challenging the ‘sanctioned discourse’ has its dangers it seems.

This illustrates yet another aspect of water politics. Oklahoma had originally been left “in perpetuity” to five Indian tribes in terms of a treaty. This treaty, it seems, was insufficient to protect the Indians when the government suddenly was confronted with the need to resettle white homesteaders who had been displaced due to drought. This could best be described as selective hydraulic morality.

This observation is the basis for the belief that the author has of the existence of the second aspect of ‘adaptive capacity’ – the willingness or ability of a social grouping to accept WDM as being legitimate. The author is convinced that it is on this intangible factor that the success or failure of WDM hinges, rather that on the actual strategies which technocratic elites may develop in isolation.

A dam site was available in the Owens Valley. This was owned by Thomas Eaton, the erstwhile Mayor of Los Angeles who, after buying the land with insider knowledge of the water management plans, wanted one million Dollars for it. This infuriated Mulholland who refused to pay, so he decided to build the San Francis dam in the San Franciscita Valley on an inferior site. This dam failed a day after Mulholland proclaimed the structure to be safe, killing many people in what was at that time the greatest manmade disaster. This also ended Mulholland’s illustrious career and brought him and Eaton back together again, this time lamenting the fact that their dispute had resulted in the loss of human life. Subsequent solutions cost considerably more than this sum, including the loss of life. This shows how powerful figures, personalities and greed can impact on water development projects. Interestingly, greed is not a new thing in water politics. In 1 AD Frontinus was governor of Britain, after which he was put into a managerial post at Rome where he was asked to sort out corruption and fraud in the city’s water supply system. He wrote a detailed account of the various hydraulic installations, citing instances of scams and fraud perpetrated by various contractors. A text and translation is available in Bennett (1980) and Evans (1994). Andrew Wilson (1997) of Oxford University is gratefully acknowledged for this information.

Mulholland was the head of the Los Angeles Department of Water and Power.

This was known as the Bureau for Reclamation and was responsible for dam construction for the purpose of “reclaiming” the desert for irrigated agriculture. Another bureaucratic entity also existed. This was the Army Corps of Engineers, who were responsible for dam construction for the purposes of flood control and navigable waterways. These two entities often clashed in what were sometimes fierce bureaucratic rivalries.

This is an important aspect of hydropolitics relating to perspectives on water.

The British Museum in London has an interesting display on the topic of ancient hydraulic engineering. An Assyrian frieze (BM reference 124939 / Room 89) dating back to 645 BC shows irrigated agriculture in great detail in what is probably one of the oldest visual records. Visible in the stone carvings are aqueducts of intricate design, along with canals leading to fields of different crops. This suggests that Assyrian society was highly differentiated already, with engineers and farmers performing specialized jobs. Presumably there would also have been lawyers to interpret statutes and to settle disputes. There are also examples of Roman mechanical engineering (BM Cat Bronzes 2573 & GR 1892.5-17.1) dating back to 3 AD in the form of a bronze double-action piston-pump from Bolsena. These pistons were housed in two cylinders, each equipped with a non-return valve (see also BM Cat Bronzes 2574 & GR 1892.5-17.5). The design is amazingly similar to reciprocating pumps that were used for high head/low volume applications earlier this century. The earliest reference to lead piping dates back to Rome in 1 AD (GR 1856.12-26.110). Terracotta drain pipes (GR 1908.11-20.1+2) that were joined by means of sockets show evidence of Roman sanitation engineering. Dr. Steve Merrett (1999), a research associate at the Water Issues Study Group at SOAS, is gratefully acknowledged for showing these to the author.

The Hoover Dam was the first “big one” that inspired subsequent projects such as the damming of the Volga, the Paraná, the Niger, the Nile, the Zambezi and other great rivers of the world.

This was larger than the pyramids of Egypt and used the greatest volume of concrete ever to be poured on one site. Like the pyramids, it seems to be regarded as a monument to the ingenuity of man, with an intrinsic value that is greater than its mere functional design and construction. This ties in with the philosophical foundation of science as being the quest to control nature (refer to endnote number 8) as some form of primordial human instinct. What was truly amazing however was the fact that this was done in three years, at a time when the rest of the world was suffering from the Great Depression, without previous engineering knowledge from a project of that magnitude. In essence, it allowed a new type of knowledge to be created. This served as living proof that man could indeed control nature, as was being
demonstrated simultaneously by splitting the atom. Significantly, the latter endeavor has severely polluted large portions of Yakima in Washington State, from radioactive sites that are still leaking today. It seems that when they split the atom, they were unaware of radiation so the research facilities were not designed accordingly. Controlling nature is not as easy as it is temptingly seems.

24 This is of course not a unique thing. Research that is currently being conducted in Spain also reveals the existence of a powerful urge to show mastery over nature, due to the shock of the loss of empire. Swyngedouw (1999) refers to this as “the production of nature”. He notes that “hydraulic politics, understood in a broad and symbolic sense as a process of transformation of agriculture from extensive into modern and intense [forms] must constitute the fundamental vector of national politics. This must catalyze an agrarian reform which would permit a balanced economic development…” In the case of Spain, the Engineering Corps, founded in 1799, is still “highly elitist, intellectualist, ‘high cultured’, male dominated, socially homogenous” and has been an organization that has played a leading role in Spanish politics and development discourse (Swyngedouw, 1999). Significantly, two Turkish Presidents – the late Targut Ozal and Suelyman Demirel - were originally hydraulic engineers. Turkey is also a state with a strong hydraulic mission. Not coincidentally the basis for the Turkish/Israel partnership was laid when Mr.Demirel spoke with another water engineer, Yitzhak Rabin who was the Israeli Prime Minister at that time (Kinzer, 1999). Israel also has a strong hydraulic mission.

25 The cost of constructing fish ladders at Bonnieville Dam’s second power-plant, conceived as an afterthought, eventually cost 65 million dollars, almost one quarter of the cost of the power-plant itself (Reisner, 1993: 158).

26 There are essentially two main root causes of the demise of Jimmy Carter as a President. Externally, it was the Iran question, whereas internally, it was his attempt to challenge the sanctioned discourse of water by trying to stop the self-perpetuation of the unsound reasons for large dam construction. Large dams mobilized cheap water which in turn created more demand which needed more dams.

27 The term ‘sanctioned discourse’ is attributed to Tripp (1996), who elucidated the concept in a personal communication with Prof. Tony Allan. Refer to Allan (1999).

28 The Tellico Dam, 95% completed at the time, became the first “victim” of this legislation. David Etnier, a Zoologist, discovered a small fish known as a snail darter, which led to the halting of construction (Reisner, 1993: 325). Then in a surprising turnaround, Congress used a loophole and exempted Tellico Dam from the law (Reisner, 1993: 328). Carter was forced to sign this, or else run the risk of losing Congress support for a treaty to give the Panama Canal back to Panama. The dam building lobby had finally defeated Carter (Reisner, 1993: 329), contributing in part to his ultimate political demise.

29 A Fresno Legislator named Ken Madden referred to groundwater regulation as “World War III” (Reisner, 1993: 342).

30 Edmond G. (Pat) Brown was the Attorney General and subsequently the Governor of California in 1958. He went on to become a rival to Nixon. Brown gave this testimony to the University of California Oral History Program.

31 This evidence was given in 1979. The perception of oil has changed drastically since then. At that time it was believed that oil would soon run out. Since the 1950s, proven reserves of oil have grown by 700% (Moore, 1995: 110). Higher oil prices have encouraged the search for alternative energy sources. This has cut oil prices to pre-crisis levels and made the oil market more resilient to other potential global crises (Bailey, 1995: 432). (Refer to endnote number 32).

32 In certain contexts, the price of water is already higher than a similar volume of oil. John Aston (1999), a graduate student at Imperial College in London, is gratefully acknowledged for pointing this fact out. The reader is urged to consult Reisner (1993).

33 The Tellico Dam, 95% completed at the time, became the first “victim” of this legislation. David Etnier, a Zoologist, discovered a small fish known as a snail darter, which led to the halting of construction (Reisner, 1993: 325). Then in a surprising turnaround, Congress used a loophole and exempted Tellico Dam from the law (Reisner, 1993: 328). Carter was forced to sign this, or else run the risk of losing Congress support for a treaty to give the Panama Canal back to Panama. The dam building lobby had finally defeated Carter (Reisner, 1993: 329), contributing in part to his ultimate political demise.

34 Refer to Homer-Dixon (1994) and Homer-Dixon & Percival (1996). See also endnote number 39.

35 Refer to Kingdon (1984) and Allan (1999). The occurrence of drought causes a short period of convergence in the ideas held by government officials and ministers (Feitelson, 1996), as well as by the media (Allan, 1996c), opening the door to policy changes.

36 Refer to Feitelson (1998) for an analysis of the case of Israel; Reisner (1993) for the case of the USA; and Turton (1999) for the case of South Africa.

37 Allan (1998b: 4) has a useful diagram to explain this. Essentially it shows that priorities are inverted for politicians and environmentally conscious water resource specialists. For politicians, the implementation of ‘end-user efficiency’ strategies is preferred. This is then followed by ‘allocative efficiency’ as a less preferred option and ultimately by achieving strategic water security by means of ‘virtual water’
importation as the least preferred option. Environmentally conscious water resource specialists on the other hand favour achieving strategic water security first, followed by ‘allocative efficiency’ as a less preferred option and finally by ‘end-user efficiency’ options as the least preferred method. Both hierarchies are inverted for the respective players, providing one of the driving forces of water politics.

In the case of Hermanus, the better rainfall, which coincided with a later phase of the WDM strategy, caused the local supply reservoir to overflow. This resulted in a public perception that the crisis was over and that WDM requirements could now be lifted because they were seen to be excessively restrictive for long-term commercial growth (Turton, 1999c). This is an example of the social component of ‘adaptive capacity’ (as illustrated in Figure 8) at work. Initially the public supported the venture when they perceived it to be necessary because of the drought. The drought was not the reason why Hermanus needed a WDM strategy however.

If this were to be allowed to happen, then ‘resource capture’ as conceptualized by Thomas Homer-Dixon (1994) (Homer-Dixon & Percival, 1996) would take place. A necessary condition for this to happen would be unequal access to the resource with the privileged few being able to wield power (Turton, 1999a) in order to monopolize access and thus capture the resource (Turton, 1999b) for their own advantage, creating a form of structural scarcity.

In a society where ‘resource capture’ is being actively pursued, ‘natural resource reconstruction’ is unlikely to occur because it reduces the overall legitimacy of the political system. This is because of three reasons. Firstly, the ‘resource capture’ is basically greed driven and greed can never be satisfied. It thus becomes self-perpetuating. Secondly, ‘resource capture’ results in ‘ecological marginalization’, which mitigates against efforts at ‘resource reconstruction’ by alienating the people who are most affected from the resource being reconstructed. Thirdly, ‘resource capture’ results in structural differentials within society. Therefore it can be said that effective WDM needs a legitimate system of government with a normative basis that is rooted in the notion of equity.
participants from Angola or Botswana, and there is no distinction being drawn regarding the nature of the participants, further invalidating the conclusions. The book is an interesting read however, and serves to alert the reader to some of the complexities regarding an understanding of perceptions of water, and how these perceptions can be manifest in decision-making.

47 The author has had some interesting personal experiences in this regard. When he first became interested in water, after presenting a paper on hydropolitics to a conference consisting of engineers, hydrologists and to a lesser degree, freshwater ecologists, the author was subsequently engaged in a discussion over a meal. The other party to the discussion was a senior engineer who noted that the author had presented some “interesting new insights into water management”, but then went on to say “but what does a social scientist know about water after all?” This statement implies that water management is no place for a social scientist to be involved in! Such viewpoints are common, but are slowly changing as social scientists start to add value to the overall debate. Social scientists will ultimately be judged, and allowed into the technocratic elite, once they can show deeper insight than the prevailing technocratic configuration is capable of doing.