‘Virtual water’: a long term solution for water short Middle Eastern economies?

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Summary

The paper addressees the issue - why has there been no war over water when many economies in arid regions have only half the water they need and many leading figures, King Hussein, Boutros Boutros Gali, have warned that there would be a water war? It will show that the Middle East region has been able to access water in the global system via trade. Economic systems, not the evidently inadequate hydrological systems, have solved the water supply problem for the region. Water in the global trading system is know a ‘virtual water’. It is the water embedded in key water-intensive commodities such as wheat. The international wheat trade is a very effective and highly subsidised global trading system (ABARE 1989, LeHeron 1995) which operates to the advantage of water and food deficit countries.

The problem
The comparative disadvantage in economic terms of the Middle East and North Africa with respect to water is an extreme and classic case.

Perceptions of the problem
It is a paradox that the water pessimists are wrong but their pessimism is a very useful political tool which can help the innovator to shift the eternally interdependent belief systems of the public and their politicians. The water optimists are right but their optimism is dangerous because the notion enables politicians to treat water as a low policy priority, delay innovation, and thereby please those who perceive that they are prospering under the old order.

'Simple truths: vital lies.' '[Governments and peoples] .. can protect themselves from painful realisations by diminishing awareness. ... This trade-off between anxiety and awareness creates blind-spots of self-deception.' (after Goleman 1997)

The solution
The economic value of the ‘virtual water’ embedded in wheat though technically incalculable is nevertheless of inestimable economic value to the MENA economies.

‘More water ‘flows’ into the Middle East each year as ‘virtual water’ than flows down the Nile into Egypt for agriculture’

Perceptions of the solution
Not all waters are equal: some waters are more evident, more accessible, more manageable, more costly and more economically valued, more integral to society, more political, more multi-functional, more conflictual, more negotiable, and more prone to litigation than others.

‘The innovator makes enemies of all those who prospered under the old order, and only lukewarm support is forthcoming from those who would prosper under the new’. Machiavelli, N, 1513, *The Prince.*

Those purveying the economic and environmental facts of life on water which contradict the deeply held belief systems of whole populations will be ignored if they do not shape their message and pace its delivery to accord with political realities.

Implementing perception change is only a preliminary to policy change
Thirty years is a rather short transitional period for the necessary major adjustments in water policies to be developed in response to limited water availability.

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Middle East and global water resources: the link

The issue of whether there will be enough water for a future global population double its present size is controversial. The answer to the question is of particular importance to the peoples and political leaders of the Middle East and North Africa. The region's economies are already as dependent on global water as they are on the renewable waters of the region. They will be much more dependent on global water in future.

The answer is almost certainly a resounding yes. There will be enough fresh water in the global system. But on the supply side, that is freshwater availability, the science has not yet been done to prove the future capacity of the global freshwater system. A researched estimate of sufficient precision to be useful for politicians and decision makers would cost many billions of dollars. On the demand side, freshwater needs are driven by rising populations. Here the range of the estimates of future global population vary by over fifty per cent. In this uncertain information domain there is space for numerous pessimists and optimists to spin counter interpretations. Whether we believe the optimists, including the author and most economists (Islam 1995, IFPRI 1995 & 1997, Dyson 1994:403), or the pessimists (Brown 1995 and 1996, Brown and Kane 1996, Postel 1997) depends upon the assumptions used by the respective analysts.

Mega questions tend to be ignored; or attract untestable ideological interpretations of religious intensity. Is there enough freshwater for future populations is a mega question and it is not given a fraction of the attention it deserves by scientists. In the 1960s and 1970s there were attempts in the former Soviet Union to review the world's water balance (L'vovich 1969 and 1974). Water availability and use have also been addressed (Shiklamanov 1985, 1986 and 1994, Shiklamanov and Sokolov 1983, Shiklamanov and Markova 1987, Gleick 1994)

Meanwhile agencies such as the World Bank are prepared to devote five million dollars a year (at least) to providing advice on managing water and on lending much more for water projects without offering a view on the status of global water. Institutions such as the World Bank can produce shelves of reports about allocating and managing water for the interested professional and general reader (World Bank 1993, Serageldin 1994 and 1995) and for the specialist focused on local and regional issues (World Bank 1991, 1993a, 1993b) without situating the debate in the global resource context. Since 1994 there has been a welcome and responsible attempt by the Food and Agricultural Organization (FAO) to address the subject of water availability for Africa and the Middle East (FAO 1995a and 1997a) and on water use by the major using sector, irrigation (FAO 1995b and 1997b). The publications provide first approximations which should be given prominence so that the reliability of the data can be enhanced by progressive iteration.

A balanced perspective on the population, water and food nexus tends to come from the International Food Policy Research Institute (IFPRI 1995) which identifies low, medium and high scenarios for population. These predict respectively 7.7 billion, 9.4 billion and 11.1 billion for the global population by 2200.

> In its 1996 study, the United Nations found that population growth between 1990 and 1995 was 1.48 percent per year, rather than the 1.57 percent projected in 1994. In light of this lower rate, the United Nations revised its projections for population growth in the next century, based on three different assumptions about the fertility of the world's women. The medium fertility model - the one usually considered the most likely - would put the world's population at 9.4 billion by 2050 (half a billion lower than the United Nations 1994 estimates). World population would continue to grow until 2200, according to this model, when it would stabilize at 10.73 billion.
>
> The medium fertility model falls in the middle of a wide range of possible outcomes. Low fertility would result in a world population of 7.7 billion by 2200, whereas high fertility would mean 11.1 billion mouths to feed in 2200. These extremes are by no means unrealistic, and the population debate is far from over. ... Public policy and individual behavior, they say, will ultimately determine the world's population.
>
> (IFPRI 1997)

About Middle East water there is less scientific controversy. The Middle East as a region ran out of water in the 1970s. The news of this important economic fact has been little exposed. In politics, facts, including those on water, which are judged to have costly political consequences can easily be ignored or de-emphasised. With selection and distortion of information being the norm in political processes it is predictable that discourses on Middle Eastern and North African water will be misleading and confusing.

For political leaders in the region political imperatives are more compelling than scientific facts. On water, these imperatives drive them to assert that their economies have **not** run out of water. An ex-Prime Minister of Egypt (Higazi 1994), and mid-1990s Egyptian ministers of water resources, of agriculture and of planning have vied in public in the vehemence of their assertions that Egypt has sufficient water. (Arab Research Centre 1995) The main reason that there can be such different interpretations by scientists and politicians is that the politicians do not specify what 'sufficient' means.

By sufficient, scientists mean sufficient 'indigenous' water to meet the total water needs *including water for food production*, for the industrial and municipal water needs of an economy and for household requirements. Politicians do not specify. They imply they mean the same as the scientists but in practice they mean only part of the 'total' needs. Without making their assumptions clear they are asserting that 'sufficient freshwater' is that volume necessary to sustain the existing jobs in agriculture and industry and for municipal and industrial needs. In an economy such as Israel this may be only 25 per cent of the water which would be needed for food self-sufficiency. For Egypt it is about sixty per cent of the water needed for food self-sufficiency. For politicians in almost all countries in the region the food gap caused by the insufficiency of water has to be ignored. To draw attention to the water gap and the food gap could be politically suicidal.

The reason the Middle East is important vis-à-vis water is because it is the first major region in the world to run out of water. The water demands of the populations of the Arabian Peninsula and desert Libya had exceeded the capacity of their water resources for food self-sufficiency by the 1950s. Israel and Palestine also ran out of water in the 1950s, Jordan in the 1960s, Egypt in the 1970s. The Maghreb countries have recently entered water deficit. The Tigris-Euphrates riparians have not fully utilised their water resources but will do so in the next decades. The Sudan has some way to go before it fully utilises the share it has agreed with Egypt on the Nile - a share not endorsed by the other upstream riparians.

The major indicator of the scale of the water deficit of an economy is the level of its food imports. The reason food imports are such a strong indicator of water deficit is that the water required to raise food is what an economist would refer to as the dominant consumptive use of water. The use is dominant whether viewed from the point of view of the individual citizen or the national economy. Water used in the agricultural sector exceeds by ten times the water used by the industrial and municipal sectors combined.

An individual needs each year only one cubic metre of drinking water, between 50 and 100 cubic metres for other domestic uses, though a much lower actual use is the norm in many rural communities in countries in other regions, for example in the economies south of the Sahara. By contrast an individual needs each year at least 1000 cubic metres of water, either naturally occurring in soil profiles, or transported to the profiles by irrigation systems, to raise the food needs for that individual. At the national level over 90 per cent of all national water budgets are devoted to the agricultural sector.

Figure 1.1 Individual water use per year

In the arid and semi-arid Middle East the dominance of the agricultural water demand is stark. There is little or no naturally occurring soil water even in the winter when parts of the region do receive rainfall. By contrast in the economies located in temperate latitudes, in Europe and the humid tracts of North America for example, the issue of the relative demands of the agricultural and the industrial (including services) sector is scarcely evident. In temperate latitudes crop production is almost totally based on soil water which occurs naturally. Soil water tends to be taken for granted in the economies located in the humid temperate zone. The huge volumes of water utilised by agriculture are not counted as part of the national water budget. Such water is a free good.

While water is treated as a free good in temperate humid regions, in the semi-arid and arid Middle East and North Africa agricultural water is expensively won because of the costs of storage and distribution. Storage is needed to ensure timely availability and to reduce the loss of water to an economic system. Mobilising such water can in addition be politically stressful both nationally - through environmental impacts, and internationally - through riparian conflict. The comparative disadvantage in economic terms of the Middle East and North Africa with respect to water is an extreme and classic case.

Soil water and the economic efficiency of water use are vital themes. The reasons, though not evident, are powerful. First, it is *global soil water* which balances the water budgets of all the economies of the Middle East and North Africa, with the arguable exception of Turkey. Secondly, the *effective allocation of water* between sectors to gain high returns and high levels of employment are fundamental to economic and political stability. The environmental significance of water and water quality will not be addressed here, not because they are unimportant. It will be argued that understanding the global availability of water and the economically sound use of water are the major current water policy and management priorities for the first region to run out of water.

The regional water gap and the global water surplus?

The rate at which food imports have been rising in the Middle East and North Africa since the 1970s confirms the scientist's contention that the region has run out of water. The production of every tonne of a food commodity such as wheat requires a water input of about 1000 tonnes (cubic metres). The trend in cereal imports reflects a reasonable approximation of the capacity of an economy to meet its strategic food needs.

Figure 1 illustrates the trend in cereal and flour imports in the Middle East and North Africa since the 1960s. The levelling off in the trend in 1986 reflects changes in particular agricultural and food production policies mentioned above by Egypt and Saudi Arabia, the two biggest players in both cereal and flour production and consumption in the region. Egypt changed its subsidies policies in 1986 which had favoured cotton, so that wheat production became a sound financial option for its farmers. By 1986 Saudi Arabia's irrigation projects had begun to produce sufficient wheat for most of its needs, and it was about to become a significant wheat exporter in the world market. Saudi has subsequently reduced its wheat production because it was palpably an unrealistic way to use its fossil water.

Figure 1.2   Wheat and cereal imports into the Middle East - 1961 to 1992

Scientists can demonstrate that the Middle East is the first region in the history of the world to run out of water. (Rogers 1994, Allan 1994) Meanwhile the peoples and their leaders in the region refuse to recognise these resource and economic realities. *Their interpretations of Middle East hydrological and economic contexts are at best underinformed and at worst dangerous; their perception of global hydrological and economic contexts is unsafe.*

Table 1.1 Middle East and global water uncertainties and the scope for optimism and pessimism

	Middle Eastern water for regional self-sufficiency			Global water for global self-sufficiency	
	Evidence (scientific & professional)	**Perception** (politicians & people)		**Evidence** (scientific & professional)	**Perception** (politicians & people)
Availability	Deficit **Pessimism** **[ignored]**	No deficit **Optimism** **[dominant]**	**Avail'y**	Surplus??? **Optimism** **& pessimism** **[contadictory optimism accepable]**	No view **Optimism** **[dominant]**
Utilisation	Productive efficiency possible **Optimism**	Productive efficiency possible **Optimism**	**Utilis'n**	Productive efficiency possible **Optimism**	Productive efficiency possible **Optimism**
	Allocative efficiency possible **Optimism**	Allocative efficiency politically **i**mpossible **De-emphasis** **[dominant]**		Allocative efficiency possible **Optimism** **[contradict'y]**	Allocative efficiency politically impossible **De-emphasis** **[dominant]**

Table 1.1 summarises the estimated status and utilisation of first, Middle East, and secondly global water resources as researched by international scientists and compares them with the perceptions of these phenomena by politicians and peoples . The table shows that there is scope for dangerous confusion and contradiction at both the regional and the global levels. Both scales are of vital economic and strategic significance to the region.

Table 1.1 also shows that global environmental knowledge is even more prone to diverse interpretations. In this case scientists cannot provide reliable information on either the supply side - the availability of water, nor on the demand side - the current and future demand for freshwater driven by future populations. Estimates of future population differ by over 50 per cent.

The Middle East's hydrological system is definitely less and less able to meet the rising demands being placed upon it. Food imports are the important indicators of water deficit. (Figure 1.1 and Table 1.2). Meanwhile the global hydrological system is evidently in surplus as it is able to meet the most demanding element of global water demand, the global consumption of food. Assuming a medium water consumption scenario of 1500 cubic metres per person per year (bn m3 ppy), global freshwater needs are about 8.25 billion cubic metres annually. (Table 1.3) A consumption level of 8.25 bn m3 ppy is well within the estimates of global freshwater availability. (Rodda 1996)   But there are differing interpretations of the future position vis-à-vis future demands driven by higher world population. (Brown 1996, Postel 1997, IFPRI 1996) At this stage in history the global freshwater surplus is palpable and so the region's water deficit is not serious because global systems - trade - balance the Middle East's deficit. (Allan 1994) Note it is an economic systems and not hydrological and water engineering systems which achieve water security for the economies of the region.

At the regional level there can only be versions of pessimism about the future availability of water, at least for irrigated food production. Optimism exists on the future volumes of MENA freshwater but it is based on non-scientific assumptions. On the other hand optimism about the capacity to use the region's water more productively is sound. And it is on this aspect of water management that politicians and regional optimists focus, as well as those who have financial and consulting services to contribute from outside the region.

At the global level there is certainty neither about volumes of freshwater available nor about the capacity to use the water effectively. In these circumstances there is evidence to support the arguments of both optimists and pessimists. Because of the mighty 'error bars' on the statistics produced by the as yet inadequate models of global change (Conway 1993:291, Conway and Hulme 1993 and 1996, Conway, Krol, Alvamo, J. Hulme 1996) very different views emerge concerning the capacity of the world's agricultural systems to raise food, which leads in turn to a very confusing debate.

The pessimistic global freshwater scenario is persuasive if we assume:

- static patterns of food consumption by individuals
- or worse, patterns even more extravagant than current diets in terms of water consumptive use
- a pessimistic estimate (high scenario) of the demographic transition
- static technology
- totally inflexible political and international institutions
- ineffective trading systems.

If, however, it is assumed that:

- communities can change their food consumption behaviour, just as they can be weaned off tobacco and over indulgence in sun-bathing
- the world's growth in population will level off in the second half of the twenty-first century at about ten billion
- economically sound policies can improve the productivity of water by ensuring that it is allocated to activities and crop production which bring high returns to water
- technology can significantly improve the productivity of water in food production
- the mechanisms of international trade in staple foods continue to operate with proven effectiveness to ameliorate the uneven water endowments of the world's regions

then one can conclude that the world's water and food futures are uncertain but not seriously insecure. Basic to a serious scientific input to the debate is the contribution by the scientific community of best estimates of the status of existing soil water surpluses in addition to the rather more easily estimated future populations of current and future water challenged regions. Unfortunately these numbers are difficult to obtain because the concept of soil water availability is hard to define and agree (Schmugge 1995) and even if the concept were generally agreed a method of monitoring comprehensively has not yet been defined. (GEWEX 1997)

The insecurity of the Middle East and North Africa arises not just from its resource endowment, which is significant, but mainly in the capacity of its agricultural sectors and governments as well as the international institutions to adapt to the resource scarcity and take measures to find and mobilise substitutes. There is also a knowledge problem in that at this point in history scientists cannot answer the question posed above about the global freshwater system - is there sufficient water in the world's soil profiles, surface water and groundwaters to meet a notional average water consumption per person for say ten billion people?

The imprecision of current estimates of freshwater demand and potential availability is immense. Will there be seven, ten or twelve billion water users? What is a reasonable estimate of average water consumption in the dynamic political economies of the future? Should it be 1000 cubic metres per person per year or 2000 cubic metres per year, for all food, domestic, drinking, municipal, industrial and leisure water? How do we factor in environmental water? Some communities in the world are already operating beyond the high end of this consumption pattern, for example in parts of the United States. At the other extreme individuals in the vast semi-arid tracts of Africa south of the Sahara have access to an unreliable and very seasonal say 1000 cubic metres of soil moisture in their local soil profiles and a tiny daily use of ten litres per day for domestic and drinking purposes, that is a mere 3.5 cubic metres per year; a total use per individual of about 1000 cubic metres per year.

Current and future water gap uncertainties are not quite of the *Himalayan scale* cited by Thompson and Warburton (1988:2) where they observed a difference between the highest and lowest estimates in a review of soil erosion in the Himalayan region of about 400 times. For Middle East water the estimates of future freshwater demand differ by a factor of at least two. (Table 1.2) The comparatively small range in the estimates should not lead to complacency in that the number of people within the range would be at least four billion

The two variables affecting the estimate of future freshwater needs are first, growth in population and secondly, the use of water per head. Population growth estimates differ by 40 per cent, with the lowest about 50 per cent higher than the current population. (IFPRI 1997) When this 50 per cent is multiplied by either the low (1000 cubic metres per head) or the high (2000 cubic metres per head) estimates of the freshwater likely to be needed per person the estimates of potential water needs for the Middle East and North Africa move further apart to a high estimate which is 180 per cent higher than the lowest, and 400 per cent higher than current levels. (See Table 1.4)

Potential water availability globally being unknown, guesses in circulation differ according to assumptions. The lowest is based on the assumption that a limit similar to existing use is imminent. (Brown 1996, Postel 1997) The highest anticipate that water will be able to be mobilised at twice the late twentieth century level.

There should be no anxiety in any region of the world, including MENA, concerning the availability of water for drinking and domestic use and for almost all industrial and service sector uses. Current and future tension will be about water for food production. Food production requires about ninety per cent of a community's water; and should there be insufficient water for local food needs, that is the predicament of the Middle East since 1970, then food water has to be imported. Domestic water may also have to be augmented by desalination.

While the underlying message in this paper is optimistic it must be very strongly emphasised that the types of adjustment anticipated by the optimists cannot be achieved quickly. Thirty years is a rather short transitional period for the necessary major adjustments in water policies to be developed in response to limited water availability. Adjustments such as the changes in the public perception of the value of water take time. The associated political discourses enabling fundamental changes in water policies take at least decades. So deep are the belief systems and so challenging any proposal that beliefs should change that politicians are loathe to contradict them, even though the measures are essential for the stabilisation of the political economy. Case studies from the Middle East will illustrate these processes in Chapter 4. (Allan 1996: 77-83, Feitelson and Allan 1998).

Table 1.2 Uncertain Middle East and North African scenarios: population and water resource scenarios and interpretations of water demand

Table 1.3 Uncertain global scenarios: population and water consumption scenarios: interpretations of global water and food demand and availability

Table 1.4 Middle East and North Africa - water availability (surface and groundwater) - 1995

Table 1.5 Population and water in the Middle East and North Africa illustrating the range of future low and high scenarios

How is it that the two camps, pessimists and optimists, can exist simultaneously and dispense such confusing contradictory interpretations? There are four main reasons, three on the supply side and one on the demand side.

The first supply side reason is the simple matter of the diverse assumptions on surface and groundwater availability adopted by the two groups. The second is that the most important variable of all, global soil water, is ignored by pessimists and is not well understood by the optimists. The third is the imprecision in the estimates of the other important components of the global hydrological system, and especially on climate change. Finally on the demand side there are so many factors affecting the demand of a community for water that it is possible to extrapolate demands for water which differ by four or five times between the low estimate and a high one. Pessimists tend to the high end of the range and optimists to the low end.

The divergence in assumptions between the water pessimists and the water optimists is so great that they cannot communicate. Meanwhile the arguments of **both** pessimists and optimists neglect the most important water of all in the water budgets quoted whether in MENA or other world economies.

Soil water, 'virtual water' and the problemshed

This silent unaccounted water is soil water located in the soil profiles of the MENA economies themselves, as well as in profiles elsewhere in the global system. The neglect is especially true of the pessimists (Brown 1996, Postel 1997). Soil water and soil moisture do not even appear in the indexes of their books, or if they do they refer to examples in some local irrigated circumstances (Postel 1997:103) and not to the pivotal role of naturally occurring soil water in feeding the world's future populations. In brief if at least half of the water needed to feed the Middle East and North Africa's people in the 1990s lies in the soil profiles of temperate humid environments in North America, South America and Europe it is surely scientifically derelict to ignore that water.

The intent here is not to discredit the inestimably important contributions of Lester Brown and Sandra Postel to international and local discourse on the under-researched and intuitively worrying state of the world's water resources. Their focus in highlighting the urgency of achieving major shifts in perception and policy is extremely important. However, by discussing only surface water and groundwater, a very partial perspective on the waters of importance to human populations is presented. In neglecting to address a comprehensive version of global hydrology including global soil water they deny themselves and their readers a balanced perspective. An analysis of the energy future of hydro-carbon short national economy would be as misleading if it neglected options to import oil and gas, or for someone wanting to get from Cairo to Khartoum to assume that the only travel options were on a boat on the River Nile. Even more neglectful is the de-emphasis of the impressive international trading systems which transfer commodities requiring high water inputs from water surplus areas to water poor ones. In practice more water flows into the Middle East each year in this ’virtual form’, embedded in cereal imports, as is used for annual crop production in Egypt. Egypt is by far the most water rich country in the arid part of the Middle East and North Africa.

The main purpose of this paper is not to contradict the concern of the eco-pessimists and those afflicted with hydro-paranoia vis-à-vis the Middle East, but to enlighten that concern by refocusing the analysis at a higher and more appropriate level, namely at the level of the international political economy. It is at the global level that explanation is to be found concerning why economies operate as they do and why water policies are as they are in the Middle East. Explanations are not to be found via narrow analysis of catchments and water budgets at the national level or even at the regional level. Catchment hydrologies are not a complete source of explanation because they are not determining of the options available to those managing a national economy. If national hydrological systems restrict economic options then politicians have to find remedies in systems which do provide solutions.

United States water resource specialists have coined the term, the ‘problemshed', to make the idea of the ‘catchment’ or ‘system’ in which solutions can be found more accessible. National economies operate in international political economic systems - in problemsheds - and not just in hydrological systems - or watersheds. The political economy of the global trade in staple cereals is the relevant ‘hydrological’ catchment for water deficit economies. Access to, and management of, the problemshed is not just via an environmental system but via an extremely powerful and flexible economic one.

The shared and limiting catchment hydrologies with all their troublesome international relations are dangerously misleading frameworks of analysis. The existence of solutions in ‘problemsheds’ enable politicians to avoid the stresses of inter-riparian relations in the ‘watershed’. In brief if half of the water needed to feed the Middle East and North Africa’s people in the 1990s lies in the soil profiles of temperate humid environments in North America, South America and Europe it would be scientifically derelict to ignore that water. It would also be neglectful of scientists in general and the governments of water short economies in particular to ignore predictable future competition for this water. The scientific neglect is just as serious as the predictable devious and selective hydropolitics engaged in by political interests.

The coming fifty year transformation of the perceptions of the value of water (Allan and Radwan 1998) will be a tough environment for those looking for quick solutions. There is no reliable check list nor a handy tool kit with which to change the perceptions of large groups of people quickly. And people 'convinced against their will [tend] to be of the same opinion still'. Even when perceptions have transformed and shifted, the implementation of new water policies, especially water re-allocation policies, has to be gradual. These processes will all be slow; sometimes painfully slow for agency officials and for economists and engineers in a hurry because of limited funding and career horizons.

In addition the foundation scientific concepts for economically and environmentally sound water policies require reforms and adjustments which politicians can see will bring high ‘political prices’ (World Bank 1997:146). Politicians will defer for as long as possible paying these ‘political prices’, which can be so extreme that they would involve loss of power. It requires an inhuman level of political courage for a political leader of a country which for five thousand years has enjoyed water security to announce that water resources are no longer adequate. To make the announcement would be political suicide.

Those innovators purveying the economic and environmental facts of life which contradict the deeply held belief systems of whole populations will be ignored if they do not shape their message and pace its delivery to accord with political realities. The authors of the 1997 World Development Report (World Bank 1997: 144) put it another way, by quoting Machiavelli who captures the political flavour of innovation:

> ‘The innovator makes enemies of all those who prospered under the old order, and only lukewarm support is forthcoming from those who would prosper under the new’.
>
> Machiavelli, N, 1513, *The Prince.*

Conclusion

It is a paradox that the water pessimists are wrong but their pessimism is a very useful political tool which can help the innovator to shift the eternally interdependent belief systems of the public and their politicians. The water optimists are right but their optimism is dangerous because the notion enables politicians to treat water as a low policy priority, delay innovation and thereby please those who perceive that they are prospering under the old order. Pessimists also bring more sensational stories to the media. Optimists bring a version of unsensational good news. The good news is complicated and indigestible as well as unsensational.

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Figure 1.1 Individual water use - cubic metres/year

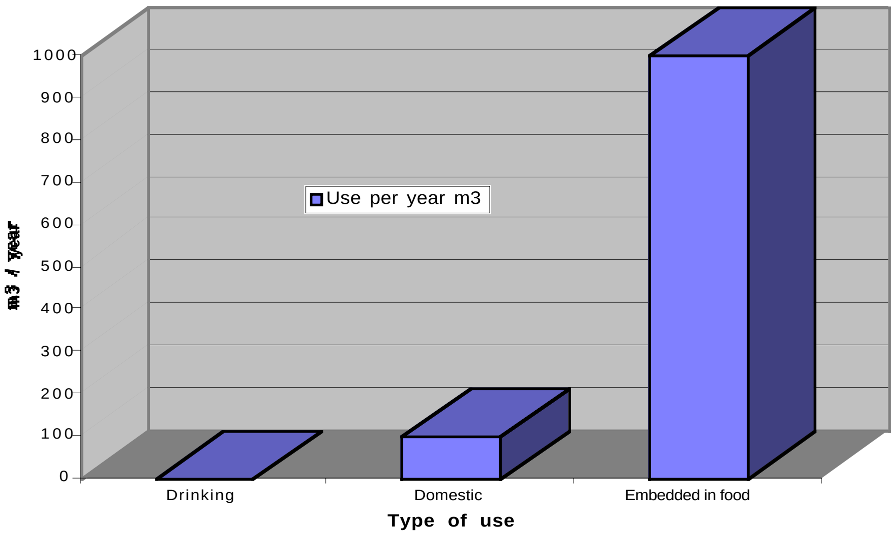

Figure 1.2 Middle East: cereal & wheat flour imports

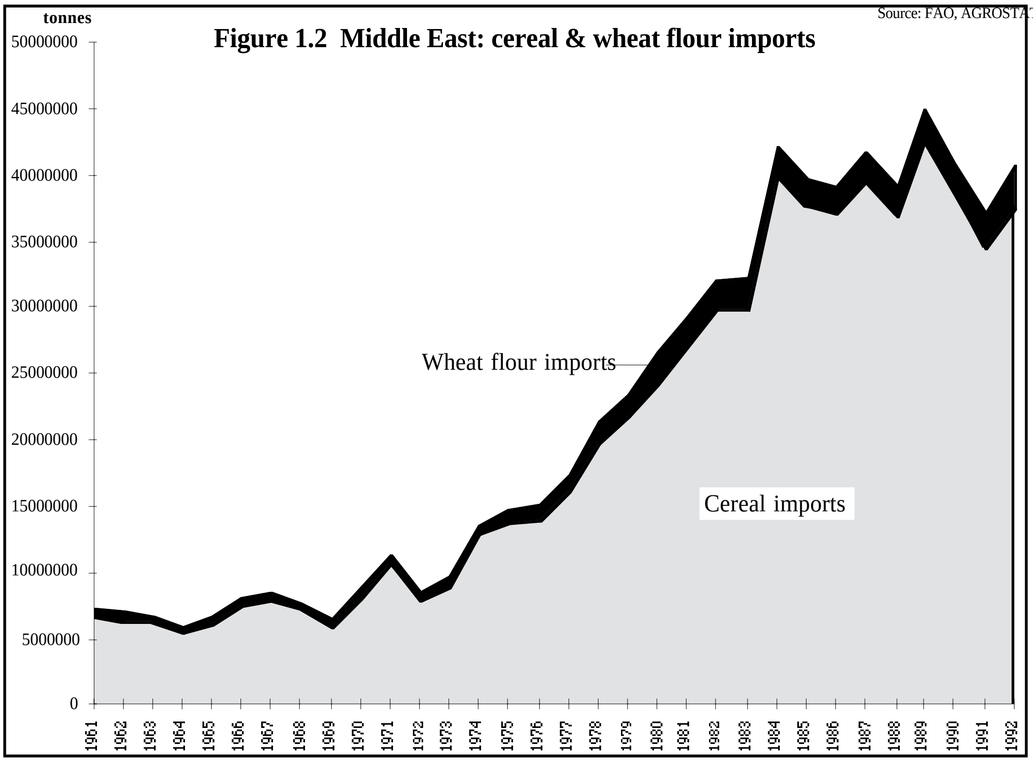

Table 1.1 Middle East and global water uncertainties and the scope for optimism and pessimism

	Middle Eastern water for regional self-sufficiency			**Global water for global self-sufficiency**	
	Evidence (scientific & professional)	**Perception** (politicians & people)		**Evidence** (scientific & professional)	**Perception** (politicians & people)
Availability	Deficit **Pessimism** **[ignored]**	No deficit **Optimism** **[dominant]**	**Avail'y**	Surplus??? **Optimism** **& pessimism** **[contadictory optimism accepable]**	No view **Optimism** **[dominant]**
Utilisation	Productive efficiency possible **Optimism** Allocative efficiency possible **Optimism**	Prductive efficiency possible **Optimism** Allocative efficiency politically impossible **De-emphasis** **[dominant]**	**Utilis'n**	Productive efficiency possible **Optimism** Allocative efficiency possible **Optimism** **[contradict'y]**	Productive efficiency possible **Optimism** Allocative efficiency politically impossible **De-emphasis** **[dominant]**

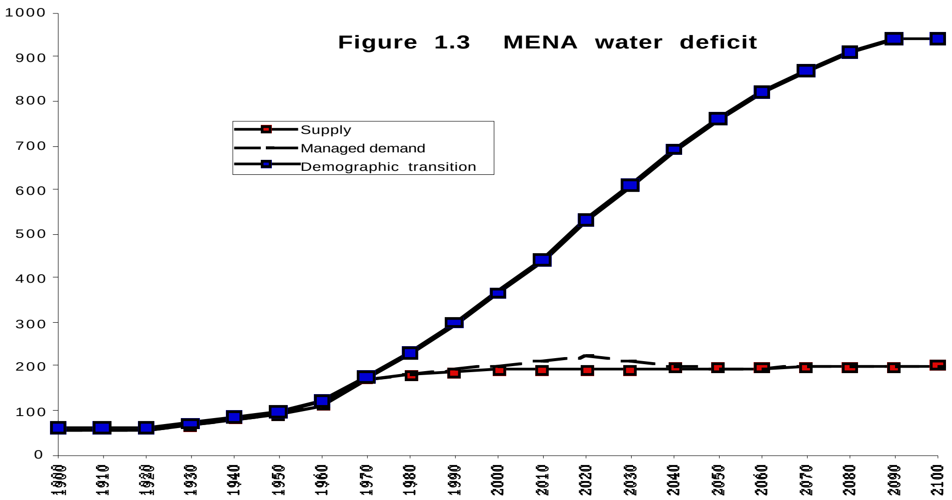

Figure 1.3 MENA water deficit

Table 1.2 Uncertain Middle East & North Africa scenarios: population and water consumption scenarios: interpretations of w

	End 20th century	End of 21st century population scenarios			
Population-billions	**0.35 bn**	**0.6 bn**	**0.7 bn**	**0.8 bn**	
		Low	**Medium**	**High**	
Water consumption scenarios	**Bn m3/year**	**Water use Bn m3/year**	**Water use Bn m3/per year**	**Water use Bn m3/per year**	**Demand managem remedies**
Water/person @1000m3/ppy	**350**	**600** [2]	**700**	**800**	**Economic, social & p development;**
Water/person @2000m3/ppy	**700**	**1200**	**1400**	**1600** [1]	**water policy refo**
Water available					**food consumpti**
Surface & groundwater	**196**	**220**	**230**	**230**	**patterns;**
Soil water (excludes Sudan)	**60**	**60**	**60**	**60**	**demand management**

Demand management remedies
Economic, social and political development; family planning

Source: population estimates - 1996

Assumptions

[1] **Pessimistic assumptions**

- static patterns of food consumption by individuals
- even more extravagant than current diets in terms of water consumptive use
- a pessimistic estimate of the demographic transition
- static technology,
- inflexible national political institutions
- inflexible international institutions
- ineffective trading systems

2 Optimistic assumptions

- changed food consumption patterns - less livestock products
- optimistic estimate of the demographic transition
- success of economic demand management policies - by allocating to high returns to water activities
- success of economic demand management policies - by technological improvements to

  high returns to water activities
- effective trade

Table 1.2 Uncertain Middle East & North Africa scenarios: population and water consumption scenarios: interpr

	End 20th Century	End of 21st century population scenarios			
Population-billions	**0.35 bn**	**0.6 bn** Low	**0.7 bn** Medium	**0.8 bn** High	
Water consumption scenarios	**Bn m3/year**	**Water use Bn m3/year**	**Water use Bn m3/per year**	**Water use Bn m3/per year**	**Demand managemen remedies**
Water/person @1000m3/ppy	**350**	**600** [2]	**700**	**800**	**Economic, social & poli**
Water/person @2000m3/ppy	**700**	**1200**	**1400**	**1600** [1]	**development;**
Water available					**'water reform', food consumption**
Surface & groundwater	**196**	**220**	**230**	**230**	**patterns;**
Soil water (excludes Sudan)	**60**	**60**	**60**	**60**	**demand management of**

Demand Managem't Remed's

Economic, social and political development;
family planning

Source: population estimates - xxxxx 1996

Assumptions

[1] **Pessimistic assumptions**
- static patterns of food consumption by individuals
- even more extravagant than current diets in terms of water consumptive use
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- success of economic demand management policies - by technological improvements to

high returns to water activities
- effective trade

Table 1.3 Uncertain global scenarios: population and water consumption scenarios: interpretations of global water and food demand and availability

	End 20th century		End of 21st century population scenari		
Population-billions	5.5 bn	7.7 bn	9.4 bn	11.1 bn	Demand
		Low	Medium	High	re
Water consumption scenarios	Bn m3/year	Water use Bn m3/year	Water use Bn m3/year	Water use Bn m3/year	Economic, s deve
Water/person @1000m3/ppy	5500	7700 [2]	9400	11100	reform' fo
Water/person @2000m3/ppy	11000	15700	18800	22200 [1]	pa
		Demand management remedies			demand man
		Economic, social and political development;			
Source: population estimates - IFPRI 1996					

Assumptions

[1] **Pessimistic assumptions**

- static patterns of food consumption by individuals
- even more extravagant than current diets in terms of water consumptive use
- a pessimistic estimate of the demographic transition
- static technology,
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2 Optimistic assumptions

- changed food consumption patterns - less livestock products
- optimistic estimate of the demographic transition
- success of economic demand management policies - by allocating to high returns to water activities
- success of economic demand management policies - by technological improvements to high returns to water activities
- effective trade

Virtual water could advocate for water conservation by discouraging the production of high water-embedded products from water-scarce regions and encouraging the water-dependent economic activity in water-rich regions.Â Increasingly, international attention is being paid to the â€œwater economyâ€ as water becomes a limiting resource in many regions. The amount of â€œvirtual waterâ€ in a product means the amount of water required to produce it throughout the production chain. The amount of virtual water in a range of products is given in Table 18.1. Making Water a Part of Economic Development. Message 3 National economies are more resilient to rainfall variability, and economic growth is boosted when water storage capacity is improved. â€¢ Decoupling an economy from rainfall variability promotes gains in GDP.Â Cost-bene-t analyses typically include short-term issues. In most analyses that are available, the long-term economic benets are not considered. This suggests that many of the cost-benet gures presented in this report are underestimated.Â Chapter 3 presents cost estimates on what it would take to reach the MDG target on water and sanitation and to improve infrastructure for water resources management.Â water management and services impede long-term growth. 'Virtual Water': A Long Term Solution for Water Short Middle Eastern Economies? Occasional Paper 3. School of Oriental and African Studies (SOAS), University of London. Alley, W. M. (2007).Â Water for food: The global virtual water trade network. Water Resources Research, 47, W05520. Konikow, L. F. (2011).