WATER STRESSED REGIONS:
THE MIDDLE EAST & SOUTHERN AFRICA
- GLOBAL SOLUTIONS

by

Suki Jobson
e-mail: sukijobson@yahoo.com
With data provided by Donald Chambers

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INTRODUCTION:

Water is a geographically limited resource, fundamental to both the societal and economic development of a state. Some eighty countries, representing 45% of the world's population, suffer from serious water shortages. In the initial stages of socio-economic development, water is considered a free gift and access to shared water is uncomplicated. As population pressures increase, the socio-economic development of the state necessitates more active water exploitation, where the development of dams and Inter-Basin transfers are necessary for development in drier regions. When all the available water has been mobilised, the costs of further development and management of resources increase rapidly. This constant pressure to secure new sources of water can result in high competition at both the intra-state and inter-state level. When access is denied to alternative sources, the politicisation of water will occur. And as a consequence, water can become the tie that binds countries and regions, or the sword that divides them.

This article aims to identify, evaluate and compare the effects of water deficiencies in both the Middle East and Southern Africa, and to determine the effects and potential effects of 'virtual water' on these water deficit economies. If virtual water has enabled Israel and Jordan in the Middle East to balance their water budgets, could such an allocative strategy play a positive role, as an integral part of a development strategy for both Zimbabwe and South Africa in Southern Africa? It is, however, essential to bear in mind that no two points of the arid realm are alike in all respects, and while the Middle East and Southern Africa may experience similar water scarcity problems, with similar causes, they will not automatically require or be susceptible to similar solutions.

DEFINITIONS:

For the purposes of this paper, the following definitions will apply:

Allocative Efficiency is one of two methods available to increase the return to water, which is based on the notion of a rational choice as to which activity, would bring the highest return to water (Allan, 1998). Allocative Efficiency is economically rational but can be politically stressful, so it tends to be avoided by politicians (Turton, 1999).

A ***Flow Unit*** is a conceptual unit that is defined as one million m^3 of water/year which is used to measure 'water stress' (Falkenmark, 1990)

Natural Resource Reconstruction exists when a social entity can effectively introduce *water demand management,* specifically by re-allocating water from one economic sector to another (Allan & Karshenas, 1996).

Sectoral Water Efficiency (SWE***)*** is the ratio of water consumed within a given economic sector expressed as a percentage of total national water consumption, in relation to the contribution of the same economic sector to overall GDP expressed as a percentage of total GDP (Turton, 1997).

Virtual Water is the volume of water needed to produce a commodity or service. It takes 1000 tonnes of water to grow one tonne of grain. This represents the 'virtual water' value of grain. 'Virtual water' is also present in hydroelectric power, and constitutes the volume of water needed to produce a given unit of hydroelectricity (Allan, 1996; Turton, 1997).

The ***Water Barrier*** is a conceptual unit that measures 'water stress', and is defined as 2000 people/'flow unit' of water, which is the maximum number of people that an advanced society is able to support and manage with currently available technologies (Falkenmark, 1990).

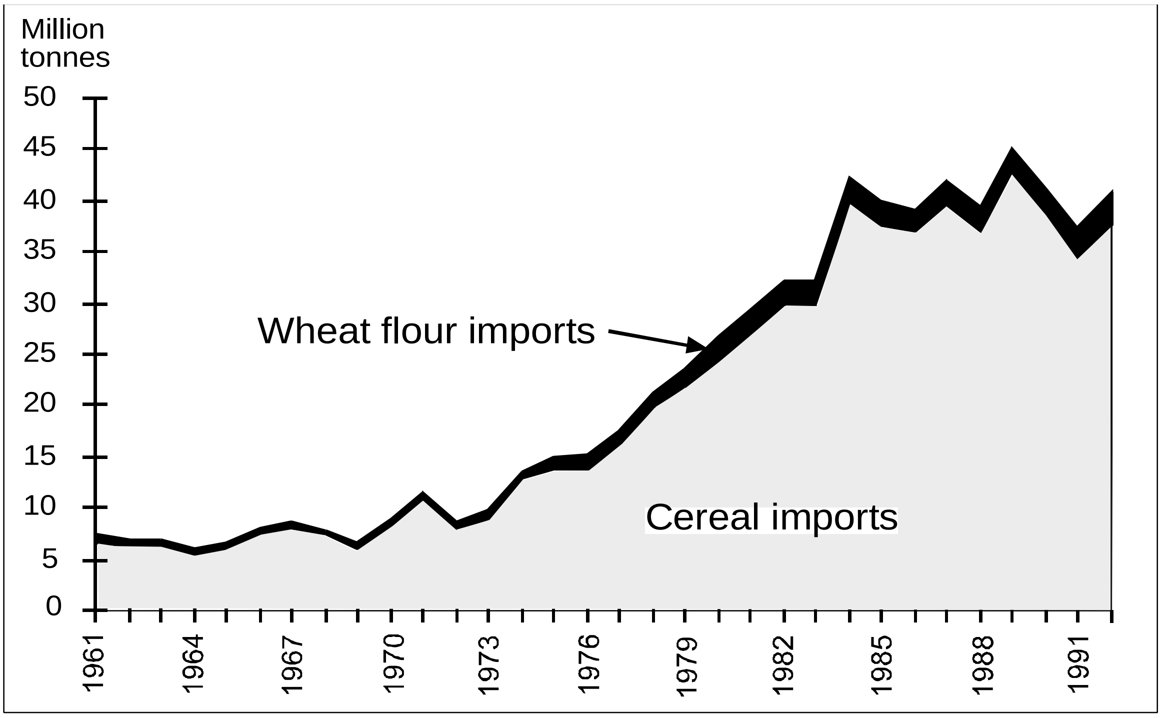
The ***Water Barrier Scale*** (WBS) is a measurement of water competition between the number of people that rely on one 'flow unit' of water, represented on a linear scale of 1-5 (Falkenmark, 1990).

Water Demand Management (WDM) is a policy for the water sector that stresses making better use of existing supplies, rather than developing new ones (Winpenny, 1997).

The ***Water Scarcity Index*** is a conceptual tool consisting of a two-digit code that is used to introduce a variable element of agricultural development, and thus take into account the higher requirements of water and technology inputs, needed to maintain self-sufficiency in arid climates. The first digit refers to the level of technological input needed to maintain self-sufficiency, designated in terms of a linear position 1-4. The second digit corresponds to the position of a state on the WBS, as defined above on a linear scale of 1-5.

THE SIGNIFICANCE OF 'VIRTUAL WATER':

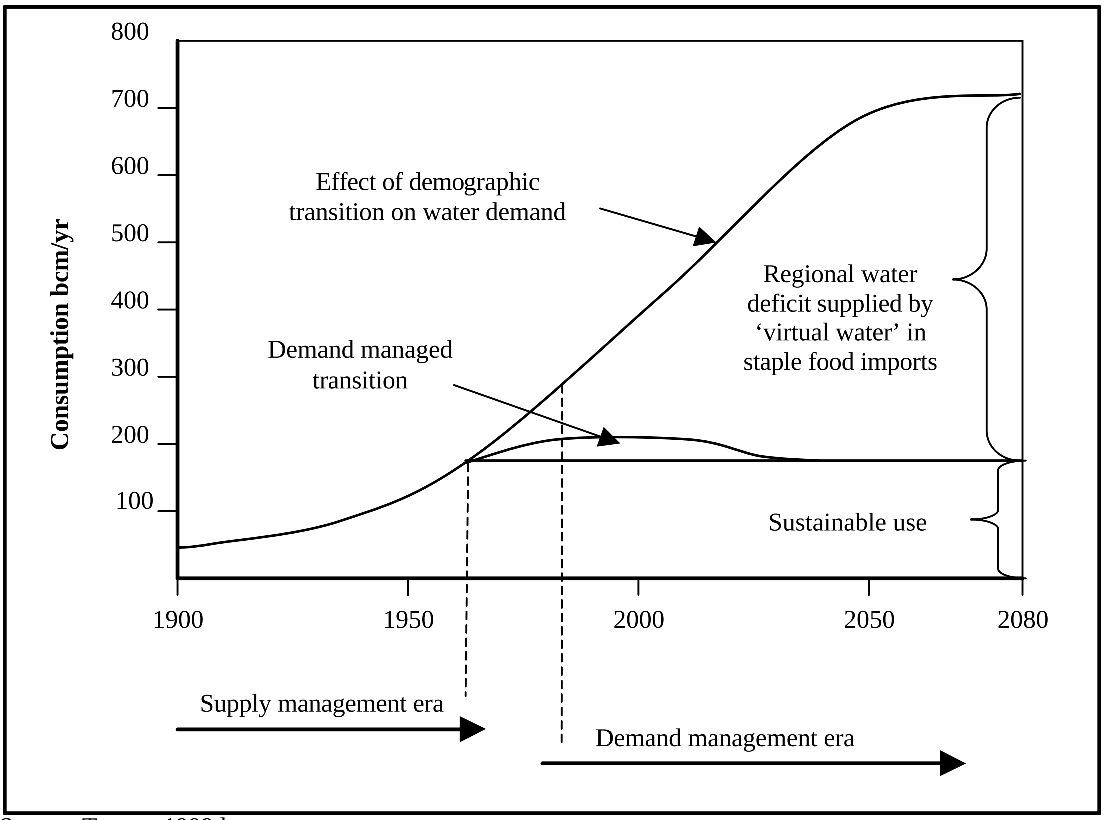
The theory analysed and applied here is drawn from economic geography, and employs Allan's concept of 'Virtual Water' as its organising principle. By adopting a strategy of 'allocative efficiency', a state makes possible the implementation of a 'virtual water' strategy, through the importation rather than the production of low value, high water content foodstuffs. Thus, effectively, substantial volumes of water can be imported at a relatively low cost, rather than utilised at a relatively high cost.



Source: FAO trade statistics

Figure 1. Middle East cereal and wheat flour imports 1961-92.

Allan's theory is derived from the Middle East, a region where the level of water competition is strongest in the world. This competition has provided a strong impetus to search for new and sustainable sources of water. Following the logic of the 'virtual water' strategy Allan suggests that, 'the rate at which food imports have been rising in the Middle East and North Africa since the 1970s conforms with the scientist's contention that the region has run out of water'. This upward trend in cereal imports reflects the capacity of the political economies within the region to meet their own strategic food needs (Figure 1). Allan (1997) also notes that, 'more water moves into the Middle East as food trade than flows down the Nile and the Jordan in a year.'



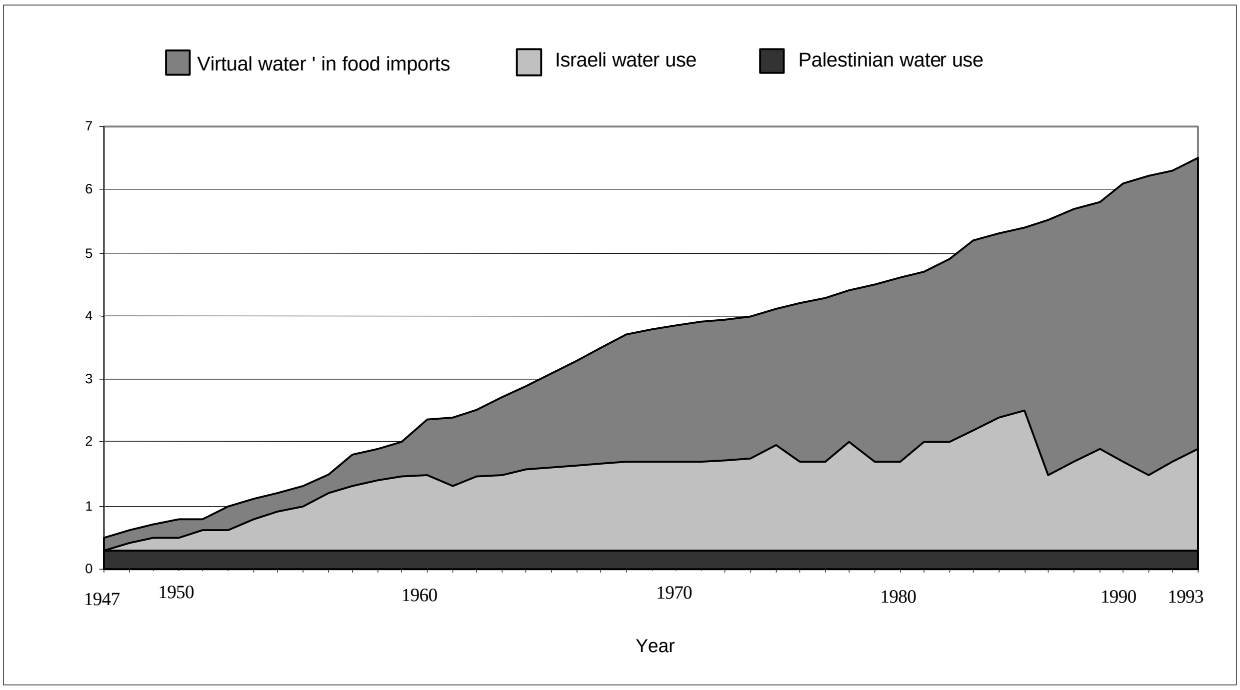
Source: Turton, 1999d

Figure 2. Estimates of water use and water availability and showing phases in water management in the Middle East (including Turkey) and North Africa.

Figure 2 provides a perspective on the relationship between water availability and water needs, together with levels of past and projected population (Allan, 1996). It indicates the change, which needs to take place within the society, in order to meet the challenge of increased water scarcity. The change is generally some form of 'second phase water management, namely demand side management…(which) comes into play at a point in time when the first phase of supply-side management faces a crisis and is unable to mobilise more water by the application of traditional supply-side solutions' (Turton, 1999d).

Israel, a severely water deficit economy, with the third lowest level of renewable resources in the region, provides the most advanced example of a transition to 'water demand management'. It has already moved from high water, low value agricultural produce (e.g. melons) to low water, high value produce (e.g. flowers, wine) to high value, low water industry and finally to 'virtual water' importation. Allan (1996) believes that, 'demand management is primarily essential in order to bring the allocation and management of the scarce water resources, into an environmentally and economically sustainable system', under which, 'the economic activities being supported will be much more effective and the returns to water will be progressively enhanced.' Consequently, there was no escape from the politically stressful water relocation that Israel experienced and that its neighbouring countries will be forced to address in the near future.

It is already evident that Israel has adopted the 'virtual water' development strategy to balance its water budget. Despite needing up to four times more water than is available, the political economy of Israel has been able to avoid conflict over access to scarce water resources because of its easy access to water that is embedded in the cereals, imported from rich water states (Figure 3). It is important to note that Israel, with the help of aid from the USA, was able to develop a diversified political economy by 1986. This enabled it to purchase its water entitlements on the international cereal market, therefore allowing it to alter its water policy.



Source: Allan, 1996

Figure 3. Israeli and Palestinian water use compared with the total water needed for food self-sufficiency, 1947-1993.

While Israel was able to implement a more sustainable water policy, other less diversified economies within the region have been unable to alter their development trajectories, with regard to water and as a result face serious consequences if policy intervention does not take place. Jordan, Gaza and the West Bank have not yet been able to follow in Israel's footsteps. It is apparent that Jordan still has to undergo the difficult task of reallocating water resources between sectors, but out of sheer necessity it has already moved towards a 'virtual water' strategy, with food imports rising sharply from $612.1m in 1992 to $967m in 1996 (EIU, 1997).

comparison, in the post apartheid era, the countries of Southern Africa face increasing population growth and water scarcity, both of which can severely effect the agricultural and industrial capacity of the states, and could slow the pace of economic growth. As Israel in the Middle East, so South Africa in Southern Africa has the most potential for leading the way to a "virtual water" allocation.

<u>Falkenmark's Water Scarcity Indicators</u>

In determining the present and future water endowments of the Jordan Basin in the Middle East, and the Zambezi Basin in Southern Africa, the water scarcity criteria of the Swedish hydrologist Falkenmark was employed. Despite the recent criticism[1] of

[1] Falkenmark (1989) has made a very important contribution to the discourse on fresh water availability by drawing attention to the minimum water needs of individuals and the challenges faced by an increasing

the Falkenmark (1989) approach her 'water scarcity' indicators are essential, in establishing the dynamics of the deterioration in water resources within states and across regions. The first of these indicators, the *'water barrier'*, measures the reliance and competition between both individuals and countries, on and for the water resources available to them over time. Water stress is defined as 2000 people per flow unit[2] (one million m^3) of water, which is the maximum number of people that an advanced society is able to support and manage under the current availability of technology and beyond which point further economic development is not possible. According to Falkenmark (1989), a state can be found within five quantifiable conditions, these are, in declining order:

Table 1. Falkenmark's Water Barrier Scale	
Well Watered Conditions	<100 persons/flow unit
Mid-European	100-600 persons/flow unit
Water stressed	600-1000 persons/flow unit
Chronic Scarcity	1000-2000 persons/flow unit
Beyond the Water Barrier	>2000 persons/ flow unit

The *'water scarcity indicator'*, on the other hand, indicates the required level of technological inputs in order to maintain self-sufficiency by states. More importantly, it indicates the economic rationality of each state's water management policies. Israel, a developed state, illustrates the high levels of technological inputs, such as large water transfers and inter basin transfers, required to maintain self-sufficiency. These, however, are managed under expensive policies of subsidisation. There are three other quantified conditions:

•*Low levels of technology*, implies that rain-fed agriculture is largely adequate with limited irrigation required.

•*Intermediate levels of technology*, implies a necessary transition from rain-fed agriculture to limited water transfer schemes.

• *Large scale irrigation*, implies that high levels of technological inputs are essential.

Turton employed these conceptual tools in his 1997 study 'The Hydro-politics of Southern Africa: the case of the Zambezi Basin as an area of potential co-operation based on Allan's concept of virtual water', along with the Sectoral Water Efficiency ratio. By utilising the SWE ratio Turton (1999c) identifies that each sector within the economy be it agricultural, industrial or domestic has a different, 'financial connotation attached to the way that it consumes or converts water into a product'. '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, as expressed as a ratio of the percentage contribution to the overall economy (GDP) of that sector' (Turton, 1999c). The SWE establishes the relative

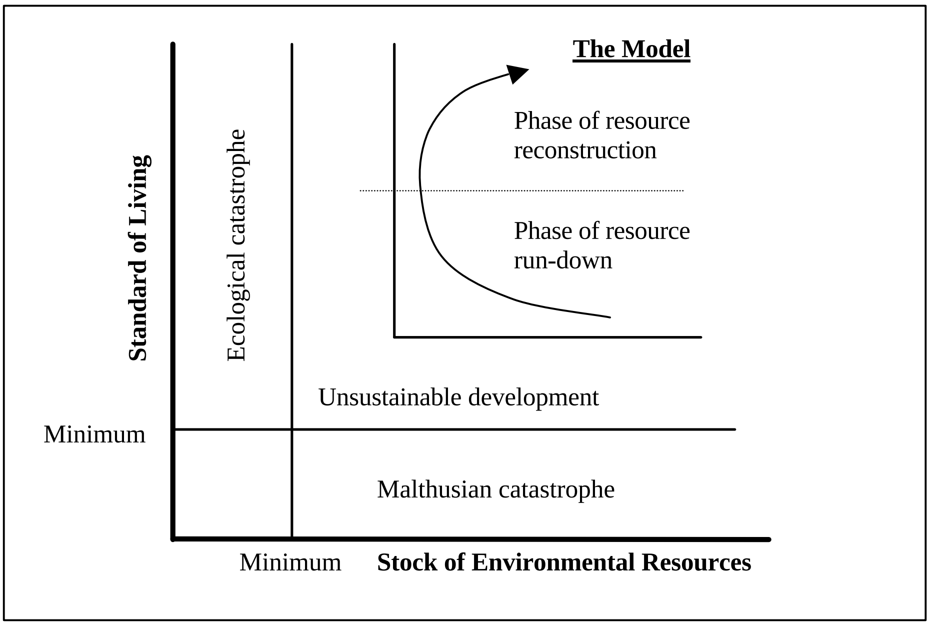
number of countries to provide sufficient water. The threshold minimum levels of water provision established useful target for politicians and communities. Unfortunately the concept is based on the assumption that water is part of a closed system. In practice the economic systems to which water makes an important contribution are very flexible and open systems, which provide numerous options to politicians and communities. Water shortages do not determine economic outcomes.

[2] A flow unit is a conceptual unit that is defined as one million m^3 of water/year, which is used to measure 'water stress' (Falkenmark, 1990).

efficiency of each state, and assesses that states potential to adopt a 'virtual water' strategy. Turton suggests that the introduction of the element of efficiency brought in to the equation will allow water planners to make rational choices with regard to water allocation, considering the overall economy.

THE THEORETICAL MODELLING OF KARSHENAS'

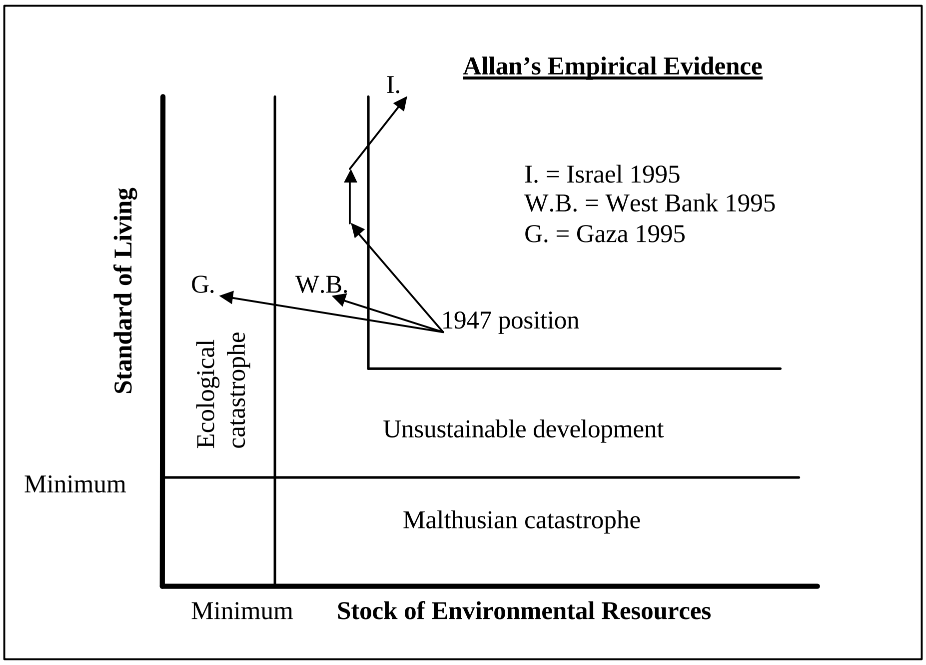
Karshenas' basic model is used to show the relationship between a state's environmental capital and its economic development. The model illustrates the tendency of economies to deplete their environmental capital, during the pre-industrial stage of economic and social development. The degree of over-exploitation that may occur 'is not necessarily irreversible provided that policy interventions are made and implemented' (Turton, 1999d). In the case of water, states, which develop and grow in their diversity and strength, will be able to pursue new and more efficient water allocating strategies, including the adoption of 'demand side management' and allocative efficient strategies.



Source: Karshenas and Allan et al, 1996; Turton, 1999d.

Figure 4a. A model

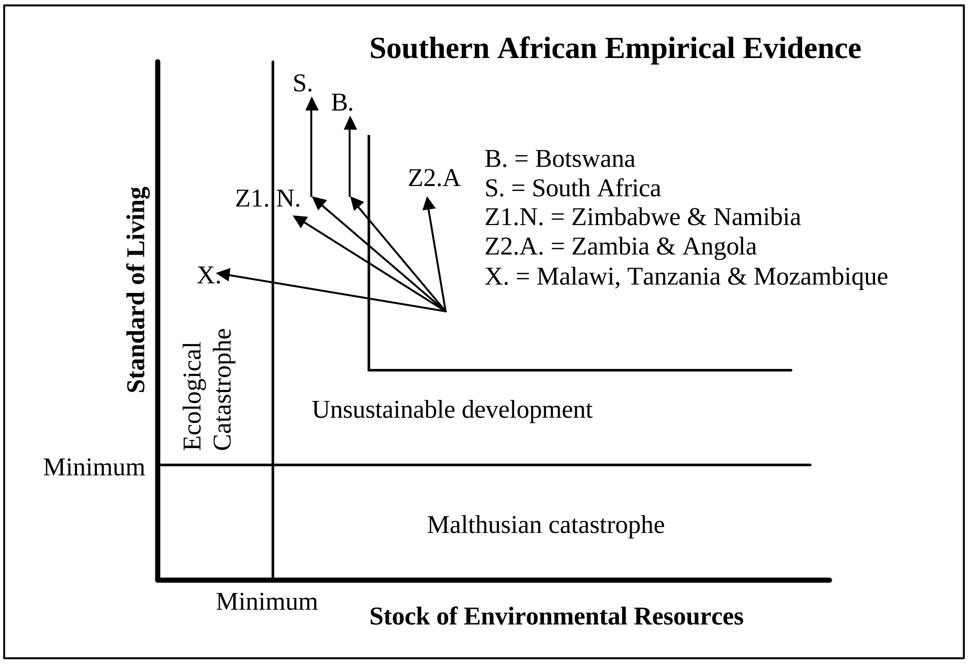
Figure 4a outlines the trajectory regarded by Karshenas as the 'normal' pattern for the use of environmental capital. Under this trajectory, environmental capital is used to develop the economy, and improve the welfare of the citizens, even if this results in over-exploitation of the resource base. When the economy grows and becomes integrated with others, it opens doors to new sources of environmental capital. With other options available, policy makers are given the space in which to contemplate and maybe implement politically costly 'demand side management' options. This then enables an economy that is both expanding and diversifying to gain access to 'virtual water' on the international market, which lessens the pressure put on local water resources. Under this diversification, a policy of 'natural resource reconstruction' can be considered (Karshenas, 1994).



Source: Karshenas and Allan et al, 1996; Turton, 1999d

Figure 4b. Some empirical evidence

Figure 4b, shows a trajectory produced by Allan, in an attempt to compare the trajectories of Israel, the West Bank and Gaza. Allan (1996) notes that Israel's trajectory conforms to that which would be expected, of a diversified industrialised economy. 'By the second half of the 1980s, it was evident that water using policies were unsustainable and had to be modified' (Allan, 1996). In 1967 Israel, determined to keep control over all the headwaters of the Jordan-Yarmuk river basin, took control of the West Bank of the Jordan River. Reluctant to relinquish control, because of the significance of the large groundwater aquifer located there, Israel's stronger economy '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' (Turton, 1999). Instead, these economies remain on a trajectory heading towards environmental catastrophe, unless policy intervention takes place. Turton (1999) suggests that this 'in turn cannot be done unless Israel finally relinquishes control over the West Bank as it has recently done with Gaza'. However, Israel is unlikely to let go of this source, which provides at least, one fourth of its overall water supply.



Source: Turton, 1999d

Figure 4c. Turton's application of Karshenas' model to Southern Africa.

In applying Karshenas's model to Southern Africa, Turton (1997) creates a graphic representation of the four distinct sets of hydro-political conditions that are evident between the riparians of the Zambezi Basin[3] and South Africa. For the purposes of this article, this model allows for a direct comparison to be made between the riparians of the Jordan Basin, the Zambezi Basin and South Africa, with regard to the relationship between economic development and the utilisation of environmental capital.

The diversity of situations has been categorised, into three defining belts, by Turton (1997). These are as follows:

- The *Eastern Belt of Povert*y includes the countries of Malawi, Mozambique and Tanzania. The prevailing high level of population growth, within these states and the resulting water scarcity, suggest that the conditions of unsustainable development that are present will result in ecological disaster, if the development trajectory is not altered. Furthermore it may be the fact that the trajectory could not be altered even if government policy intervened, due to the seriousness of this situation. This same situation can be compared to that of Gaza in 1995, and increasingly to the West Bank, today. Turton (1998) suggests that the conditions of these states would have a spill-over effect on the whole of the Southern African region, as both environmental and economic conditions would create the inevitable 'push' factors necessary for a large scale refugee crisis. It would therefore be in the interest of the rest of the region, to create water sharing policies that include and assist these states.

- The *Western Belt of Resource Abundance*: Zambia and Angola are in an unusual position, not to be found within the Middle East. Situated in a position of resource abundance, sustainability is not an issue. These states hold a potentially powerful position in the region. Zambia, with its superior riparian position, will be able to exercise considerable political leverage within the region, by becoming a major

[3] Zambezi riparian States: Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe.

hydro-political actor, to which many downstream states in a weaker resource position will be subordinate. These states, following the logic of a virtual water strategy, have the water resources to become 'virtual water' exporters.

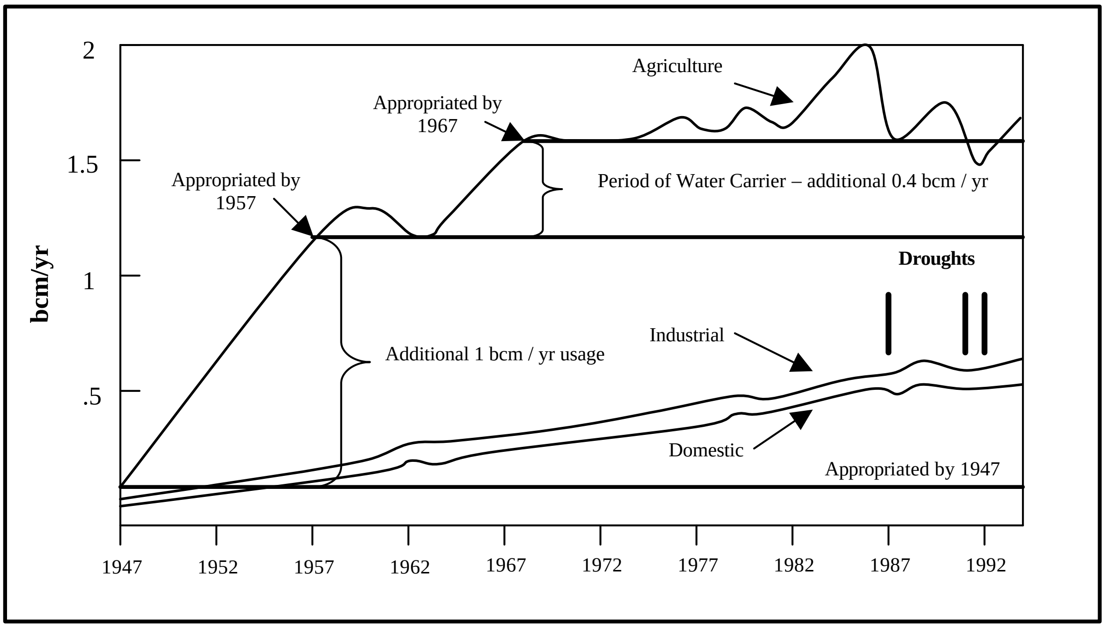
- The *Central Belt of Scarcity* includes the states of Zimbabwe, Botswana, Namibia and South Africa, where the water resource need is the greatest, and also the resource most limited. Turton (1997) suggests that, 'all these states are relatively economically strong, but the magnitude of this development is skewed in favour of South Africa and Zimbabwe, which have the most diversified economies. Water competition is high in this belt and water availability can be regarded as being a constraint on long-term development'. Under these circumstances, it is felt that these states are most inclined to be the hydro-political driving force in the region.

MIDDLE EASTERN CASE STUDY: THE PREDICAMENT OF ISRAEL AND JORDAN

The intensity of regional politics in the Middle East reflects the importance of each states perception of its rights of access to water. When the downward trajectory of regional surface water was first noticed in the 1960s, competition between states in the region for scarce water resources was such that it led to hostilities on a number of occasions. However, the large-scale water wars previously predicted by water pessimists, have not as yet taken place. With the vision of developing national self-sufficiency in a region of hostility and water shortage, the governments became aware of the crucial significance of controlling their water supply at any cost, even if this was to the detriment of the downstream countries. In hydro-political terms, Turton (1999c) suggests that, 'just as water is needed by people to sustain life, engineering solutions like pipelines are needed to sustain governments under conditions of water scarcity'. Through the expensive storage and mobilisation of their water resources, governments have created a myth of national self-sufficiency. This policy, which favours the traditional water user, the farmer, through the subsidisation of water, in turn only serves to hinder the adoption of more durable and sustainable approaches, to the use of this scarce environmental capital. Therefore, governments, through the employment of viable strategies, will have to address the politically stressful issue of misallocation and equitable management of water resources. At the same time, in order to avoid political tension on all levels, water scarcity can be overcome by employing non-conventional techniques in permanently or periodically dry areas.

ISRAEL

Between the 1950s and 1970s Israel's position on Falkenmark's (1989) '*water barrier scale*'(Table 2) attested to the high levels of water scarcity within its own boundaries. In order to maintain self-sufficiency, Israel followed a supply-side management ethos during this period, developing large and expensive water transfer schemes. An example of this can be seen in the construction of the Water Carrier in the early 1960s (Figure 5).



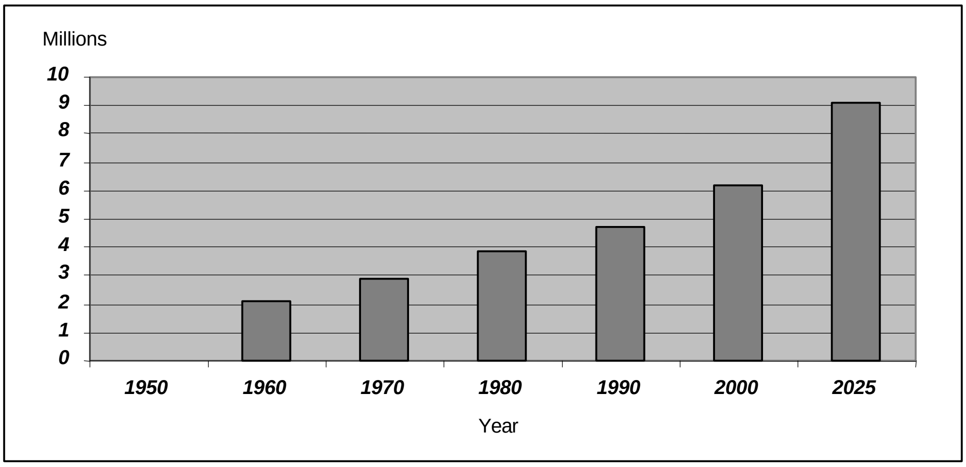
Source: Allan, 1996; Turton, 1999d

Figure 5. Israeli water consumption, 1947-1993 by sector, showing the impact of the 1987 and 1992 droughts on sectoral water allocation.

This pipeline carries 1 million m³ of water, per day, from the Sea of Galilee, 200m below sea level, to the coastal and desert farms in the Negev (Falkenmark and Lindh, 1993). The process of pumping the water to its required destination uses one fifth of Israel's electricity, and has subsequently failed to meet the growing needs of the political economy of water.

It became evident by the end of the 1960s that the Middle East, with the exceptions of Turkey and Lebanon, had run out of surface water, and it was under these conditions that a supply sided management approach, ceased to be a sustainable option.

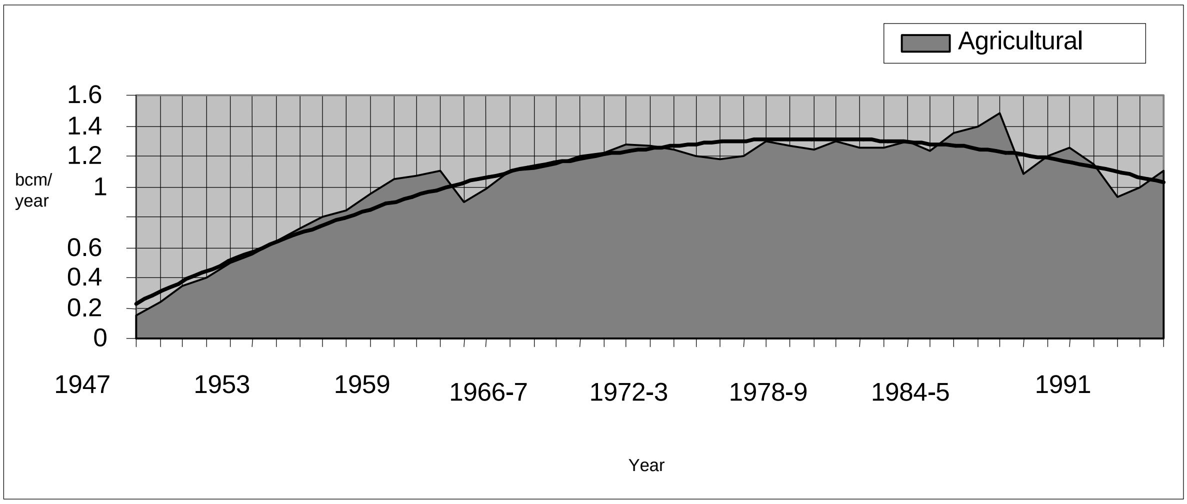
Table 2. Falkenmark's WBS for Israel						
Year	**1950**	**1960**	**1970**	**1982**	**2000**	**2025**
Position	**Chronic Scarcity**			**Beyond Water Barrier**		
Persons/ Flow unit	1411	1588	1822	2294	3529	5823
Source; EIU, 1996; Beaumont, Blake and Wagstaff, 1988.						



Source: Demographic Yearbook, Population Census Statistics, United Nations.

Figure 6. Population growth for Israel, 1950-2025.

In 1985 Israel's agricultural sector was consuming 80% of the water supplies yet only contributing 5% to the annual GDP, by 1995 it was consuming 58% and still only contributing 5% to the annual GDP (FAO, 1997). In addition, the SWE ratio (Table 3) (Turton, 1997) shows a poor correlation with regard to agriculture, but a fair correlation with regard to industry. Industry, on the other hand, has been consuming, on average 20% of water supplies, while contributing 50% to the annual GDP (EIU, 1997).



Source: Allan, 1996

Figure 7. Israeli agricultural water consumption, 1947-1993.

These figures reflect the reductions made to the agricultural sector during the droughts of 1986 and 1991, after which Israel was forced to take notice of its inefficient and unsustainable policies. The droughts created a situation of emergency, which in turn allowed for the subject of 'water scarcity and misallocation' to come onto the political agenda and facilitated the imposition of the 'reserve sector role' on agriculture (Turton, 1997). Overall, this allowed for a 60% reduction in water allocation to agriculture between 1984 and 1991, (see Figures 5 & 7) which prior to this date would have been politically suicidal. This set in motion a chain of events which re-allocated water freed from agriculture to the municipal and domestic sectors. The reflexive curve in Figure 7 is similar to that of Israel's trajectory in Allan's adaptation of the

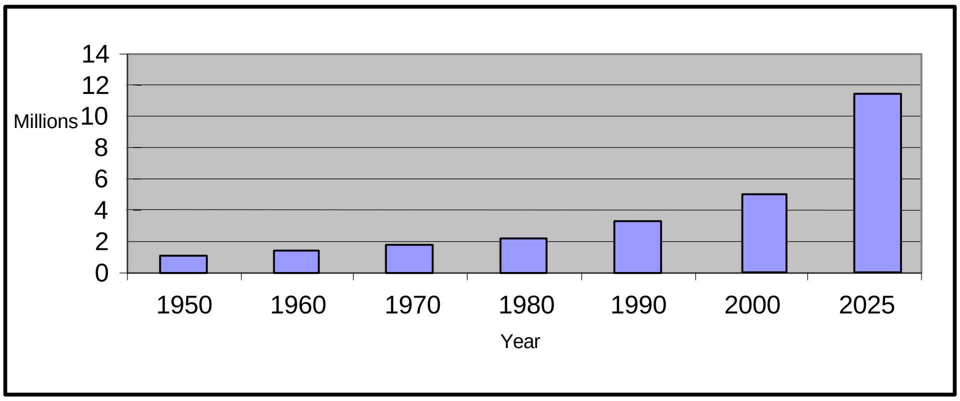
Karshenas model in Figure 4b, which shows Israel's current position as one of resource reconstruction. Turton (1999d) notes that natural resource reconstruction 'exists when a social entity can effectively introduce water demand management, specifically by re-allocating water from one economic sector to another'.

Table 3. SWE ratio for Israel			
	1975	**1985**	**1995**
Agriculture	71:5	80:5	58:5
Industry	21:50	18:43	18:42
Source: Turton, 1997; EIU, 1996; Beaumont, Blake and Wagstaff, 1988.			

Since1986, Israel's Water Commissioners have been involved in a fundamental re-evaluation of the role of water in the political economy. By modifying its approach, Israel has in effect turned its unsustainable development trajectory away from ecological disaster and conflict and instead towards a more sustainable future.

JORDAN

Moving beyond the water barrier as early as the 1960s, Jordan currently endures water levels of somewhere between 20 and 50 m³ per capita a year, depending on the location (Table 4)(FAO, 1997). This is not surprising when one considers Jordan's circumstance: the lowest level of annual renewable resources in the region, accompanied by one of the fastest growing populations in the world (Table 8)(FAO, 1997). Estimates of domestic water consumption in Jordan are difficult to obtain, but on average water levels are two thirds of Israel's per capita consumption. Considering that a figure of at least 1100 m³ is required to provide all the water needs of an individual each year[4], the nature of Jordan's deficit is stark (Allan, 1997).



Source: Demographic Yearbook, Population Census Statistics, United Nations

Figure 8. Population growth for Jordan, 1950-2025.

[4] An individual requires one cubic metre of drinking water annually, and between 50-100 m³ for other domestic uses. However it is the 1000 m³ required in the production of each individual's annual food consumption, which places the major demand for water supplies. As a result, about 90% of all national water budgets are devoted to the agricultural sector (Allan, 1997).

Table 4. Falkenmark's WBS for Jordan						
	1950	**1960**	**1970**	**1982**	**2000**	**2025**
Position	**Chronic scarcity**	**Beyond the Water Barrier**				
Persons/ 'Flow Unit'	1571	2142	3142	5000	9428	17857
Source: EIU, 1996; Beaumont, Blake and Wagstaff, 1988						

Only 5% of Jordan's landmass receives sufficient rainfall to support cultivation, where even in a good year, wheat production covers only 20% of food requirements, and 85% of the cultivable land is still totally dependent on rainfall (EIU, 1997:18). Therefore state intervention in the agricultural sector has been and remains essential in order to increase staple food production in response to population growth. In 1958 intensive irrigation projects were implemented, the first of which diverted water from the Yarmuk river, resulting in the construction of the East Ghor Canal, now a major water artery for Jordan. Not surprisingly it has never been able to reach its full potential, as Israeli threats have meant that Jordan has never been able to construct adequate reservoir capacity on the Yarmuk. With few options that do not involve Israel, Jordan has developed plans to build a dam on the Yarmuk with Syria as its partner, yet they cannot proceed without adequate financial assistance. However, the World Bank will not fund a project in any international river basin if one riparian is opposed to it, as in this case, Israel is (Caffrey, 1993).

As a result water remains scarce and expensive, yet low-value crops and water-demanding production systems have been encouraged up until recent years (Rogers and Lydon, 1994). Private irrigation projects in the southern and eastern desert areas continue to fail to meet the increasing demands. The agricultural sector remains dominated by acute water shortages, where withdrawal continually exceeds renewal, and the cost of supplying irrigation outweighs any economic returns. Two thirds of crops remain under irrigation, and contribute only 30% of the total agricultural contribution to the GDP. Under the continuous pressure to mobilise water resources, Jordan now consumes 110% of its water stock annually, and has accumulated a deficit equivalent to one year's supply, through over pumping of groundwater aquifers (Rogers and Lydon, 1989). The SWE ratio (Table 5) (Turton, 1997) confirms that Jordan is a water inefficient country. It shows a decreasing SWE for the agricultural sector, which consumed a greater percentage of water in 1995 for a lower percentage of GDP, than previously in 1975. Jordan's industrial sector, in contrast, has a medium efficiency.

Table 5. SWE ratio for Jordan			
	1975	**1985**	**1995**
Agriculture	64:14	91:8	93:7
Industry	1:18	2:35	4:38
Source: EIU, 1996; Beaumont, Blake and Wagstaff, 1988			

In recent years, Jordanian water planners have become aware of this misallocation, and are gradually curtailing irrigation expansion in the Jordan valley (Rogers and Lydon, 1994). This, however, is politically strenuous as the intensively irrigated Jordan valley, allocated to wealthy Amman families since the 1960s, is highly subsidised by the government, and is also responsible for the 80% of the total agricultural production, which is produced there (EIU, 1997). These families wield great political power, suggesting that political acceptability will continue to win over economic rationality in the Jordan valley.

Jordan's industrial sector has only been partially efficient since the 1980s. However, the service industry dominates the economy, contributing 66% of the GDP, and more importantly uses insignificant amounts of water (EIU, 1997). If Jordan can further develop this sector it has the potential to purchase its way out of its water problems, at the same time as avoiding difficult politically suicidal decisions. In the 1960s Jordan became a net importer of foodstuffs when it lost access to its principal growing areas on the West Bank of the Jordan River, through conflict with Israel.

Table 6. Water Barrier Scale projection for Israel, Jordan, Zimbabwe and South Africa 1950-2025.

	Well Watered <100 persons per 'flow unit'	**Mid-European** 100-600 persons per 'flow unit'	**Water Stressed** 600-1000 persons per 'flow unit'	**Chronic Scarcity** 1000-2000 persons per 'flow unit'	**Beyond Water Barrier** >2000 persons per flow unit
1950	Zimbabwe South Africa			Israel Jordan	
1960	Zimbabwe South Africa			Israel	Jordan
1970		Zimbabwe South Africa		Israel	Jordan
1982		Zimbabwe South Africa			Jordan Israel
2000		Zimbabwe	South Africa		Jordan Israel
2025			Zimbabwe	South Africa	Jordan Israel

Source: Reproduced from Falkenmark, 1989; Turton, 1997; Arnestrand et al, 1993; Ohlsson, 1995 and MacDonald, 1990.

The above table transfers information gathered from the study and produces a setting from which the movement of each states past, present and future situations with regard to water can be evaluated, assessed and compared to other states (table 6). It can be seen that South Africa and Zimbabwe have not as yet entered into a period of 'water scarcity', although Falkenmark's water scarcity indicators predict that South Africa will find itself increasingly under pressure. The table predicts that South Africa will enter a situation not unlike that of Israel and Jordan in the 1950s, when they were forced to address the issues of 'water scarcity'. Israel to a greater extent, and Jordan to a lesser extent have been forced to alter their management capabilities, and in doing so have begun to turn their development trajectories towards a more sustainable use of this scarce but vital resource. The table above suggests that both South Africa and Zimbabwe, will too be forced to consider alternate policies when dealing with the issues of 'water scarcity' in the 21st century.

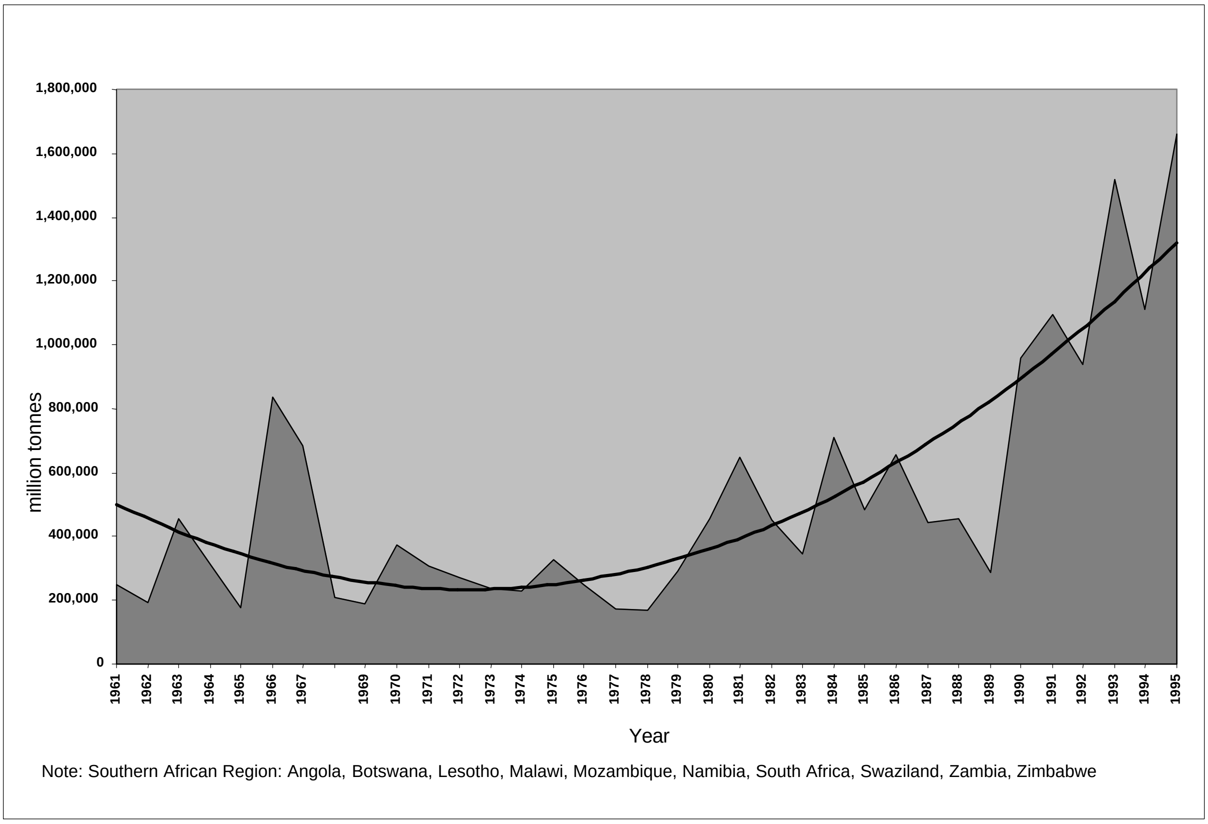
IS 'VIRTUAL WATER' A VIABLE OPTION FOR SOUTHERN AFRICA?: THE CASE OF ZIMBABWE AND SOUTH AFRICA

The scarcity of water in Southern Africa poses definite limitations to economic and societal development. Turton (1997) notes that the 'spatial and temporal mal-distribution of water and its relationship with the spatial distribution of the human population' poses a 'key developmental problem' within Southern Africa. Turton (1997) also notes that 'without sufficient water, the respective economies of most states cannot function', therefore there exists an inextricable link between the water that is available to a state and the strength of its economy. Falkenmark (1998) asserts that, 'the last decades have brought the plague of extended drought to many African countries'. Under these conditions it is essential that methods be found, 'to improve life quality and food security in Africa's semi-arid countries, despite the constraints of hydro-climatically-induced water scarcity and the considerable inter-annual fluctuations which characterise the natural freshwater supply'. These conditions in turn 'impact on water management because it means that large storage reservoirs have to be planned and built because the reliability or predictability of the precipitation patterns are of a low order of magnitude' (Turton, 1999c).

Therefore, it is understood that as population-induced demands for water increases, there is an accompanying increase in the need for engineering (supply-sided) solutions. This is however finite, and there will be a point beyond which water cannot be continuously mobilised, using traditional engineering solutions, to meet the growing population curve. This will result in water scarcity and when also accompanied by drought, the 'social stress' will force the issue of water allocation to be challenged. This signifies the coming of a 'demand sided' management approach, which in a situation of drought would be politically acceptable. However, it now remains to be seen whether such policies can remain in the long term, when the crisis has passed. It is in these times that Turton (1999d) suggests that, 'popular support for water demand management is reduced, placing pressure on politicians to reduce the demand management to 'acceptable levels'.

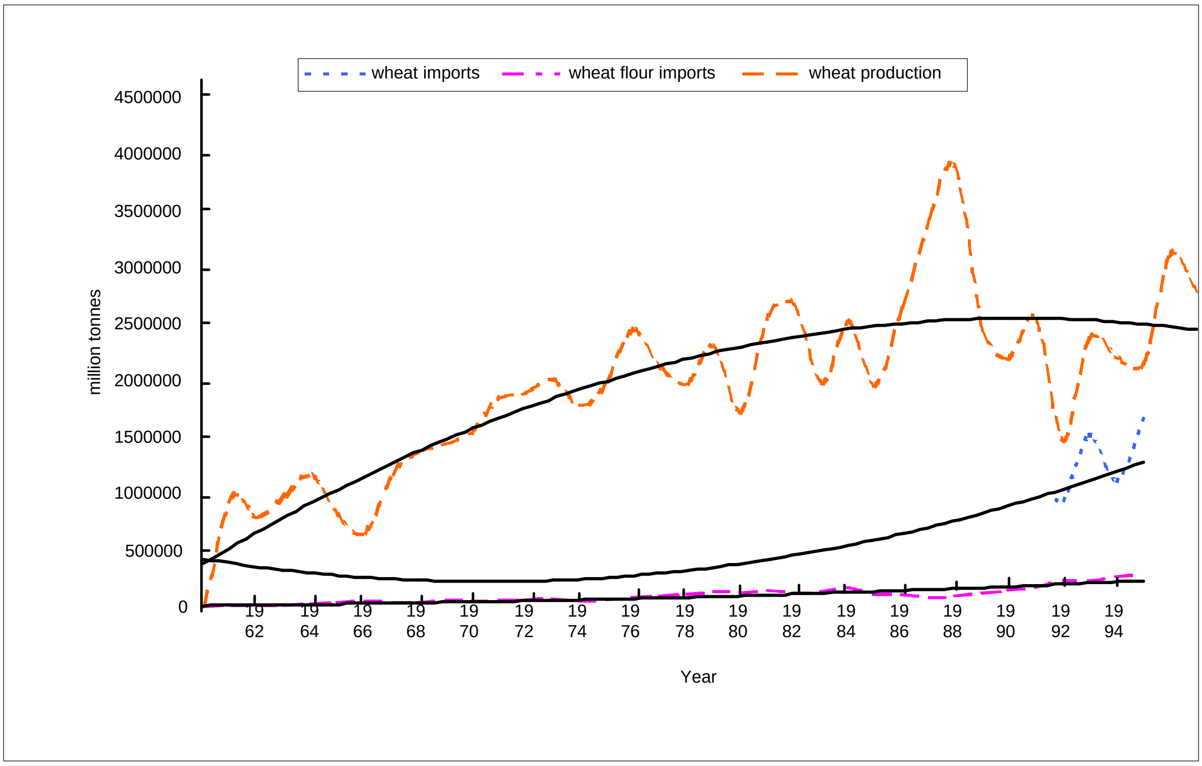
Turton continues by suggesting that it is now the 'adaptive capacity' within the social entity concerned, which will allow for a society to follow through with a new water demand management strategy. It is also under these conditions that, 'politicians tend to avoid having to deal with this reality, 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 needs to be told in order to keep the political integrity of the given social entity' (Turton, 1999d). It is under these conditions that the 'softer option of virtual water becomes increasingly attractive…(enabling) 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' (Turton, 1999d).

With limited options available to the political economies of the Middle East and Southern Africa, the most powerful strategy and the one, which promises to be the most efficacious in reducing the potential for conflict, is that of 'allocative efficiency'. This measure will directly contribute to the creation of a diversified, industrialised and internationally integrated political economy within which water policies sympathetic to water scarcity can be introduced.



Source: FAO Data, 1998

Figure 9. Wheat imports for the Southern African Region, 1961-1995.



Source: FAO Data, 1998

Figure 10. Southern Africa cereal production, cereal imports & wheat flour imports.

The successful implementation of such policies will stabilise the internal economy and society and will simultaneously enable the purchase of ‘virtual water’ on world markets for food products. Effectively, substantial volumes of water can be imported and the states’ dependence on local water resources lessened, at the same time as raising its economic potential and diminishing occasions of conflict over shared water resources.

While a ‘virtual water’ development strategy may prove to be a viable option for the political economies of the Middle East, as already proved by Allan (1996) this may not hold true, at present time, for the political economies of Southern Africa. In order for a state to adopt this strategy a strong industrial base is first required. The revenue then enables the state to purchase commodities with a high water content, on the international market. Turton (1997) notes that there was a general trend throughout the Southern African region showing even the strongest economies to be globally non-competitive. This fact suggests ‘a severe constraint’ to a ‘virtual water’ development strategy. Therefore the states of Southern Africa need to realise the necessity for regional co-operation under which a regional strategy will ‘be based on the understanding that competition for global trade can be as destructive as competition for water’ (Turton, 1997).

However, it must be noted that both Figures 9 and 10 suggest that a virtual water development strategy may be already being adopted in Southern Africa. The graph depicting wheat imports (Figure 9) shows a tenacious increase, even when the drought years are taken into account. The trends depicting wheat production and importation (Figure 10), explain by example that Southern Africa is largely self-sufficient in wheat, this however is highly susceptible to drought years. This also suggests that wheat production is heavily reliant on an unsustainable mobilisation of water. The downward trend of production and the upward trend of importation suggest the adoption of allocative efficient and economically rational policies towards the use of this scarce environmental capital.

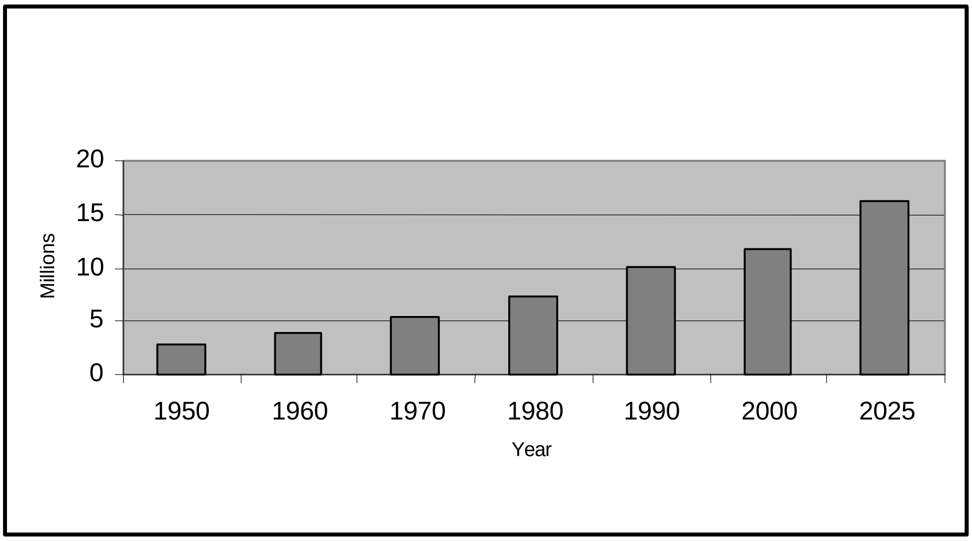
ZIMBABWE

With the fourth highest projected population for the year 2025 (Figure 11) and the second lowest level of recoverable water resources in the region, measured at 23 km^3/year, the state of Zimbabwe most closely relates to the position held by Jordan in the Middle East (World Bank, 1996). Falkenmark’s (1989) WBS predicts that Zimbabwe will face chronic water scarcity by the year 2025 (Table 7), if it fails to alter its water allocation policies in the meantime (Turton, 1997).

Table 7. Falkenmark’s WBS for Zimbabwe

	1982	2000	2025
Position	**Mid European**	**Water Stressed**	**Chronic Scarcity**
Persons/ flow unit	350	660	1400

Source: Falkenmark, 1989; MacDonald, 1990; Arnestrand et al, 1993; and Ohlsson, 1995.



Source: Demographic Yearbook, Population Census Statistics, United Nations.

Figure 11. Population growth for Zimbabwe, 1950-2025.

Under the sanctions imposed on Zimbabwe, in the post-UDI era, local manufacturing and agriculture flourished. Yet today, without sanctions, their continued production remains only viable in the context of their own economy, as it is non-competitive on the global market (Turton, 1997). Agriculture therefore is the main source of hard currency, and 50% of Zimbabwe's industry is dependent on it for the supply of its raw materials (EFGAZ, 1997). As a consequence, this increasingly water deficit country will find it politically stressful to move to an allocative efficient strategy. However, Zimbabwe has the capability to intervene and make the necessary policy re-adjustments, without which it will find itself in a very serious position.

As one of the most successful agricultural economies in sub-Saharan Africa the task of re-allocating water resources between sectors, will prove politically stressful. In 1995, Zimbabwe's agricultural sector consumed 79% of the total available water supplies, and contributed only 14% to the GDP (Table 8). In 1990, 40% of the nine principal crops' value was produced under irrigation[5]. Turton (1997) notes that agriculture continues to dominate the economy due to 'the fact that relatively high value crops such as tobacco are produced, essentially for the export market. This, in turn, means that foreign revenue is generated by these exports. This revenue is circulated throughout the economy with a multiplier effect being felt'.

The dependence of Zimbabwe's economy on the agricultural sector means that economic development relies heavily on the development of its water resource potential. An example of this can be seen in Zimbabwe's disappointing performance in its programme of structural re-adjustment in 1995. Part of the blame lies with the vulnerability of its agriculturally driven economy to drought. Following a recovery in 1994 from the severe economic effects of the 1991-92 drought, a return to drought in the 1994-95 agricultural season saw economic activity decrease, yet only to rebound strongly in 1997, buoyed by a significant upturn in agricultural output (EIU, 1997/98). Unlike Israel, Zimbabwe did not take this opportunity to address the issue of water misallocation, and presently continues to pursue a supply side management approach. This has resulted in massive expansion of expensive irrigation areas, which tripled

[5] The major irrigated crops are wheat, cotton, sugar cane, soybean, tobacco and maize.

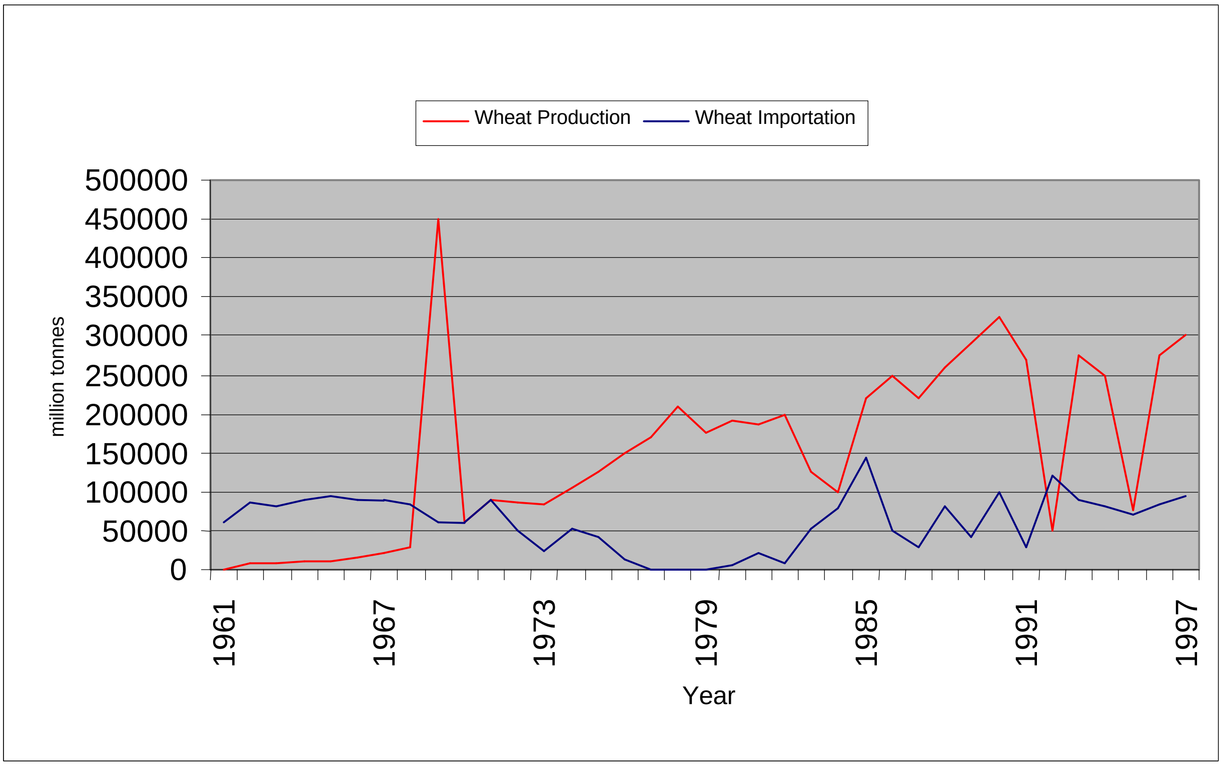
from 60.000 ha in 1968 to 191.000 ha in 1990. The huge rise in wheat exports and increase in sugar cane production for exportation express the economic opportunity the continued mobilisation of water has allowed; however, the economic rationality of this must be questioned.

Table 8. SWE ratio for Zimbabwe		
	1987	**1995**
Agriculture	79:13	79:14
Industry	?:30	7:29
Source: World Bank, 1996; Turton, 1997		

The government's annual subsidisation of irrigation schemes costs US$42m, and is biased in favour of the 4000 commercial farmers who control 83% of the irrigated land. This supply-side management approach, which depends entirely on expensive storage works and high pumping costs, will only result in an uneconomic and unsustainable use of this scarce environmental capital (MacDonald, 1990). Furthermore, Zimbabwe's current low levels of technological inputs will not suffice in maintaining self-sufficiency, and it will be forced to obtain intermediate levels of technology by 2025 (Falkenmark, 1989).

Conditions of scarcity will continue to persist, if the actual cost of water is not factored into the economics of agricultural production. Since 1986, water taken from dams for agricultural purposes has had a charge applied to it; however, this charge does not reflect the actual costs incurred in mobilising these vast amounts of highly subsidised water. This inefficient use of water is in stark contrast to the comparative efficiency of water used in Zimbabwe's industrial sector. In 1995, the industry's sectoral water consumption was 7% while contributing 30% to the GDP, the double of that produced by agriculture (Table 8)(Turton, 1997).

Figure 12 depicts both Zimbabwean wheat production and importation, where the combination of these two trends only serve to enhance the unsustainable and economically irrational policies of the Zimbabwean government towards the use of their scarce water resources. While the governments' desire for self-sufficiency is realised in the huge increase in wheat production, it should also be noted that production is susceptible to drought, and therefore entirely reliant on the continued mobilisation of water. When drought occurs, wheat imports automatically increase. However a steady rise in wheat imports can also be noted.



Source: FAO Data, 1998

Figure 12. Zimbabwean wheat production and importation, 1961-1997

Zimbabwe, the second most diversified economy in Southern Africa, maintains the capability to intervene and make the necessary policy re-adjustments, where a 'virtual water' development strategy would in effect be an allocative efficient programme. By allocating water away from an economically inefficient agricultural sector, as a result of food importation, water resources would be 'freed' and instead used in the highly efficient industrial sector, creating higher economical returns, with which it could purchase its water entitlements on the international market. However, Zimbabwe does not seem to be following a water demand management approach. Zimbabwe's position as the third largest rose exporter in the world in 1995 (Africa Review, 1996) would seem to suggest that the production of these crops, which produce high economic returns to the water utilised, would be a positive move towards water demand management within the political economy (Turton, 1997). Yet, this is not the case and while some farmers are shifting to rose growing, this is due to economic initiatives of the farmers themselves, and not because the government is adopting a water demand strategy as a conscious policy[6].

Zimbabwe is also non-competitive on the global market having based its industrial strategy on import substitution (Turton, 1997). Today, Zimbabwe continues to fervently guard its policy of national self-sufficiency and views water increasingly as a strategic natural resource. This does not fit with the 'virtual water' strategy, which, 'implies moving away from a paradigm of national self-sufficiency towards a

[6] Turton (1997) understands that the international tobacco lobby is a threat to Zimbabwean tobacco farmers who are now starting to diversify into higher value crops such as flowers, which are being exported to Europe.

paradigm of co-operation in a regional context' (Turton, 1997). As a result Zimbabwe is less likely to take on the potential benefits of 'virtual water' and regional co-operation, under which it could free its resources through the importation of cheap, high water foodstuffs, paying for this by selling high value, low water content commodities. It is instead likely to follow the 'Realist' approach, an approach, which Turton (1997) suggests has a 'natural inherent conflict creating dynamic'. In its desire for increased amounts of water for self-sufficiency, it is highly probable that Zimbabwe will face situations of conflict with neighbouring states, also requiring access to water resources[7].

SOUTH AFRICA

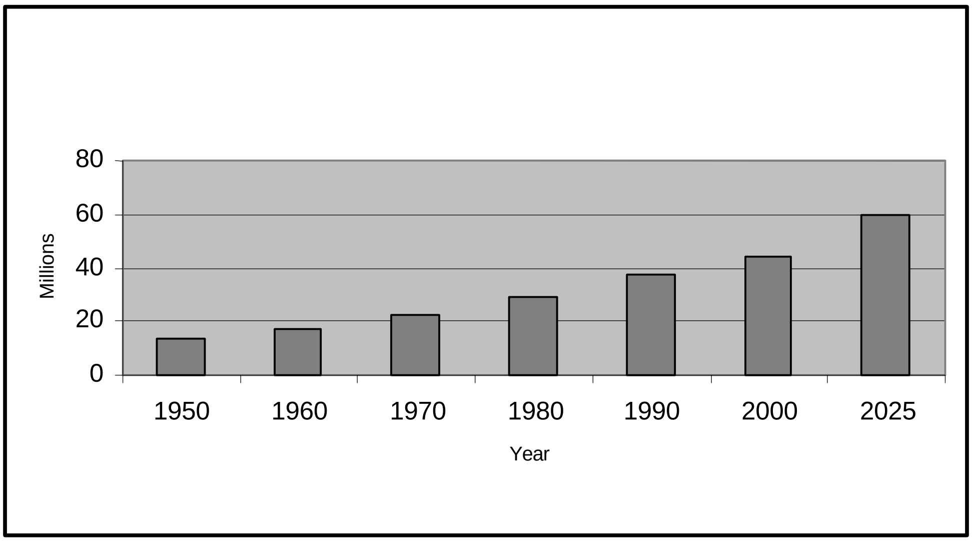
South Africa follows closely the situation experienced by Israel between 1947 and 1995, where the prevailing conditions constitute unsustainable development at a turning point. If the policies, currently being considered, are implemented, the development trajectory will move towards 'sustainable development'. The following authoritative statements, made by South African specialists, are indicative of these prevailing circumstances:

> We can no longer rely on developing yet another water source, our actions dominated by apparently simple but often misleading solutions. These will not contribute to solving the problems of the coming decades. What we require now is a conscious and strategic change of direction regarding the use and conservation of the country's water. We should not hesitate to consider measures that may be contentious, and cannot afford the luxury of continuing to use water without considering its most beneficial use, or be side-tracked by taking short-term measures while a real crisis develops around us. Our water should be applied to best advantage to achieve the greatest overall benefit for the country in an environmentally sustainable manner.
>
> - Prof. Kader Asmal, Minister of Water Affairs, Department of Water Affairs and Forestry, August 1997.

> South Africa at present represents an example of a country, which has reached a stage of its development where its scarce water resources will have to be allocated increasingly to the most worthwhile purposes only. …South Africa's returns on agricultural production per unit of water give comparatively low returns for high consumption. While South Africa has neither the weather nor the soil to make it an ideal country for agricultural expansion, some of the more northern countries have sufficient water and land and would welcome additional economic opportunities. …Being freed from the need for agricultural self-sufficiency, which its period of isolation imposed, it would make economic sense for South Africa to satisfy its increasing needs for agricultural products from the open market, while employing its water to better advantage.
>
> -Conley, 1996

[7] Zimbabwe is already aware of South Africa's plans, as a non-riparian, to gain access to the Zambezi upstream in Zambia, and as such will be very attentive of its actions knowing that it may impair their water supplies.

South Africa’s water resources are, in global terms, scarce and extremely limited in extent, with only 35% of the country surviving without irrigation. In addition it has the largest population in the region, expected to reach 60 million by the year 2025 (Figure 13). According to Falkenmark’s WBS (Table 9), the high level of water competition within South Africa’s borders, is set to continue with all the conventional water resources of the country being fully utilised in 30 years time.



Source: Demographic Yearbook, Population Census Statistics, United Nations

Figure 13. Population growth for South Africa, 1950-2025.

Table 9. Falkenmark’s WBS for South Africa

	1982	**2000**	**2025**
Position	**Water stressed**	N/A	**Chronic Scarcity**
Persons/ flow unit	741	N/A	1 419

Source: Falkenmark, 1989; MacDonald, 1990; Arnestrand et al, 1993; and Ohlsson, 1995.

Under these conditions dramatic changes in water usage will be forced upon the state over a short period of time. Therefore the judicious and beneficial utilisation of the country's water resources is essential, if the future prosperity of the country is to be sustained. There are many options available to alleviate the situation, but they all require focussed attention immediately, if the necessary action is to be taken.

In 1995, the agricultural sector utilised 72% of total water consumed and contributed only 3.9% of the GDP. In contrast, the small volume of water utilised in the industrial sector, 11%, contributed a third of the GDP in 1995. Turton’s SWE ratio (Table 10) indicates a medium water efficiency, where the heavy consuming agricultural sector produces a relatively low proportion of GDP, while a relatively low consuming industrial sector contributes a large portion of the GDP. Even though South Africa can be classified as a ‘relatively water efficient state’, there is room for improvement, that would then lead to a reduction of low value grain crop irrigation in favour of either crops with higher economic returns or to industry, yielding the highest returns.

Table 10. SWE ratio for South Africa			
	1980	**1990**	**1994**
Agriculture	54:6	52:6	72:6
Industry	11:45	13:31	11:30
Source: World Bank, 1996; Turton, 1997.			

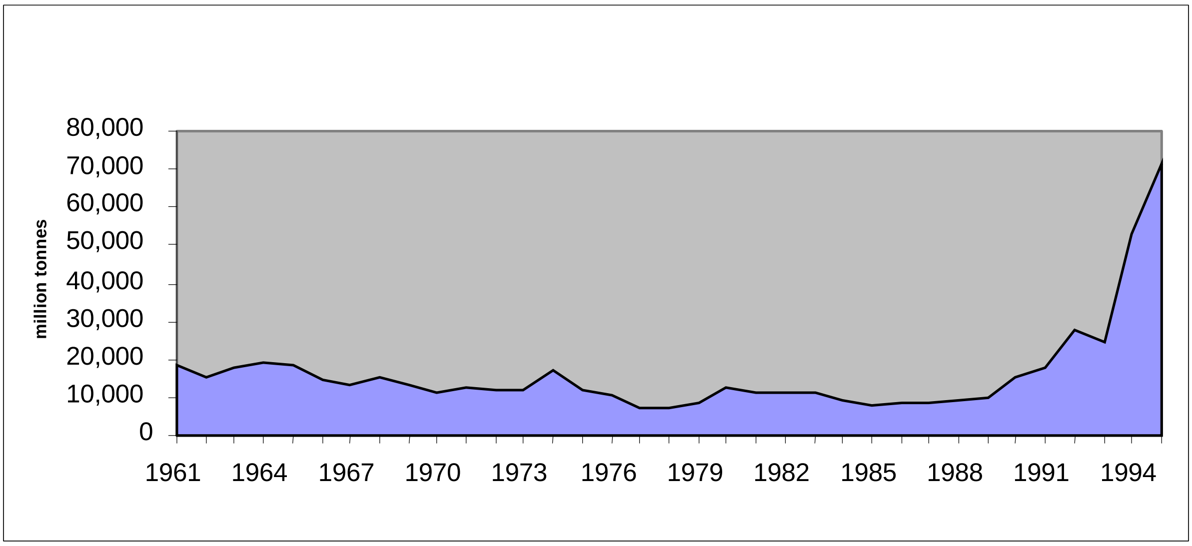
Although agriculture is the dominant user of water, it is predicted that the most dominant growth in water requirements will come from the domestic, urban and industrial sectors in the future. Water demand projections indicate an annual growth of 1.5% between 1990 and 2010, ranging from 3.5% for urban and industrial use to 1% for irrigation. This is largely driven by population growth, together with the accompanying urbanisation, increased standards of living and services as well as the supporting economic development and industrialisation (Basson et al, 1997).

In order to maintain these high levels of production, South Africa will need to mobilise vast quantities of water, and if these are not to be found within the confines of its own boundaries, it will be forced to search further a field. Within its own boundaries South Africa has two major rivers, the Limpopo and the Orange. These rivers are already highly utilised making future significant abstraction potentially unsustainable (Conley, 1996). As a result, South Africa plans to act as a 'surrogate' riparian of the Zambezi, to which it has no legal claims; however, this has not as yet been officially acknowledged (Turton, 1997). It is entirely relying on Inter-Basin transfers, including the mooted Zambezi Aqueduct, which involves the transference of water via a 1200 km long set of pipelines and canals through Botswana to South Africa to develop its supplies of water (Ohlsson, 1995). It is hoped that this Inter-basin transfer will also be extended in the future to transfer water from the Zaire River Basin via the Zambezi (Africa Analysis, 1996). Another proposal was quoted as follows in the Financial Mail on the 1st of September 1995:

> “The Vaal Dam long ago ceased to be adequate for Gauteng’s needs. A project put into effect in the 1970s was to tap the Tugela River and feed water into the Sterkfontein Dam. ...When this proved insufficient, the Lesotho Highlands Water Project was adopted. The Highlands Scheme, second in size only to Kariba, will take water from the rivers of eastern Lesotho. …The trouble is that the Highlands Scheme will only satisfy Gauteng until 2005. Other options are needed. …often talked of, and frequently dismissed as impractical, is the possibility of laying a pipeline from the Zambezi west of Victoria Falls, …to transfer water to Johannesburg. The distance is substantial - around 1800 km - but can be managed with modern technologies. …this presupposes the need to negotiate the purchase of this water at a price which is affordable.”

If access is denied, South Africa may be pressurised by the weight of its requirement to use alternative options. As Turton (1997) notes, 'access will therefore have to be negotiated for, elevating the water issue as a potential area of 'high politics' for South Africa as state survival will increasingly become linked to this one aspect in the future'. Therefore, it may well be in South Africa’s interest, both politically and financially, to remain on beneficial terms with the riparian states of the Zambezi river basin, creating a hydro-political dynamic within the region by adopting a virtual water rationale. Government policies that abolish subsidised water supplies will not only improve irrigation efficiency, resulting in a reduction in the area of land under low-value crops in favour of crops yielding the higher returns, but will also pave the way to the adoption of a water demand management approach. However, the reduction in water availability will most likely result in internal state conflict over water allocation. For instance, afforestation versus sugar cane in Natal; power generation versus irrigation in Eastern Transvaal or conflicts between farmers in the developing sector and producers in the commercial sector about the allocation of water quantities (FAO, 1995).

The government of South Africa, on the other hand, has become increasingly aware that water is a fundamental and indispensable natural resource, without which no regional or national development plan can take shape. It is evident that South Africa, in light of this knowledge, is aware that the conservation and re-allocation of water is the most viable and sustainable long-term option. There has been a reduction in wheat importation, and increased production in other crops, some of which require higher water inputs but with a higher economic return, for example the expansion of vineyards. Therefore, the supply-side management approach needed to sustain this production does not as such fit a 'virtual water' rationale. Figure 14 depicts the effects of sanctions imposed on South Africa up until the late 1980s. While the huge increase in wine exports is partly due to the lifting of sanctions, it also constitutes the production of crops with higher returns to water such as wine produced for the export market. This suggests that South Africa has begun to adopt a 'virtual water' strategy, through the approach of allocative efficiency, whereby the production of higher value crops means both a high SWE and therefore a more rational use of water.



Source: FAO Data

Figure 14. South Africa exported wine, 1961-1994.

South Africa's Department of Water Affairs and Forestry's, has already published papers, which underline the 'Future options on availability and utilisation of water'. One of these options reads, *'Virtual or embedded water'*, and suggests the following as a viable long-term strategy to alleviate the water constraints of South Africa.

> 'Associated with the principles of water conservation and the re-allocation of water is the concept of virtual or embedded water. It refers to replacing the production of an item (which is not water efficient) with the competitive importation of the item from elsewhere, and thereby freeing the water for a more beneficial use. A typical example would be the

importation of grain from elsewhere in southern Africa where agricultural conditions are more favourable than in South Africa, and making the water currently used for irrigation of such crops available for industrial purposes and domestic supplies…The concept of virtual or embedded water obviously can apply to a wide range of uses or products, including products such as electricity or objects that contain no water but require water for their production. The concept of virtual or embedded water can also hold great potential for strengthening trade and political links between countries'.

- Department of Water Affairs and Forestry, Pretoria (1996)

CONCLUSION

As a concept, 'virtual water' has promise, and will prove a useful tool for states regarding their water policies. However, it is clear that solving the water scarcity problems of political economies in arid and semi-arid regions requires a certain degree of industrial diversity within each state, a fact that is more evident in the Middle East than in Southern Africa. It is also evident that like Israel, South Africa has reached a point where it can make a policy decision in regard to its water resources, which will allow it to change the direction of its trajectory towards sustainable development. This further illustrates that policy intervention, if implemented at the appropriate time, can do much to help avert the depletion of natural capital, in this case, water.

Evidence from this analysis, suggests that the major economy of Southern Africa, that of South Africa, freed from trade embargoes and isolation from its natural trading partners to the north, has begun to develop a sustainable approach to its national water management strategy. These strategies have already been adopted by one major Middle Eastern economy, Israel, and are being adopted by another, Jordan. Virtual water has begun to figure significantly in South Africa's cereal imports since 1992, and both the rhetoric and the published policy of the Department of Water Affairs, refer to measures, which are inspired by principles of productive and allocative efficiency. Both the extensive works of Allan on the Middle East and Turton on Southern Africa suggest that these trends are all too evident.

However, while similar in certain respects, the regions are characterised by stark differences, and these would need to be taken into account before one could rest confidently on a positive conclusion. What is clear from the study is that the theory has explanatory and predictive promise, and that there exist abundant grounds and wide horizons for further research.

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