3. The turning of a screw: Social adaptation to water scarcity

The story of meeting the challenges of water scarcity is a social story. It is the story of societies employing different means of adaptation over time, at different stages of scarcity, and in response to different perceptions of what constitutes the challenge to be met. Like all good stories it can be told in many different ways.

The ways we tell it reflect the *conceptual glasses* through which we understand the challenge. And the implicit *arguments* in our recountings of those challenges constitute *guidelines for action*. Therefore, it is important to identify what the stories we tell teach us to do, and to reflect upon whether it is really the best story to tell, in order to help us understand what the most urgent challenges are, and how to respond to them.

Here are some stories presently told. They are all true stories, and good stories, since they each teach us something important about the present predicament, and how we have arrived there. Let's see if there isn't also the beginning of an entirely new story here.

I. Identifying the problem

"Rivers running dry" – a story of increased human appropriation of water

Even large rivers are running dry these years. The mighty Yellow river in China regularly does not reach the sea for weeks, sometimes months in a row during the dry season (Brown & Halweil 1998). The consequences are far-reaching. Food production in the fertile Shandong Province is affected since the irrigation water that used to be readily available from the river is no longer there at times when most needed. Industries have to close down, since they do not get enough of water. Salt water gets into the piped water of cities. Irrigated agriculture suffers doubly, since once the water returns, it will go to cater for the need of industries and cities first.

Most years the Nile no longer adds very much water to the Mediterranean any longer. Virtually every drop reaching Egypt is sucked up into irrigated agriculture and growing cities. The Colorado river does not reach the Bay of

California in the dry season. Long before that, all of its waters has been diverted through a multitude of pipelines, aqueducts and canals to agriculture and growing cities in California and the southwestern U.S. (Postel et al., 1998). In Bangladesh, people along the lower Ganges/Brahmaputra estuary increasingly migrate, even to hostile Hindu areas in India, since they no longer can secure their livelihood from the diminished amount of water during the dry season.

These are the true stories of an ever increased human appropration of the great hydrological cycle of renewable water, precipitating fresh water over land, and bringing it back to the ocean through surface flows in rivers. As estimated by Postel, Daily & Ehrlich (1996), humans now appropriate a quarter of all evapotranspiration over land, and more than half of the surface flows geographically available at the time it is needed.

It is also the story of discernible limits to further large appropriations. New dams could increase the appropriation of available surface flows with a further ten percent over a thirty-year period (Postel et al., 1996). Over the same period of time, population is expected to increase by some 40 percent.

“The numbers game” – a story of shrinking per-capita accessibility

The “rivers running dry” story, coupled with the insight that a large part of the projected population increase over the next decades is unavoidable, forms the basis for the most common understanding of the problem. *If* the only sustainable amount of water available to societies is the renewable part of the hydrological cycle (the runoff part of precipitation over land, ultimately collected in rivers and watercourses, or groundwater aquifers); *if* populations unavoidably will increase for the duration of at least the next decades; and *if* desirable welfare increases unavoidably are coupled to increased water appropriation – then the challenge is easily translated into a harsh numbers game:

Given the finite amount of *renewable* water in rivers, lakes and groundwater aquifers; the unavoidable part of population increases; and the desirable welfare increases; then the accessible per-capita amounts of fresh water unavoidably will decrease dramatically over the next decades. But the decrease will not be uniform across the globe, nor for all people. Some people and some of the myriad of activities which rely on water, will have to face a relatively larger cut-back in availability than others. Based on previous experience, it is also most probable that some stakeholders will demand and also get increases in their shares. This seems to be at odds with the objective of equity and socio-economic progress. Previous experience, however, is a poor guide in this regard. Analyses of the value(s) that water generates in its various potential, alternative uses illuminate that it is often socially and politically justified to re-distribute. Access and ‘rights’ to water that have been historically aquired, do not guarantee that water is put to the most worthwhile use. As we will discuss below, a re-allocation of water provisions between various water users is always difficult, often painful and risky, but it may be warranted and even necessary. It certainly requires social and political ingenuity to accomplish such shifts though.

How serious is this problem? To answer that, hydrologists have studied societies in different conditions of water accessiblity in order to arrive at some benchmark figures for what level of societal development is possible to achieve under differing conditions of water availability. These studies have resulted in a number of common denominators for different degrees of water scarcity:

i) Countries where the number of people in relation to the available renewable water resources are in excess of 2,000 per flow unit (1 million m^3/year), that is, less than 500 m^3/capita, year, are designated as “beyond the water barrier”. At this level of population pressure on the available water resources, self-sufficient agriculture is not an option, and great difficulties will be encountered for achieving a modern, industrialized society.

ii) Countries with a population of 1,000 persons or more per flow unit (that is, less than 1,000 m^3/capita, year) are designated “water scarce”. Very likely they will not be able to keep up a self-sufficient agriculture. Industrialization may be feasible, albeit with difficulties.

iii) Countries with 600 people or more per flow unit (roughly corresponding to about 1,700 m^3/cap, year) are designated “water stressed”. They will run into significant trouble in water management, particularly during dry spells.

This is the story of water limits, and how they will become increasingly discernible during the coming decades. Originally told by Falkenmark (e.g. 1986), it is now almost universally recounted. An easy-to-access and up-to-date source is Gardner-Outlaw & Engelman (1997).

The notion ‘water scarcity’ and its various stages as presented above, are widely accepted. The predominant focus in the interpretation of the phenomenon behind notion is that water is becoming ever more scarce. An alternative analysis of the same phenomenon would be that it is not water that is becoming scarce, but the number of people and people’s wants that are becoming plenty. The distinction is not merely a matter of semantics, but may rather be seen as an illustration of what kind of problem that is put in focus. Instead of discussing demography and human issues, the concern is about how to solve the ‘water problem’ – as if water is to blame.

Anthropocentric concerns are laudable but sometimes counterproductive. The tendency to stress the water problem rather than the population or societal problem is illustrated by the prevailing definition of water scarcity as a ratio of water/number of people and the hammering of phrases like ‘water crisis’, ‘water shortages’, etc.

In her pioneering article on the concept of water scarcity, Falkenmark (1986) emphasized the demographic dimension and constructed an index as the ratio: people/flow unit of water (as presented above). Why the original index has been converted into its inverse form is not clear. The original definition explicitely illustrated that it is population growth which is the determining factor behind growing water scarcity.

The difference between natural water and water as a social service

All of us have experienced the difference between water in a river or in the ground as compared to having it coming from a tap whenever one wants it at the turn of a handle. For a growing number of people, it is no longer the natural availability of water that counts, but how well we are provided with water through technical and institutional arrangements. This is most clearly seen in urban areas where the reliance on rainwater in streams, wells, etc. is most problematic, and entails considerable risk of exposure to polluted water. Reliance on provided water, which may be considered as a social or societal service, is also a most significant feature in rural areas, notably in irrigated agriculture. By far, it is the single sector that literally consumes most of the water that is provided in society.

Surprisingly, the distinction between naturally available water and provided water is seldom made explicit and its significance is far from comprehended. Throughout history, no society has reached a high standard of living or development on rainwater alone.

Water scarcity index as presented above, for instance, says nothing about what fraction of the available water, which realistically can be withdrawn and provided to society. Similarly, the confusion regarding how much water that is used (evapotranspired) in connection with food production is related to the failure to show how much of the water that is provided and how much is naturally available. Finally, the distinction between naturally available water and water services (that is, provision of water through technical and institutional arrangements) is crucial when discussing financial and economic aspects of water.

The shift from a reliance on natural sources of water to provision of water has a number of important implications, which may be summarized under two major points.

i) While rain water is freely accessible, the provided water certainly is not. Irrespective of who is making the arrangements, it is quite costly to provide this service. Even if water is provided for free, or at subsidized rates, somehow the full expenses must be covered. The structures and institutional arrangements that are necessary to deliver water to the users constitute a substantial entry in national budgets. Even higher are the costs incurred if proper treatment of waste water is to be made. Financial considerations are therefore necessary but a sensitive issue.

Ironically, it may be the user him- or herself who pays for water services – although (s)he usually vigilantly opposes water fees – since public expenditure is covered through taxes, fees, export and import licenses, etc. With increasing cost, it is no longer possible to neglect to whom water is allocated, under what conditions and how it is used. Society does not provide land or other essential resources to members of a community without a plan, so why should it adopt a laisser-faire attitude when it comes to water services?

ii) An augmentation in the provison of water through the taps in society means that there will be comparatively less water remaining in the natural water bodies and courses. Some of the water that is provided to society will return to Nature, but not all of it, nor to the site from where it is diverted and not of the same quality. The implications for the in-stream functions are obvious.

Provision of water through technical and institutional arrangements is, of course, only possible if a society can mobilize the required resources. Gradually, it is not so much the technical resources that count, but rather the social and human resources to manage complex issues.

The limits for management efforts are ultimately determined by the amounts of water that are potentially feasible to provide. For all practical purposes, that potential is delimited by basic hydroclimatological contexts. As shown in the last column in Table 3.1, the rate of withdrawal varies quite significantly between different countries of the world. In some parts, notably most countries in the Middle East and North Africa, there is virtually no more freshwater to develop. In other countries, the ratio of withdrawal is still modest or quite low.

Table 3.1: Examples of various levels of annual renewable freshwater resources per capita, ratio of withdrawal and GNP.

Country:	Population (Millions of people 1996)	GNP per capita (US $)	Annual Renewable Freshwater (Mm^3)		Per cap. Availability (m^3/year) (1995)	Withdrawal Ratio (% of total renew. freshwater)
			Within country	River flow from others		
Group A – High withdrawal ratio:						
Libya	5,593	(n.d.)	600	0	111	766.0
Qatar	558	18,030	195	0	353	102.0
Israel	5,664	13,920	1,700	500	390	84.0
Egypt	63,271	660	1,800	66,700	1,068	77.6
Jordan	5,581	1,190	1,300	400	312	41.8
Group B – Medium withdrawal ratio:						
USA	269,444	24,740	2,459,100	18,900	9,413	18.9
Mexico	92,718	3,610	357,400	(n.d.)	3,815	21.7
Poland	38,601	2,260	49,400	6,800	1,464	21.9
Italy	57,227	19,840	159,400	7,600	2,920	33.7
Group C – Low withdrawal ratio:						
Argentina	35,219	7,220	694,000	300,000	28,739	3.4
Sweden	8,819	24,740	176,000	4,000	20,580	1.6
Brazil	161,087	2,930	6,190,000	1,760,000	42,956	0.6

(Sources: Table based on figures collected by the Steering Committee for the Comprehensive Assessment of Freshwater Resources of the World (UN 1997). Population figures for 1996 from Department for Economic and Social Information and Policy Analysis, UN).

The table illustrates significant variations in the average per capita availability of water between various countries on a national level. Similar to other national statistical information, there might be considerable variations between various parts of the countries as well as over time. This is, for example, the case with Brazil where the huge availability is ”explained” by the Amazonas but where the drought problems in the northeast are hidden. The Table also illuminates that a low natural availability tends to be associated with a high withdrawal ratio. This partly due to the fact that a given amount of withdrawal implies different ratios depending upon how much of water that is available. But it is also a sign of the capacity a country to withdraw water, that is, what technical and financial means that are available and what kind of water policy that is pursued.

One paradoxical implication in this regard is that it is technically quite possible to *improve per capita provision of water parallel with a reduced per capita availability*. This is actually what has happened in many countries since the rate of withdrawal has been about two to three times faster than population growth (Falkenmark & Lundqvist 1995). For consumers who have seen an improvement in water supply, the talk about an impending water crisis may be hard to understand. But this kind of improvement can not be pursued indefinitely.

Optimists would point at still untapped opportunities. One is to increase the re-circulation and re-use of water. Israel is quite advanced in this regard. Visionary proposals are presented which suggest that all freshwater supplied through the National Carrier should be delivered to urban sectors. Agriculture should only receive treated waste water. The social, economic and political ramifications of such a shift are difficult to forsee but they are certainly considerable. Partly of another character, but still an example of a sophisticated solution to severe water shortage is Namibia. In Windhoek, the responsible authorities have managed to introduce a system by which about 25 percent of the water that is supplied in the capital, consists of treated and reclaimed waste water (van der Merwe 1998). In Namibia, there has been no inter-sectoral re-allocations of water.

The ultimate untapped resource are the oceans. They contain all the water ”in the world” and desalinization would be the saviour from water scarcity, perhaps in combination with the towing of icebergs. These grand solutions still have to prove their viability. Present experience shows that they could be an option for providing the small amounts of water required for household purposes and perhaps to strategic industries who can afford to pay the price. But a supply from these non-conventional sources to agriculture runs into logistical, financial and environmental problems of great magnitude. For all practical purposes it is not a realistic option for food security.

“Hydrocide” – a story of usability depletion through pollution

Even if water is available/accessible in required quantities, countries may run into significant troubles due to their misuse of water. Polluted water is a massive cause of induced water scarcity in terms of usability, particularly in newly industrializing countries. This kind of scarcity is, however, quite different from the one portrayed above. Pollution of freshwater means reduced use options and/or hazards in connection with use. In addition, the disposal of polluted water implies impacts also after use.

Growing scarcity in use options is most discernible in the dynamic parts of society, demographically and economically. Almost all (some 80 percent, or 2 billion people) of the projected population increase over the next decades is expected to arrive into growing cities in developing countries. It is an enormous figure, comparable only to the combined populations of India and China. And some 90 percent of waste water in developing countries most of which is produced in urban areas, is not treated at all.

A common pattern is, first, that available water resources are over-utilized and polluted. Most of the pollutants from industry are persistant or only slowly degradeable and when disposed with the effluents, these substances accumulate in recipients which, at the same time, are the very sources from where water supply is drawn. Gradually, the water sources are polluted to the degree that they are no longer usable at all. This is a new type of pollution which is not only related to poverty, but to the rapid growth of income and job generating activities.

The significance of this is that countries in the middle of their modernization process and with a vibrant economic growth are caught in a dilemma. Doing the right thing environmentally could be political suicide and incur social and economic hardship. Pollution thus entails a new and deceptive type of water scarcity. Concurrently, water scarcity means that the degree of pollution of recipients tends to accelerate (there is simply less water available to dilute pollutions with).

This is the story of "hydrocide", as told by Lundqvist (1998). Three ramifications of the "hydrocide" story should be noted: i) water pollution will affect morbidity and mortality; ii) loss of productivity in ecosystems, including food- and biomass production; iii) repercussions on the economy and general economic strains as a result of increasing costs and difficulties to assure supply of freshwater (through the necessity of long-distance water-transfer solutions and treatment facilities), but also as a result of trade-barriers ("green labelling" in already industrialized countries).

The conclusion of the "hydrocide" story is that it is not enough to consider the quantitative aspects of water scarcity, but that water quality is a most potent threat in society and for the continuous functioning of our life-support systems (as emphasized in Chapter 2). Proper stewardship of our water and other basic resources means a call for a new water-ethics, where water users must assume responsibilities alongside with rights and benefits.

Water quality problems is a serious concern in the U.S.

Serious and widespread degradation of water quality is not a phenomenon restricted to developing countries. In their 1996 National Water Quality Inventory The US Environmental Protection Agency shows that 40 percent of the nation's surveyed waters remain too polluted for swimming, fishing, and other recreational activities.

For rivers and streams, runoff form agricultural lands remains the largest source of pollution, affecting 25 percent of all surveyed river miles.

The 1996 report is the result of surveys conducted by states in 1994 and 1995 of 19 percent of the nation's river miles, 40 percent of lake acres, and 72 percent of estuarine square miles.

"The Dublin Principles"– a story of cementing lessons learned into principles.

Set down immediately before the Rio Conference, the so called "Dublin Principles" of 1992 is an attempt to make the lessons learned so far of water management explicit:

> 1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. 2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers

> at all levels. 3) Women play a central role in the provision, management and safeguarding of water. 4) Water has an economic value in all its competing uses and should be recognized as an economic good.
>
> (ICWE 1992; Lundqvist & Gleick 1997)

The story behind these four principles is much richer than it might seem at a first glance. The first point contains not only the basic understanding of the limits imposed by the hydrological cycle; implicitly it also conveys a criticism of large-scale engineering optimism (while not denying the necessity from a basic human needs point-of-view to appropriate larger amounts of the hydrological cycle): The available amount of renewable freshwater is finite; humans need more of it to support desirable welfare increases; yet all of it cannot be appropriated since ecosystems depend on it (as emphasized in Chapter 2).

The picture painted thus is one of a dilemma, the resolution of which can only be had by improved *management* of the resource. This, in turn, will run into several social dilemmas. One of them, women's role in water management, and the way their conditions of life are affected by men's control of water, is still waiting to be resolved. Another, the economic aspects of water, has gained a very strong ascendance.

The story of the Dublin Principles thus marks the entering of water issues into the distinctly social sphere. They underwrite the widely felt need for a broadening of the perspective on water management and utilization, from a technical supply-oriented approach to an approach where the role of water in all kinds of development is taken seriously. Equally important, they represent a chain in a string of events that preceded and followed the UNCED Conference in Rio after which these principles have repeatedly been endorsed, albeit not yet implemented on a large scale. *That* is where the real story is to begin.

Caught in supply-side management
– the downfall of a U.S. President

The classic and original example of dependance on large-scale supply-side engineering efforts in the present century is the conquering of the American West by damming the rivers, enabling aqueducts to bring in enough water from rivers far away, and the pumping of aquifers to the brink of economic depletion.

If a date of birth for this supply-side management era should be set, it would have to be 17 June 1902, when the Land Reclamation Act was signed by President Theodore Roosevelt. In a speech prior to the launching of the legislation, Roosevelt said that "the western half of the United States would sustain a population greater than that of our whole country today if *the waters that now run to waste* were saved and used for irrigation" (Reisner 1993, 112, emphasis added).

The "waters that now run to waste" is a strategic phrase. "The theory was that if any water reached the ocean, it was wasted. So you ought to grab it and put it somewhere else", says George Miller, Congressman for California, in a recent TV-serial on the dam-building era (PBS: "Cadillac Desert: Water and the transformation of nature").

The ideology of the American Hydraulic Mission was that all river waters should be “conserved” by damming and piping it in order to “make the desert bloom”. Reisner (1993, 114) notes: “The engineers who staffed the Reclamation Service tended to view themselves as a Godlike class performing hydraulic miracles for grateful simpletons who were content to sit in the desert and raise fruit.”

Inaugurated during the Great Depression the Hoover Dam was the largest structure at that time to be erected in the USA. It was to be followed by a number of Federal dams, symbolizing the advent of the era of Great Expectations. The Bureau of Reclamation in fact paved the ground for an eightfold increase of population in the West. As a consequence, a number of new members of Congress were placed in important gate-keeping positions. Reisner (1993, 308) notes: “To a degree that is impossible for most people to fathom, water projects are the grease gun that lubricates the nation’s legislative machinery. Congress without water projects would be like an engine without oil. It would simply seize up.”

The demise of that era came about as a result of two coinciding influences: i) the ecological movement, starting in the 60s; and ii) the new economics of demand management, introduced by Martin & Young (1973), who showed for the first time, that as the cost of water rose, farmers would start doing more with less. This was a form of natural water demand management (WDM) which dictated that farmers would switch to higher value crops and increased irrigation efficiency as water became scarcer and, notably, more costly to aquire. In fact this study challenged conventional wisdom by demonstrating that if a farmer was to take the so-called “cheap” irrigation water that was being offered as a bailout, it would almost certainly lead to his ultimate bankruptcy (Reisner 1993, 299).

The first American administration to challenge the era of large-scale supply-side water management was Jimmy Carter’s, who started off his term of office by launching an effort to bring the Bureau for Reclamation and the Corps of Engineers under control with a water reform program based on the concept of “realistic water pricing”.

In doing so, however, he encountered the formidable political opposition of the U.S. Congress water-lobby. His “hit list” of irrigation projects (some of which would only return 5 cents on every taxpayer dollar) alienated some 200 Western Congressmen. Reisner (1993, 11) maintains that this is one of the main explanations to why Carter failed to make it to a second term of office.

Some of the experiences of this historic case relevant for the reasoning in this section are:

- There are powerful vested interests that become linked wih water availability and allocation. So powerful, in fact, that Presidents can fall from office as a result.
- Steady supply of water gives rise to increased demand, which in turn feeds a vicious cycle using the rationale of supply-sided solutions.
- At certain points of time a window of opportunity opens (perhaps as a result of a drought episode) that politicians and environmentalist pressure groups can use to change the prevailing sanctioned discourse.

- Demand management may then be introduced, but almost invariably also results in political stress. Polititicans therefore may be hesitant to act.

What is the crucial scarcity encountered, at the critical point of time when it is realized that large-scale engineering solutions no longer can meet the social demands for more water? “More water” is an answer that leads to circular reasoning, since inherent to the crisis is the realization that more water realistically cannot be mobilized.

What abilities would informed politicians (like the Carter administration) like to have most, in such a crisis? Some tentative answers would be the ability to placate the powerful vested interests among water-users presently benefitting from subsidized water, and their political lobbyists; and the ability to create alternative livelihoods for people whose jobs may be at risk as a result of new regulatory measures.

The ability to mobilize these kinds of social resources emerges as the really scarce resource when supply-sided management arrives at a crisis. The case study shows that the most industrially powerful nation in the world could not do it the first time it tried (a decisive shift in California water laws did not come about until the 90s). The American case remains an indication of the magnitude of the challenge facing countries with much less capabilities to start with.

(*Source*: Turton 1999, “Water scarcity and social adaptive capacity”.)

II. Identifying resultant changes in the societal use of water

“The triple squeeze” – a story of changing social goals and tools

Caught in the squeeze of trying to mobilize more blue water for cities, industries and hydropower, and the need too augment the available amount of green water by diverting more blue water to irrigated agriculture, societes have appropriated an ever larger part of the hydrological cycle. In that process the social character of the water resource itself has changed radically: From being a common property resource, water has changed; first into a social and managed good; then into a public worry. This is “the triple squeeze” story, as told by Lundqvist (1996).

At the first squeeze, water changes from having been an open access resource, in terms of the direct rainwater and other easily accessible water flows which are free for all to use (albeit probably always within socially determined limits), into a socially managed good. Most often water retains a character of a public responsibility good, through communal piped waters, state-sponsored irrigation schemes, and large hydropower dams. Increasingly, and depending on the water regulations of each country, water may also attain the character of a private good. Common to both aspects, is that *in reality*, water is turned from something free (still “the gift of God” in many cultures), into an economic good with a price tag, and ensuing problems of scarcity and distribution. Common conceptualizations of water, however, still linger around the notion that water should be free, or even a human right issue.

At the second squeeze, the new economic character of water gives rise to competition for this social good. This squeeze is most keenly felt in cities, who now compete directly with agriculture for the finite amount of available renewable freshwater.

At the third squeeze, an ever larger appropriation of freshwater in combination with unsufficient care to minimize and mitigate waste water problems turns water into a “public worry” good. By definition, pollution problems result in a reduced amount of available freshwater, and costs for treating water to an acceptable standard rise astronomically (cf. the story on *Hydrocide* above).

The learning lesson of this story is that a change in the degree of resource utilization of a renewable, finite, and vital natural resource such as water will give rise to corresponding and deep-seated social changes. A larger appropriation of the hydrological cycle, requires a larger amount of social regulation. But, as we shall see, social regulation is in itself a most complicated task.

The reverse side of the coin:
Water pollution from development efforts

Following an era of rather sluggish social and economic progress in most countries in the South, it is reassuring to see several examples of a rapid and seemingly continued improvement in many countries. Impressive growth rates and stories about ’economic miracles’ are told from many countries. China’s economy has been growing at about 10 percent a year for a very long time and for some parts of the country, the expansion is much faster. Incomes have doubled since Deng Xiaoping initiated market reforms in 1979. Currently the Chinese economy is ranked anywhere from the third to the seventh largest but is expected to advance to the top already by 2010 (Hertsgaard 1997).

Against this phenomenal growth, its devastating environmental consequences should be contrasted. Mark Hertsgaard provides vivid glimpses of what obviously is a tremendous threat and dilemma. The following excerpts from his reporting from a visit to ChongQing, squarely display the gravity of the situation:

> ChongQing .. is a naturally foggy place. When pollution and the fog are both at their thickest, locals say ”if you strech you hand out in front of your face, you cannot see your fingers”. … ChongQing Paper factory, a massive state owned facility .. had been for a long time a terrible polluter, discharging enough chlorine and other toxic chemicals into the Jialin [river] to cover the entire river with white foam. [Inside] the factory we saw a broad stream of bubbling water cascading out of the back of the plant and down the hillside. The astringent odor of chlorine attacked our nostrils, and once we reached the stream’s edge, the smell was so powerfull that we immediately backed away. Below us, were the discharge emptied into the Jialin, a frothy white plume was spreading across the slow moving river.
>
> (Hertsgaard 1997, 97)

Basically, the same story is told about many other places in China. Like in Bhopal, India, occasional outbursts of pollution are also regularly taking place in China. The Huai River, for instance, which runs through densely populated areas, has been severely polluted for years. But it got drastically worse in July of 1994, when a sudden flood of toxins turned the river black and deadly for weeks. Hundreds of thousands of people were left without drinking water, several thousands were treated for dysentery, diarrhea, and vomiting, and 26 million pound of fish were killed (*ibid*.)

According to the Official China Daily, the annual cost of China's environmental degradation is seven percent of the GDP. Other observers, like Vaclav Smil at the University of Manitoba, calculates the cost at no less than 10 to 15% of GDP. If true, the fruits of the economic miracle are therefore rather seeds of environmental destruction and the future is a bleak one.

Environmental cost of T-shirts

One of the most booming industrial cities in India, Tirupur located in the dry part of Tamil Nadu, in the south of India has shown an impressive growth of its textile and hoisery industry in the recent past. A large part of the industry is involved in the manufacturing of T-shirts most of which are for exports. The textile industry begun to flourish after frequent monsoon failure. Farmers who found agriculture unviable, switched over to become successful industrial entrepreneurs.

From a humble beginning in the 1930's when most of the produce was for the domestic market, the Tirupur's hosiery industry has grown immensely. In 1985, the exports generated about 0.18 billion Indian Rupees (IRs) and about a decade later, the export had expanded to about 20 billion IRs. The number of people employed in the industry and associated business is estimated at 400.000. A similar story can be told for another equally booming town, Karur, some tens of kilometers away fram Tirupur.

The social change and adaptation to a new trade in itself a remarkable story. The phenomenal growth rate of the industry has, however, also been associated with significant environmental cost as shown in various reports, e.g. Jacks et al. (1994), Blomqvist (1996) and Krishnakumar (1998).

The use of production technologies which makes it impossible to control the flow of chemicals, means that large quantities of pollutants are disposed with the effluents into the recipients. Since this is a dry area, the concentration of pollutants in the receiving waters is high. Most of the pollutants are toxic or in other ways deleterious, and they are also non-degradable, or only slowly degradeable. Hydroxides, hydrochloric acids sulphuric acid and sodium nitrate are commonly used in the dyeing and bleaching units. Water quality of the effluents is shown below:

Pollutant:	Concentration (mg/l)	Maximum permissible
Suspended solids	2,000	100
TDS	5,000	2,100
BOD	250	30
COD	600	250
Chlorite	4,000	1,000

A growing concern over the environmental impacts is prompting the authorities to try to handle the problem. Considerable efforts have been made to enforce legal sanctions, but the required changes are slow in coming as discussed by Krishnakumar (1998).

Sources: Jacks, G., Kilhage, M & Magnusson, C. The Environmental Cost of T-Shirts (1994); Blomqvist, A. Food and Fashion. Water Management and Collective Action among Irrigation Farmers and Textile Industrialists in South India (1996); Krishnakumar. A. A Pollution Challenge. (1998).

Challenges to combine economic growth with environmental sustainability

The cases referred to from China and India illustrate that pollution is not only the result of stagnation and poverty. It is rather the result of a successful growth rate, rapid industrial development, creation of job opportunities, export earnings etc. Under these circumstances, it is perhaps understandable that this kind of change has initially been allowed to happen. This kind of development is all the more likely since imaginative and sound foresight is a rare commodity Those who are successful carriers of development may not always be the custodians of environmental sustainability. But why is this type of dismal development allowed to continue? A few hints may help to understand the logic of this truly alarming story.

Faced with a choice of either closing down or reducing the level of operation of the polluting factories to save the environment, or allowing the factory to continue to operate and thus to continue to pollute, the authorities, together with industrialists and employees, invariably allow the factories to continue. The alternative would imply throwing hundreds or thousands of people into unemployment and taking away their basis for an income. A much better alternative, of course, would be to introduce environmentally friendly technologies or to build treatment facilities. The best approach would be to address the problem at source, that is, to switch to a technology that is environmentally sound. Unfortunately, this is far from easy. Apart from financial difficulties, patent barriers, etc., modern technologies are often capital intensive and do not employ as many people as the polluting ones. Moreover, the skills required to run such technologies might not be available and education and training is not an instant undertaking. Social regulation itself therefore is often regulated by a wider social context.

"Virtual water" – a story of changing ways of livelihood

A parallel story to the "triple squeeze", but depicting the changes taking place in societies' food procurement strategies as a result of a larger appropriation of a countries renewable flow of water, is the story of "virtual water". As told by Allan (e.g. 1997) the story of virtual water is about how countries, which no longer find it feasible or at all possible, to mobilize a sufficient amount of blue water in order to augment the green water needed for an increased food production, instead turn to importing food. Virtual water thus denotes the amount of water needed (but not available) to grow the food which is now imported instead. A tonne of food imported roughly corresponds to a thousand tonnes (cubic meters) of virtual water.

This is the story of "food security" – essentially a strategy of buying food instead of growing it – which has superseded the traditional strategy of food self-sufficiency. The strategy has saved, for example, countries in northern Africa and the near Middle East from devastating food deficits. These countries alone today import an amount of food which it would take another Nile of water to grow.

Is this a feasible strategy? Yes, say its proponents. Cities and industries need comparatively little water to produce many times the economic revenues from agriculture. Agriculture, on average uses some 60-70 percent of the blue water societies divert, while industry uses some 20-25 percent, and households some 10-15 percent. Only a small amount of the water today appropriated by agriculture will suffice a long way for the modern sector in cities to pay for the virtual water imported in the form of food.

A successfull switch from using water in agriculture to using it in urban sectors does, however, depend on fundamental and rather harsh circumstances. The re-allocated water must be used in an industry that is able to produce goods and services that must be marketed and which can compete on the international market. The export must be composed of goods and services that fetch a price and earn foreign currency that will enable the country to buy the needed food that is no longer produced domestically.

There are comparatively few countries which have developed that capacity. The prevailing situation is quite different. A combination of poverty, large proportion of people in rural areas, most of whom with few skills applicable in modern industry, poor state of infrastructure, etc. make the virtual water strategy unrealistic for many countries, at least in the short run. If the opportunities for a successfull export industry, or generally, a foreign exchange earner are uncertain, a continued emphasis on the rural/agricultural sector is the only realistic option.

In the long run, however, it is hard to see what would be the alternative for countries with a large population in relation to available water and land resources. If they cannot produce the food they require, it must come from somewhere else, or hunger and famine will haunt people. The ecological footprint (Chapter 2) of these countries by necessity must be allowed to be large.

The virtual water strategy is also a story of how the triple squeeze works. As competition for water between cities and agriculture grow, cities tend to win out, since the economic value of water in industrial production may yield some 20-70 times higher economic value than the same amount of water applied in agriculture. Industrial demand for water thus will increase the need to import virtual water (food), at the same time as it will enable countries to raise the economic revenue necessary to do so.

The ultimate learning lesson of the virtual water story is that constraints for countries increasingly dependent on virtual water may show up, not as water scarcity per se, but as a scarcity of means to meaningfully employ growing populations in cities, at a time when agriculture no longer can fulfil that task.

Virtual water is not the only way forward for Africa

Virtual water (that is, imported food) de facto plays a major role in the food-security policies of, for example, the countries in north Africa and near Middle East. It is however not realistic to envisage that African countries in other parts of the continent will stand a chance to afford large quantities of food imports. Virtual water thus may not be able to play a significant role in solving the enormous food and nutritional challenges facing sub-Saharan Africa.

So how is that huge problem going to be addressed? By better utilization of rainwater, if needs be by the *rainwater harvesting* schemes under research in many parts of sub-Saharan Africa. This would significantly decrease the risks of conflicts over water between different sectors of water-scarce societies.

It is often said that a comparatively small amount of water taken out of agriculture will suffice for the need of industries and cities. This image may be misleading, however. In southern Africa it is not agriculture as such that withdraws up to 80 percent of the annual available freshwater flow – more precisely it is *irrigated* agriculture. And irrigated agriculture in sub-Saharan Africa plays a very limited role in overall food production and especially overall biomass production (for food, feed, construction, fibre, fuel).

This means that in most countries in SSA there is no immediate risk for conflicts over water between agriculture and industry/households, as these sectors use different waters.

The risk for conflicts arises if farmers are successful in returning a very significantly higher proportion of the rainfall back to the atmosphere as productive green water flow (transpiration), thereby affecting runoff and drainage flow. Water conflicts in the large part of the continent thus stand between irrigated agriculture and industry/urban households, and not so much between the by far dominating source of livelihood security rainfed agriculture, and the blue water withdrawers in industry and households.

It is often stated that water harvesting schemes, because of their small scale, are unlikely to have a significant impact in the foreseeable future on incremental food production in SSA. The truth may be more complicated than so. There is a very large, documented, presence of indigenous water harvesting systems being used by farmers in sub-Saharan Africa, which primarily improve rainfall partitioning in favor of productive green water flow. These systems are wide spread, and contribute to significant yield increases.

Added to these systems, are the myriad of systems for flood water harvesting (which largely explains the success of paddy rice in semi-arid Tanzania, and also form the corner stone of Eritrean dryland farming and many farming systems in Ethiopia), and storage systems for supplemental irrigation.

The major question is, what potential does such small scale water harvesting systems (thus including water conservation, flood irrigation and supplemental irrigation systems) have on a catchment scale, regional scale, and national scale? And what effect on the hydrological cycle would upscaling of small-scale systems have? The answer to these questions are still sought for, and they indicate an area in need of further research.

A starting point for further discussions should be that the majority of food increase in SSA will have to come from increased productivity (i.e., increased yields per unit area), and not from the expansion of cultivated land. This would entail that the food needs to meet the increasing population are so large – with yield increase needs largely exceeding what was e.g. achieved during the Green Revolution – that nothing but a concerted effort both in rainfed and irrigated agriculture, covering the range of agro-ecological zones where sedentary agriculture is practiced, will have even a theoretic possibility of doing the job.

Finally, researchers propagating this approach also note that a doubling of cereal food production in sub-Saharan Africa, if achieved from rainfed agriculture, would not necessarily have a seriously significant impact on the water balance of a region.

(*Source*: Rockström 1999, on virtual water vs. rainwater harvesting in Africa)

"Social resource scarcity" – a story of changing perceptions of scarcity

The understanding of what "management" of water in fact amounts to has evolved very rapidly over the last decade. Three distinct phases of such "management" can be identified:

i) The phase of supply management. This is the "get more water" phase, often involving large-scale engineering projects. It has been the dominant, main-stream perception of what water affairs constitute until quite recently.

ii) The phase of demand-management by end-use efficiency measures. This is the "get more out of every drop, wherever it is used" phase, involving more efficient irrigation methods, water-saving appliances in households, etc.

iii) The phase of demand-management by allocative efficiency. This is the "get more value out of every drop by allocating it to high value products" phase, involving a shift of water usage from agriculture to industry and cities, at the same time employing a strategy of food-security by importing virtual water in the form of food.

Accomplishing these rapid shifts of water use means the involvement of an increasingly large number of socio-economic incentives, changes of institutions, water-laws, and regulations. Above all, it implies the involvement of people. Societies and institutions are made up of people; with their abilities, ambitions, greed, knowledge, vested interests, etc. It is these qualities, good and bad, that form the basis for institutions, for collective action, in short for management.

This is what has led some authors (Ohlsson 1998, 99; Appelgren et al. 1998, Kluhn et al. 1998, Turton 1999) to concentrate on the social bottlenecks encountered when attempting to implement increasingly sophisticated efficiency measures. Water scarcity in such a context of rapid social change, these authors argue, emerges as a "social resource scarcity", rather than a natural resource scarcity.

The learning lesson of the social resource scarcity story is that the strategic bottlenecks in societies' attempts to accomplish increasingly difficult efficiency measures, in order to be able to adapt to water scarcity, are to be found in societies themselves. Just as sustainability of the natural resource utilization is a recognized goal, it ought to be recognized that the amount of social resources needed to accomplish a change in water use constitutes important sustainability aspects too.

The success of a society's attempt to adapt to water scarcity depends on the amount of social resources it is able to employ. Furthermore, the level of social resources needed increase at every step of higher efficiency measures attempted. Failing to mobilize these resources, may mean a failure to adapt.

Social resource scarcity – the dilemma of governments

It is very rare to find an example of a case study of water scarcity focusing on the difficulties faced by governments to implement new rules and regulations necessitated by harsh hydrological realitites. Here is an exception.

In a case study of the Gharb region in northwestern **Morocco**, authors Abdelhadi Bennis and Houria Tazi Sadeq note that the percentage of young people under the age of 15 has only slightly declined, to 37 percent in 1994. By 2014 the rural population will remain at current levels, while the urban population will increase by 70 percent. Population will double towards the middle of the next century, reaching about 50 million, posing major challenges in the areas of nutrition, satisfaction of social and economic needs, and the rational and sustainable management of natural resources.

Morocco is said to be fully aware of the challenges implicit in these trends, and the authors stress the need for all the components of "integrated water resources management", even including a wider agenda of family planning, literacy programs, children's education, emancipation of women, job creation, and a campaign against subdivision of the land. Yet, the crucial scarcity emerges from the following:

> Will the population accept high annual costs for participation in investments that were decided without their consent […] ? […] Organizational initiatives rarely come from the population under the socioeconomic conditions that exist in rural areas. The government is forced to take the initiative, hoping the population will follow. On the one hand, there is the government's duty to initiate and maintain basic installations, and on the other hand there is the government's desire to transfer management, within an organized and democratic framework, to a local population that, unfortunately, is not ready to handle it. (Bennis & Sadeq, in de Sherbinin & Dompka 1997, 278-9).

In the final analysis, the authors note that the government must be able to act in an effective, dynamic, and intelligent manner in order to exploit and protect the investments it has made, and to win the population's confidence and gain its adherence.

What emerges as the ultimate scarcity, once the limitation of the available supply of renewable water is fully realized, thus is neither water itself, nor the plethora of available water resouces management tools, but the very *capacity of the state government* to implement what is known to be right and good, and to get people's consent.

(*Source*: de Sherbinin & Dompka 1997, *Water and Population Dynamics*.)

Water harvesting in India, through mobilization of social resources

Water harvesting and integrated land-water management is not new to India. Agarwal and Narain (1999) recount how the art and science of “collecting water where it falls” is ancient in the subcontinent, but how this “dying wisdom” needs to be revived to meet modern freshwater needs.

Water harvesting can be undertaken through a variety of ways: capturing runoff from rooftops and local catchments; capturing seasonal floodwaters from local streams; conserving water through watershed management. In order to do it successfully, however, four ”actions points” are necessary to address:

1) *Village ecosystem planning*: This is socially and ecologically a difficult option, not impossible however, provided the three principles of *control*, *unity* and *equity* are observed:

i) The commons must be brought under the control of the village communities. Government agencies must be divested of their control over the comon lands through changes in legislation, although this does not necessarily mean transfer of ownership.

ii) The entire community must be involved in the protection of the commons under its control. If only a few members of a group are left to protect a common resource against the wishes of the rest, they will fail. ‘It does not matter whose goat enters the protected patch, the damage will be the same. All have to keep their animals away’.

iii) All the members of a group will protect a common resource only if all of them know that they will benefit from the resource equally.

2) *Village institutions*: A village-level institution is needed that can work with a high order of democracy in decision-making as well as discipline within the group members.

Open public forums can work much better than elected councils to bring about good natural resource management and sorting out intra-community differences, especially if properly created and adequately supported by the state, even within the existing circumstances of poverty and inequality.

In those areas where inequality is intense, there will definitely be greater difficulties in achieving equity through any public.

3) *Enabling property rights*: As the village ecosystem will invariably consist of many components that are common property resources (which in many countreis are owned by the state), the state will ahve to create appropriated community-based property rights so that the community can undertake the management of these resources.

4) *Village funds*: No village institution can work without money. Village institutions can raise substantial sums of money for the common good especially if they can organize their common property resources to reach a high level of productivity.

But any village institution will need start-up funds. This is where the role of government funding is crucial. The government ought to provide village institutions directly with financial grants. These grants can be minimal but they should be sufficient to enthuse the people to get the feeling that they can set their own priorities.

(*Source:* Agarwal & Narain 1999, 'Community and household water management'.)

III. Identifying the conflicts associated with changes in water use

"Water wars" – a story of changing perceptions of conflict

The logic behind the fear of water wars is simple, and seemingly incontestable: If access to water is vital for almost every aspect of societal development; if the amount of renewable water is finite; and if the main part of a particular country's water supply stems from a resource shared with other countries – then the risk of international conflicts over water is bound to be very high; particularly so if the countries involved are subjected to still large yearly population increases; the development expectations of the population are high; and the dependence on the shared resource is high.

Yet available evidence seems to show that no such conflict over shared water resources has taken place so far. Although control over water resources certainly has become a part of the goals of contending parties (most notably Israel's annectation of the Golan Heights and the West Bank in the 1967 war), water resources in and by themselves has not led to the outbreak of war. On the contrary:

> ... over 3,600 water-related treaties have been negotiated, dealing with all manner of water management.
>
> Our findings should not be taken to mean that there is no conflict over water – as we all know, there is lots – only that it does not happen at an international level. In fact, our findings suggest that the likelihood of violence increases as the scale decreases. […] rather than being causal, environmental degradation leads to *internal* political instability, which *in turn* can provide an environment conducive to acute conflict. This interpretation allows a less disingenuous argument which has the advantage of being backed up by data.
>
> (Wolf 1997, citing findings from the Transboundary Freshwater Dispute Database at Alabama)

Attempting to explain this empirical, conflict researchers have directed their attention to what actually is the point of conflict over water. To begin with, at least four different reasons for potential conflict should be distinguished: i) conflicts over the use of a water resource; ii) conflicts over pollution of a water resource; iii) relative water scarcity leading to distributional conflict; iv) absolute scarcity leading to distributional conflicts (Haftendorn 1999).

Judging from a study of archetypical cases (Wallensteen & Swain 1997) conflict over use and pollution are comparatively easy to resolve, particularly if the parties to the conflict are wealthy countries. In these cases, the issue turns into one of compensation, or, in the case of pollution, of mobilizing enough social resources to clear up the cause of contention.

Distributional conflicts are much more difficult to resolve, particularly if the parties are poor or not yet fully industrialized countries. The options here are much fewer, since the amount of social resources needed to adopt a strategy of food security based on virtual water may not be at hand, and the pressure to appropriate more water therefore greater.

The archetypical distributional conflict situation is the upstream-downstream dilemma, where water appropriated by one country (most often an upstream country) means opportunities lost for other riparians (most often downstream countries). In order to resolve this, what Haftendorn (1999) terms a "Rambo" type of situation, something else has to be brought into the equation, in order to transform it into a "dilemma" situation. As shown by experiences in the real world (e.g. the 1994 Israel-Jordan peace treaty, importantly involving an agreement to share the waters of the Jordan more equitably) it is quite feasible to accomplish.

The story of water wars thus is a story of changing perceptions of water conflicts. Seemingly impossible to manage at the outset, international conflicts over water nevertheless may be averted. The original pressure on the state to provide more water, however, remains. The remaining question, then, is if the pressure for conflict also remains; and, if so, where it is most likely to materialize.

"Environmental scarcity" – a story of the role of environmental resources in creating internal conflicts

Provided that international conflict over shared water resources is considered too great a price to pay for securing more water, pressure on the state increases to accomplish the desired goals of the intended water use with less amounts of water. It is thus a powerful driving force for demand-side management, both by end-use efficiency measures, and ultimately by allocative efficiency measures (industries instead of agriculture, and import of virtual water in the form of food).

What this entails, in effect, is that the distributional conflict between countries now is transferred inside the borders of each country sharing the scarce water resource. Groups of different social empowerment, perhaps sharing a common water resource within countries, increasingly will be pitted against each other. Mechanisms of inequality will result in the stronger parties capturing a larger part, resulting in the marginalization of weaker groups.

This is the story of "environmental scarcity", as told by Homer-Dixon (e.g. 1994). It is the story of how scarce environmental resources, such as water, will play a particular role in the formation of conflict patterns within countries. Significantly, environmental scarcities will work together with existing cleavages along national, regional, ethnic, or religious fault lines.

Furthermore, and as described by the "triple squeeze" story, different water user groups in a society (e.g. agriculture and cities) will be pitted against each other in a context of scarcity. The process of institutional change necessitated by demand management, particularly allocative efficiency measures, will not proceed harmoniously and without incurring social costs. New regulatory mechanisms will benefit some groups, while previously privileged or even subsidized water users, will meet with harsh restrictions.

In such a context, it is very easy for grievant groups to form alliances against the changes imposed by government. Even democratic groups, such as water user groups and cooperatives, may turn against the state. To counter these disruptive tendencies, the state will find itself in need of extraordinary amounts of social ingenuity and conflict resolution capabilities.

This is the story of “narrow coalitions” and the “ingenuity gap”, as told by Homer-Dixon (1995). The point of this story is that the conflicts created by the new restrictions on water use – the very tools whereby society, through the state, attempts adaption to scarcity – may work powerfully against the very capacity to adapt. It is thus a story of a particularly vicious circle.

**Environmental scarcity breeding inequality,
in turn breeding more scarcity**

Applying the conceptual glasses of *environmental scarcity* to existing case studies of water scarcity can provide additional insights to the mechanisms at work.

Environmental scarcity (as defined by Homer-Dixon 1994) should be understood as the outcome of three large processes of change: i) environmental impacts; ii) population increase; and iii) unequal social distribution of resources, also termed “structural scarcity”. Very often unequal access to water resources emerges as the most important cause of diminished water availability. Furthermore it tends to lead to increased social inequalities, thus creating a vicious circle. Here is how the mechanisms of environmental scarcity works, when applied to a recent book of case-studies on water scarcity:

• 50 percent of the Central American population will be living in poverty by the end of the present century. One result of changing ownership rights in **Guatemala** has been large-scale migration towards urban areas and agriculturally marginal zones prone to severe soil erosion.

Here, in terms of environmental scarcity, the *resource capture* of the more powerful segments of society has led to the *ecological marginalization* of powerless people. The result of this typical example of structural scarcity has resultede in the social effects of increased poverty and migration to cities and frontier areas. Ecologically, the effects are soil-erosion and depleted water resources in marginal areas receiving a large influx of people.

Petén, a particularly stricken area, has been subjected to a population increase from 40,000 to 350,000 people in just 12 years, with enormous impact on natural resources. The available amount of potable water is extremely limited and sensitive to disturbances.

The social effects in Petén has been alarmingly high rates of infant mortality and high incidences of intestinal infections and respiratory illnesses. The proportion of coffins made for children is five for every one made for an adult.

In Guatemala as a whole unequal resource access had contributed to the state of war and general violence reigning over the last 40 years.

• In **Zambia** hydropower dams and the Nakambala Sugar estate have effected a similar resource capture, blocking water demands from local populations and increasing land degradation, leading to ecological marginalization.

As a result the Kafue Flats area has been the subject of ecological destruction and oscillating conflict for nearly 30 years.

• In the state of **Karnataka**, India, the availability of water has declined to a much greater extent than other resources for the small and marginal farmer. The decline results from the de facto ownership of water by large farmers with private boreholes. The collapse of community water management systems has led to the silting of water tanks and the decline in their use.

The overall effect of this unequal social resource distribution has been that land area used for irrigated coconut plantations (owned by the wealthy elite) has doubled, resulting in a reduction of irrigated land for annual crops to a mere 15 percent of the amount under irrigation some 25 years ago, a good illustration of structural scarcity resulting from resource capture, and the consequent ecological marginalization.

• Rahuki, Sindh Province, **Pakistan**, provides an almost epic example of how structural scarcity evolves, and what the social consequences may be. The people of six small villages at the far end of an irrigation system were marginalized by more powerful land-owners at the head of the system. The increased economic and social power clearly had come as a result of the upstream opportunity to capture illegally a larger amount of irrigation water for producing more valuable crops.

In the end, three of the villages were left totally empty as a result of forced out-migration. Two of them remained half-empty as canals (important for agriculture and for drinking) ran dry. Only in the last village did people hang on. Those forced to migrate had to sell their land to destructive brick-kiln works, in turn polluting the remaining water. Women, culturally forbidden and afraid to leave their villages alone, were often the only wage earners and had to fetch water twice a day from as far as ten kilometers away.

In the end, the plight of the now dispersed villagers was taken to a human rights court. They won a judgment that guaranteed a minimum amount of water flow, sufficient for them to return and try to rebuild their lives.

(*Source*: de Sherbinin & Dompka 1997, *Water and Population Dynamics*.)

IV. The new story emerging – a turning of the screw

The stories we tell about water form a progression. They are about i) identifying bottlenecks; ii) finding the appropriate social tools to meet the challenges posed; and iii) dealing with the conflicts created by the the new ways of using water resources socially.

It is not a linear progression, however. The story of changing social uses of water rather forms a spiral movement, oscillating between a perceived scarcity of the natural resource water, and a perceived scarcity of the social means required to overcome the original scarcity; all the while progressing towards ever increased amounts of social resources applied to overcome the natural resource scarcity.

A more appropriate simile, therefore, is a turning of the screw, periodically encountering what has been termed (Ohlsson 1998, 99) the *first-order scarcity* of the natural resource water; alternating with the *second-order scarcity* of the social resources required to successfully adapt to the first-order water scarcity.

First order/second order conflicts:

Similarly, the task of managing this process essentially is about learning how to deal with: i) the conflicts encountered as a result of the natural resource scarcity itself (both international and internal conflicts about the distribution of the resource); and ii) the conflicts encountered as a result of the social resources applied to overcome the natural resource scarcity (internal conflicts, often directed at the state, and therefore a dangerous impetus for external conflict).

The management task therefore constantly shifts between managing *first-order conflicts* over the scarce resource itself; and managing *second-order conflicts*, caused by the very means societies employ to overcome the first-order scarcity (Figure 3.1).

Any discussion aimed at finding appropriate strategies for managing water scarcity therefore seemingly would benefit from starting off with some reflections on *where* on the thread of the ever-turning screw a particular country is situated at a given moment. Summarizing the previous discussion, three such large turnings of the screw can be identified generally:

1. The phase of large-scale engineering projects.

At the first turning of the screw, the problem is perceived as water scarcity, pure and simple. It is a first-order scarcity, the solution to which is to mobilize more water, that is, supply-side management.

The means to do so are found in increasingly large-scale engineering efforts: dam-building, pipelines, and aqueducts diverting blue river water; and the drilling of boreholes to abstract groundwater. The closes low-tech equivalent at this stage is rain-harvesting as practiced in South Asia and some Sahel countries.

Symptoms of a second-order scarcity at this stage appear as rising first-order conflicts over blue water, between users at the local and regional level within countries, and between countries sharing a common resource of blue water, such as a river. In addition, second-order conflicts may arise between, for example, the often large number of people displaced by dam-building projects, and the state.

At the local and regional level within countries the mechanisms are those described by the concept "environmental scarcity": demand-induced scarcity ensues from the water needs of increasing populations with justified demands for increased welfare; supply-induced scarcity as rivers running dry, lowered water-tables, and polluted groundwater and surface water courses; and structural scarcity as more powerful segments of water users confiscate a larger part of the scarce resource, resulting in the ecological and economic marginalization of the less powerful.

At the international level the mechanism of conflict is the perceived zero-sum upstream-downstream game, sometimes described as a "Rambo"-type of conflict where one country (most often upstream) holds other countries ransom to its own capture of water resources.

The second-order scarcity at this stage, as always, is a social resource scarcity, namely the lack of ability of communities, societies and states to find the social tools to deal with the first-order and second-order conflicts caused by supply-side management efforts.

2. The phase of institutional change.

At the second turning of the screw the perceived problem is to find the social tools which would enable communities and societies to alleviate an absolute scarcity, reappearing at a time when supply-side, large-scale engineering solutions no longer suffice to increase the available amount of water. The solution is to save water by doing more with every drop, that is, end-use efficiency, the first stage of demand management. The means to do so are found by changing rules and regulations, administrative bodies, and economic incentives, that is, the institutional framework, in order to bring more water-efficient modes of usage into practice (cf. the discussion above on the need and difficulty to export industrial goods).

Water scarcity now becomes relative, since the available amount of water depends on the social willingness and economic rationality of employing more labour and technology-intensive, but less water-consumptive modes of production. On a high-tech level examples are drip-irrigation, re-circulation of waste-water, and water-efficient appliances.

The means whereby this more water-efficient mode of usage is brought into practice are however not without social costs. Institutional frameworks (rules and regulations, administrative bodies, and economic incentives) are always designed to facilitate a certain mode of water use, and to pave the way for a particular group of water users, be they cooperative farmers, large-scale irrigators, or parastatal hydroelectric companies.

To change such an institutional framework is not only cumbersome and tedious; it will also infringe on the vested interests of societal segments that may have become very powerful and entrenched over time (cf. example above on President Carter). The potential second-order conflicts at this stage will thus occur within countries, and most likely exhibit a fault-line with the state (trying to impose new regulations and economic incentives) on one side, and previously subsidized large water users on the other side.

To summarize, the management effort at this stage involves transforming an absolute, and therefore by definition unmanageable, scarcity of water, into a relative scarcity, amenable to management. It is a solution that will grant at least a breething space to some of the conflicts encountered at the first turning of the screw. End-use efficiency measures will alleviate the pressure to find more water, and thus will ease the risk of international conflict.

Concurrently, however, it will create new second-order conflicts within countries, requiring more social resources in the form of policies placating social segments that have benefitted from the phase of subsidized supply-side management water projects, and the ingenuity to design appropriate new institutional frameworks.

At this turning of the screw things that are still worth doing (despite new economic incentives) will be done in a more water-efficient way. Some things, however, will be found not worth doing any longer at the higher social and economic cost incurred, and therefore will go out of production. Such cases represent a precursor to the final turning of the screw – the social challenges following from the need to do other, and better, things with the available water.

3. The phase of large-scale social restructuring

At the third turning of the screw, the new economic disincentives for water-squandering production will raise the logic of the second stage of demand management, namely allocative efficiency, succintly formulated as follows:

> “If allocative efficiency is not achieved, it is possible, and even common, to be doing the wrong thing extremely efficiently. It would be much more useful to be doing the right thing, that is with efficiently allocated water, a little badly.” (Tony Allan in Lundqvist & Gleick 1997, 19)

The problem at this phase, the third turning of the water screw, is perceived as achieving a quantum-leap in water efficiency by maximizing the economic return of every drop of water mobilized in society. It is a logic that, once realized, follows almost inevitably from the institutional change and new economic incentives introduced during the previous stage.

The solution, then, becomes a concious effort to redirect water to cities and industries, yielding some 20-70 times higher economic returns to water compared to agriculture. Concurrently, a shift in food procurement strategy takes place, from food self-sufficiency, based on what a country can grow internally, to food-security, based on the degree to which a country can afford to import the food it no longer can find the resources for growing, water prime among them. It is thus a strategy of relying on virtual water.

The second-order conflicts at this stage do not arise as much over competition for the amount of water diverted to cities and industries, since a comparatively small proportion of the water used for agriculture will suffice for those needs. The social challenge is much more basic and has to do with agricultural expansion as such no longer being an option. Thereby the issue of livelihoods, as separated from just food procurements, becomes central.

The challenge is enormous, since it involves creating new jobs in cities and industries to compensate not only for the stagnating or even shrinking number of jobs in agriculture, but also to do this at a time when populations in many cases still are growing rapidly, and people have justified demands not only for basic livelihoods, but also for better lives more generally (housing, education, health-care, and an increased level of consumption).

The conflicts likely to occur are extremely difficult to predict. Most likely they will not be directly coupled to changing water allocations, but to widespread ruptures in the social fabric, stemming from the inability to incorporate such a large and growing proportion of people into the modern sector, at the pace required by both continuing population increases and the structural change from agriculture to cities and industry. The social resources during this phase are taxed to the outmost, while the supply of social ingenuity may be severly hampered by social conflict.

How a natural resource scarcity necessitates social resources mobilization

At every turning on the screw, oscillating between a perceived natural resource scarcity of water, and the social resource scarcity of adaptive capacity, the crucial task for society and water managers is to identify the social bottlenecks which stand in the way of new kinds of adaptive measures.

When large-scale supply-side engineering efforts no longer is the appropriate solution, a way must be found to overcome the vested interests of what by then will have become a powerful and entrenched economic and political sector.

When the new economic incentives entailed by the first stage of demand-management ("getting more out of every drop") creates conflict and disagreements with previously subsidized water uses, ways must be found of compensating grievant parties.

When irrigated agriculture no longer can be the main source of livelihood for people, the influx to cities must be handled, and new jobs created at a rate that will satisfy justified demands for better lives from still increasing populations.

Each step, gigantic as the challenge is, means turning a natural resource scarcity into a challenge to overcome scarcities of *social* resources, in the sense that the ability to mobilize a sufficient amount of social resources in order to *change* societal water use emerges as the strategic bottleneck.

Bringing the adaptive capacity of a society into the equation thus means transcending the notion of ‘absolute’ scarcity. By regarding the task at hand as a case of social resource scarcity, a previous *absolute scarcity* of water (under prevalent social forms of usage) is turned into a *relative scarcity*; in the sense that whether societies will succeed to live with less water now depends on how well they handle the challenges of adapting to another social usage of water.

The paradigmatic example is what has been called “the sleeper story of the century” (Gardner 1997, 40), namely the increasingly rapid progression from growing food, to buying food on the international market. It is a gigantic process of change, the implications of which by far are not yet realized.

V. Measuring the problem – what you see depends on the story you wish to illustrate

All of the many quotations you see of water scarcity spreading, and the risk of conflict it entails, basically are founded on a common index meant to capture the seriousness of water problems. Such statements are meant to be awareness-raising, alarm bells indicating that action of some sort urgently ought to be undertaken. They are thus good things, meant to provide a direction for societal action.

But just as the stories we tell about water tell us to do different things, depending on what the story concentrates on, indicies are no fixed stars. They are created by humans who wish to underline the importance of the particular story they tell at the moment, and the importance of doing certain things. Indicies thus should be scrutinized with a view to if they really point at the most important but neglected area of action, in a particular country, at a particular moment in the turning of the water screw of that country.

What you see with the help of an index is what you already postulated as important in the construction of the index. Thus, how an index is constructed will tell you something about what the authors thought was important at the time of construction of the index.

If, for example, you think that the prospects of a society for development and welfare increases are tied to that society’s available annual amount of renewable water, *and* that amount is regarded as both fixed and fully utilized, then an index showing how the per capita availability of water will decrease over time as a result of population increases will tell you a lot about the future difficulties of that country.

If you think that the crucial factor is the available amount of water in the root-zone, so called “green” water, then an index including the thirst of the climate, the variability of precipitation, and the renewal rate of groundwater resources will be similarly illuminating.

And if you think that societies may be able to live with water scarcity, provided they can adapt through doing things with water in a better, more efficient way, and perhaps doing entirely other things than agriculture, then an index portraying the adaptive capacity of a society will provide a relevant picture of the impending challenges of that society.

Different indicies thus clearly mirror the perception of the character of water scarcity at different stages of the turning of the water screw.

Looking for more water for still large yearly increases of populations

The first generation of water scarcity indicies correspond to the first turning of the screw, where the amount of available renewable "blue" water in streams and aquifers is perceived as the bottleneck. A simple per capita measurement (annual amount of renewable water per capita), or its inverse (number of people having to share a fixed amount of available annually renewable water, usually a million cum), these are Malthusian indices. As measured by these indices, the available amount of renewable water will decrease as populations, and expectations of better standards of living, continue to increase.

Inseparably connected to Falkenmark (e.g. 1989) and fixed limits for different stages of water scarcity ("water stress" at 600 people per flow unit of water, or 1,700 m^3/cap,year; "water scarcity" below 1,000 people per flow unit, or 1,000 m^3/cap,year; "beyond the barrier" beyond 2,000 people per flow unit, or below 500 m^3/cap,year), the index and these levels of water scarcity are widely used by almost everybody writing on the larger social consequences of water scarcity (e.g. IBRD 1993, Postel 1992, Gardner-Outlaw & Engelman 1997), not mentioning the plethora of popular writing.

The conclusions that emerge from using these indices are ambivalent. On the one hand they will indicate the need for more water or the urgent need to curb population growth or re-structure the economy. The indices thus belong squarely to the phase of the first turning of the water screw, stressing large-scale engineering supply-side management.

Furthermore, this kind of index is foundational to the widespread fears of water wars. Since the available amount of renewable water is fixed, the conclusion is almost inevitable: As populations grow and per capita demands grow even faster, states will be forced into a logic of fighting for more water.

On the other hand, since the available amount of water is finite, such indices could also be taken as pointing at the need for adaptation to water scarcity.

Looking for ways of adapting to water scarcity

The second generation of water scarcity indices pick up on the last conclusion following from employing the first generation of water scarcity indices. This group of indices belong to the second and third phase of the turning of the screw, adaptation by end-use efficiency, and allocative efficiency. They are also much more diverse in what they try to measure.

a) The first branch of indices in this group attempt to point at the specific tasks entailed by adaptation to water scarcity. They are more of a categorization of countries, according to the difficulties they will face in mobilizing a sufficient amount of water in the root-zone of plants during the growing season. It is thus an *ecological* index (e.g. Falkenmark and Rockström 1993, discussing water challenges in tropical drylands).

This would correspond to a special case of the second turning of the water screw, attempting end-use efficiency. In this case, the strategic end-use efficiency measure indicated would be to concentrate the available amount of water in the root zones of growing plants, gaining "more benefit per drop".

Interestingly, this categorization has been taken a step further, by bringing in the capability of societes to carry out changes in the social use of, while retaining the physical availability of water from the first generation of indices, and the ecological aspects of green water availability. (Compare Chapter 2 for different ways of categorizing countries along the variables vulnerability to green water scarcity, and social adaptive capacity.)

This kind of refined categorization represents the border-line between the second and third turning of the water screw (allocative efficiency).

b) The second branch of indices in this group concentrate entirely on the social capability of adapting to water scarcity. A suggestion by Appelgren (1997) to include the institutional and economic constraints facing water managers into the concept of water scarcity, was taken up independently by Raskins et al. (1997) in the preparatory work for the UN Global Freshwater Assessment.

A number of water stress and vulnerability indices were constructed with the aim to estimate future water vulnerability at the nation level. Variables used were i) use-to-resource ratio (a measure of the total pressure on water resources and aquatic systems); ii) coefficient of variation of precipitation (a measuer of hydrological fluctuations); iii) storage-to-flow ratio (an indicator of the infrastructural capacity to ameliorate fluctuations in supply); and iv) import dependence (an indicator of the reliance on virtual water).

As a complement to these physical vulnerability indices the "socio-economic coping capacity" sought for by Appelgren was introduced in the form of average future per capita income, taken to represent the ability of a country to adapt to impending water scarcity and vulnerability.

A fine-tuning of these efforts was produced by Ohlsson (1998, 99) using the widely accepted Human Development Index (instead of merely income) as a proxy for a country's social adaptive capacity.

What the development in water scarcity indices tells us

The learning lesson of studying the development of different generations of water scarcity indices is that they mirror the progression in the perception of what constitutes the real scarcity in water affairs at different stages of the turning of the screw.

The first generation of water scarcity indices were appropriate for identifying a problem in the prevalent supply-side management efforts, and to sound the alarm. As a by-product, they spurned the fears of international conflict over water.

As the perception of the character of the challenge of adapting to this first-order water scarcity grew, refined indices evolved, some of them concentrating on fine-tuning the perception of the challenge at hand from an ecological point of departure, while other focused on the challenge of mustering a sufficient amount of social resources nessessary to both manage adaptation, and handle the second-order conflicts ensuing from the very means societies were likely to employ in order to adapt to scarcity.

All of the indices high-light important aspects of water scarcity. None of them should be used to the exclusion of others; rather they complement each other. The interesting part is the way they mirror a growing and changing perception of the complexities involved in water management.

A Social Water Scarcity Index employing the Human Development Index

If you think that the capability of a society to respond to difficult challenges depend on factors such as, for example, distributional equity, political participation, access to education (all of them very likely important to foster commitment, and political loyalty of the population) – then there already exists a very appropriate and widely accepted indicator, namely the UNDP Human Development Index.

The human development index measures the average achievements in a country in three basic dimensions of human development – longevity, knowledge and a decent standard of living. A composite index, the HDI thus contains three variables: life expectancy, educational attainment (adult literacy and combined primary, secondary and tertiary enrolment) and real GDP per capita (in PPP$).

If you construct a water scarcity index by taking the equally widely used first-generation water scarcity index of per capita availability of renewable fresh water, and *dividing* it with the HDI (and some arbitrary but common correction factor) you will get a *Social Water Scarcity Index* (SWSI) which not only would serve to high-light the importance of a society's social adaptive capacity facing the challenges of water scarcity, but also gets rid of some annoying anomalies in that first-generation index.

As an example, the SWSI index will no longer classify countries such as South Korea, Mauritius, Poland, Iran, Cyprus, United Kingdom, Belgium, and Peru as water-stressed. Due to their higher social adaptive capacity (as measured by a higher HDI) they will now be classified as relatively sufficient (at present). Countries such as the United Arab Emirates and Oman will move from water-scarce to "merely" water-stressed. On the other hand countries such as Niger, Afghanistan, Burkina Faso, Eritrea, and Nigeria will move from "relative sufficiency" to "water stress"; and a country such as Ethiopia will move from "water stress" to "water scarcity", in all cases due to their low adaptive capacity as measured by the HDI.

The SWSI also seems to be able to shed some light on the anomaly of Israel being able to maintain a high level of modern society, in spite of both of them being classified as "beyond the barrier" according to the first-generation water-scarcity index. According to the SWSI Israel is "merely" water-scarce, due to its high level of social adaptive capacity. A similar change of category goes for Tunisia, while Egypt is moved from "water scarcity" to "water stress", if you take social adaptive capacity into account.

A comparison of hydrological and social water stress indices

	1995 Hydrological water stress (HWSI)		1995 Social water stress (SWSI)		Rank diff.
Water-stressed or water-scarce countries significantly better off due to surplus in SWSI /HWSI rank:					
South Korea	7	Stress	4	*Rel. suffic.*	+18
Mauritius	5	Stress	3	*Rel. suffic.*	+16
Poland	7	Stress	4	*Rel. suffic.*	+15
Iran	6	Stress	4	*Rel. suffic.*	+15
Cyprus	8	Stress	5	*Rel. suffic.*	+14
United Kingdom	8	Stress	4	*Rel. suffic.*	+14
Belgium	8	Stress	4	*Rel. suffic.*	+14
Un. Arab Emirates	11	Scarcity	6	*Stress*	+12
Peru	6	Stress	4	*Rel. suffic.*	+12
Oman	11	Scarcity	8	*Stress*	+8
Water-stressed or water-scarce countries significantly worse off due to deficiency in SWSI/HWSI rank:					
Niger	3	Rel. suff.	7	**Stress**	-26
Afghanistan	4	Rel. suff.	10	**Stress**	-25
Burkina Faso	4	Rel. suff.	8	**Stress**	-24
Eritreas	4	Rel. suff.	7	**Stress**	-19
Ethiopia	5	Stress	11	**Scarcity**	-18
Selected North-African and Middle East countries:					
Algeria	19	Scarcity	13	Scarcity	+2
Tunisia	23	Beyond	15	*Scarcity*	+1
Libya	90	Beyond	56	Beyond	±0
Egypt	11	Scarcity	9	*Stress*	+3
Israel	26	Beyond	14	*Scarcity*	+3
Jordan	31	Beyond	22	Beyond	+3

TheSWSI, Social Water Stress Index is calculated by simply dividing the traditional hydrological index, HWSI (in hundreds of people per flow unit as recommended in Chapter 2), by the Human Development Index for each country. In order to get the order of magnitude of the numerical value down to that of the WSI, the result is divided once again by a factor 2. The idea is to make the two indices directly comparable. Rank difference is among all 158 countries for which data was available. Improvements in scarcity are *italicized*; deteriorations **boldfaced**.

The SWSI is an example of how the character of water scarcity is changed visibly by employing a more fine-grained perception of what really constitutes the strategic bottle-necks at different stages of the turning of the water screw.

(Source: Ohlsson 1999, *Environment, Scarcity, and Conflict*)

VI. The triple challenge:
– Grow more with less water
– Earn enough to buy more food
– Establish an international order for the right to buy food

A rapidly increasing number of countries now go through a fundamental change in their basic strategy for feeding their populations, from *food self-sufficiency* (being able to grow what a population needs within the border of one's own country), to what euphemistically has come to be termed *food security* (relying on the ability to buy food on the international market). It is a process of change that will place new challenges on the agenda of societies; challenges that ultimately will have to be dealt with on the international level. The gravity of the challenge may be gleaned from the following:

> Events in Europe 1995/96 heralds what may become a serious and recurring problem in the future. As world grain prices escalated in the late summer and fall of 1995, leaders within Europe became concerned that this would translate into rising food prices. In early December 1995, the European Union imposed a wheat export tax of $32 a ton in an effort to arrest the rise in bread prices. In early January 1996, a similar step was taken for barley, the principal feedgrain, to control prices of livestock products. In effect, with these actions a two-tiered grain price system was created in the world: a lower price within Europe and a higher price outside it, where the world's low-income populations live. With the stroke of a pen, the European Union's agricultural policy effectively nullified the positive effects of its international food assistance programs.
>
> (Brown 1996, 113, building on: "Wheat Soars to 15-Year High As Europe Puts Tax on Exports", *New York Times*, December 8, 1995; "EU to Conserve Barley by Curbing Exports", *Journal of Commerce*, January 12, 1996).

Europe, one of the world's net exporters of grain, thus chose to raise barriers against prospective buyers in other parts of the world, in order to keep prices down internally. One of the buying regions at that time was China, who now has entered the community of grain importers, with an unprecedented potential future demand, and the ability of paying the price for their imports.

For societies in regions where water for agriculture is scarce, while present and future demands are growing, the challenge thus is three-fold: i) to grow more from less amount of diverted water; ii) to increase their economic strength in order to be able to buy food; and iii) to gain access to potentially exportable amounts of grain.

1) Grow more food from less water

The first challenge, to grow more food from less water, represents the second turning of the water screw, achieving higher end-use efficiency. Not even considering the other challenges, this one is awesome enough. The technical documents at the FAO 1997 Food Summit summarized the challenge to 2050 in the following terms (FAO 1996):

- Considering only energy requirements, caloric intake in developing countries ought to be multiplied by a factor two.
- Considering only desirable increases of consumption, and taking into account distributional inequality within countries, per capita increases in Africa ought to be 30 percent (40 percent in tropical Africa), 15 percent in Asia and less than 10 percent in Latinamerica.

- Considering only the need for a varied diet (in accordance with the FAO world prognosis for 2010) Africa would need to increase agricultural production a further 25 percent (46 percent for countries with a mainly tuber diet), and Asia a further 21 percent.

Summing up the above (multiplying the different requirements for increases), developing countries as a group would need to increase energy intake from plant growth 174 percent. For Latin America and Asia this boils down to roughly a doubling, while for Africa it mean a five-fold increase (of which countries with mainly tuber diet would need to increase seven-fold!).

For Asia and Latin America this means continued increases, but at a lower rate than what has been experienced during the last fifteen years. Africa would need to increase production drastically. If a demographic transition in accordance with the UN low scenario is accomplished, yearly required increases are restricted to 2.6 percent, against a staggering 3.3 percent according to the UN high population scenario.

Taking Africa as an example, the first tentative conclusion on the first challenge of being able to grow more food is not to divert more water for irrigation from ever more scarce sources, but to effectively utilize the full potential of the mainstay of African food production, rainfed agriculture. (Winpenny 1999, Rockström 1999).

2) Generate the economic strength to make "food security" a viable option

The second challenge, to be able to generate enough economic strength to be able to choose the strategy of "food security", represents the final turning of the water screw, that is, buying food from the world market. Coming on top of the previous challenge, is by itself equally daunting.

True, Japan, Taiwan, and South Korea, in an era of agriculture glut, were able to master this challenge successfully. China, today, has enough purchasing power to be able to out-compete all poor countries. But for Africa, today and during the next decades, the challenge is enormous, as succintly noted by Kijne (1999):

> For Africa prosperous agriculture is the engine without which poverty cannot be reduced, resources cannot be managed sustainably, and food security cannot be assured. Very few low-income countries have achieved rapid non-agricultural growth without corresponding rapid agricultural growth. The key role of agriculture in Africa's economic life is apparent -- agriculture accounts for 35% of the continent's GNP, 40% of its exports and 70% of its employment. Today about 70% of Africa's poor live in rural areas and depend for their livelihoods on agriculture and agribusiness.
>
> With ever-decreasing potential to expand the agricultural area in many countries of SSA, increases in agricultural production will have to come from more intensive use of land. As land use intensifies, fallow periods decline, and cultivation spreads into marginal and ecologically fragile lands. Intensification inevitably leads to degradation of the resource base. There are two types of intensification; that which results from population pressure and that which results from market demand. Farmers intensifying because of population pressure become poorer, affecting the potential for technological change. (Kijne 1999, K-5, K-6, emphasis added)

The problematic process hinted at in the last paragraph is the one identified here with, first, *environmental scarcity*, and then *social resource scarcity*. As per capita allocations of land, and available water, get scarcer, the process of increasing inequalities set in, enabling some to capture larger portions of the scarce resource, while the majority become increasingly ecologically marginalized.

To overcome this requires increased amounts of *social resources*, in the form of, for example, collective work for preventing soil erosion (the famous Machakos case; Mortimore & Tiffen 1994), or in order to harvest rainwater (Rockström & Tilander 1996).

Many authors (for example, Rockström 1999) warn against the danger of ever believing that food-security in the sense of buying food from abroad will be a viable option for Africa. One reason for this is the third challenge:

3) Manage the growing competition for exportable food supplies

The third challenge is that even if the economic strength to buy food from abroad somehow could be mustered in the near future, this option may be rapidly closing during decades to come. The reason is the growing competition for exportable food quantities, as exporting countries may chose to close themselves off from increasing grain prices on the world market. Notes Kijne:

> Africa's ability to earn from exports to buy food on the world market has not improved in recent years. National macro-economic reform can only succeed if there is a response from the world market. How can a country be asked to move from food self-sufficiency to food security if access to the world market is not assured? (Kijne 1999, K-6, emphasis added)

If food-security is not a viable option, what use then of the last stage of demand-side management, “allocative efficiency”?

Although outside the scoop proper of this treatise, the challenge of creating a viable international security regime for the right to buy food on the world market nevertheless emerges from the logic followed here, in particular the last turning of the water-efficiency screw, involving allocative efficiency, dependence on virtual water, and the need for large-scale structural change. It is also a task that lands squarely within the charter of the FAO as a whole.

The case of Egypt – growing food, or growing for jobs?

A very large volume of work exists on the sharing of the water between countries of the Nile Basin, and particularly about the situation of **Egypt** as a downstream country. Here is a short version of that story, concentrating on a single question: Given the large pressure on governments to provide livelihoods (not just food), and the risk for social disruption, is the optimal reallocation of water from agriculture to cities and industries a realistic expectation?

Egypt is import-dependent to 70 percent for food. It is a very high import-dependence – but far from unique. The entire North Africa region and the Middle East has the same degree of import-dependence – and so does Japan, Taiwan, and South Korea, to name but a few.

An often quoted figure is that the region imports food that would require the amount of water in another river Nile to grow. The countries are thus dependent on *virtual water*, that is the ability to buy the food one lacks the water to grow. The entire amount of Egypt’s largest source of foreign income, tourism, goes to food imports.

Egypt is the largest user of Nile water and regularly utilizes the entire amount of water the Nile brings. It is a rare year when the river actually adds any significant amount of water to the Mediterranean. And the country urgently needs to use even more for new irrigation projects. The country thus so far remains caught in the trap of dependence on *supply-side management* through large-scale engineering efforts.

The New Valley land reclamation project in the Western Desert (a “second Nile”) is planned to receive seven million people. Although gigantic, this figure corresponds to less than six years of the country’s projected population increase. A pipeline will carry up to five billion cum of water from Lake Nasser via the Toshkan spill canal to facilitate the construction of new cities and provide irrigation to more than 200,000 ha of desert.

These abstractions will amount to almost ten percent of the flow of the Nile through Egypt, and provide a *source of tension with upstream countries* at a time when all countries in the basin plan to increase abstractions and the flow of the Nile already in many years is fully utilized.

The diplomatic tone of voice between Egypt and Ethiopia in water affairs is extremely bellicose. Ethiopia supplies some 80 percent of the Nile water through Egypt and urgently needs to develop the water resources for its own development. Egypt traditionally maintains a military capability to intervene throughout the entire Nile Basin.

The Ethiopians hold it for a fact that Egypt “is trying to monopolize” the Nile and cite the Aswan dam, the Tochkan canal, and the Peace canal as examples of how Egypt step by step claims a larger amount of the Nile water; claims that may be used as evidence of an “acquired right” in future negotiations. This is the classic upstream-downstream dilemma, unsatisfactorily managed by international law, which has given rise to fears of *water wars*.

The sleeper story here, however, is not that a water war over Nile water is imminent, but the real character of the driving forces for Egyptian (and, for that matter, every Nile Basin state) attempts to aquire more water. Ultimately the need for water stems from the difficulties facing all Nile Basin states during the next decades to *absorb growing populations into the society*.

The battlefield is not necessarily one of getting more *water for irrigated agriculture* (which isn’t available); and not even one of getting enough *water for cities and industries* (which would be possible, since a relatively small proportion of the water used by irrigated agriculture goes a long way to satisfy the relatively small demands of cities and industries).

The burning issue is to find ways of satisfying demands from rising population for better lives through jobs in cities (since agriculture cannot absorb more people, given the non-availability of more water). The bottlenecks of creating jobs in industry (and finding the market for items produced) is the real reason for new irrigation projects.

Egypt is *internally very volatile* with fundamentalist opposition movements and terrorism. Some half of the population in Cairo is under 15 years of age and unemployment is widespread. Nevertheless, Egypt is socioeconomically most developed of the Nile Basin states, with the highest Human Development Index.

At the same time, water issues retain a high position of “life and death” issues in the mind of common people. The legitimacy of any government that is seemed as “giving in” to pressures from abroad will be seriously threatened. Conversely, *water issues may be readily used* for any faction that wishes to mobilize a following against the government.

The gigantic “New Valley” project in the Wester Desert is not only the most sensitive international issue of contention at present; more interestingly, it is also a potentially highly contentious issue in Egypt internally. Egypt maintains that it will be able to save the amount of water needed for the project (some ten percent of its present allocation of Nile waters!) by groundwater abstractions, using existing irrigation more efficiently, reclaiming wastewater, and growing less water-intensive crops than rice and sugar cane.

The groundwater abstractions referred to are examples of the last possible *supply management* measures (getting more water). To the extent that they do not constitute abstractions of seepage into the ground from the river, or from the many dams on it, they will be unsustainable abstractions of fossil groundwater from the aquifer shared with Libya.

Irrigation efficiency and reclamation of wastewater are typical examples of *end-use efficiency* measures (saving water), which is the first step of demand management, coming into play when supply management is exhausted, or nearly so.

The growing of less water-intensive crops would exemplify *allocative efficiency* measures (doing better things with the available water), the last step of demand management. Ultimately this road will entail *large-scale restructuring* from agriculture to industry, which may render some 70 times higher economical value of the production water is used for than agriculture ever will.

The point here is that each and every such step, necessitated by the growing water scarcity, entails high and rising social costs, including risks for *internal conflicts*. Necessary changes in the institutional arrangements for farm-level irrigation will have to include higher water-prices (both in order to recapture the enormous costs involved, and to foster end-use efficiency). As a consequence, they will almost certainly lead to *increased social inequality*, with entailing inequalities in water allocation (by the *resource capture* mechanism associated with environmental scarcities, noted earlier).

But the risk for conflict does not stop here. Ultimately, Egypt may find that the water they are prepared to save in order to facilitate the New Valley project might be better used for creating new cities, adjacent to present population concentrations. Waterbury & Whittington pose the crucial question:

> Would food security be sacrificed by pursuing an urban, industrial economic development strategy instead of expansion of irrigated agriculture? Not really. As Egypt’s population grows, albeit at slower rates, it will have little choice but to import at least half of its food and food-product needs. Increasing its cultivated surface by 15 percent will not make much of a dent in that reality. Egypt’s future has to lie in the non-agricultural sector and the exports of manufactured goods and of services. New cities can be platforms for both. (Waterbury & Whittington 1998)

The authors note that such ordered expansion of settled areas has been going on for the last 100 years in Egypt, minimizing transport costs and disruption of existing patterns of settlement in a way that the New Valley project would not.

Rather than distant and costly satellite colonies scattered across Egypt's desert hinterland, the authors envisage "new contiguous layers adjacent to the zones of traditional settlement". Such settlement expansion need not be dependent on agriculture, and the water intended for the New Valley project would be sufficient to support over 650 new cities of 200,000 inhabitants, with at total population of over 130 million people.

This is exactly *large-scale structural change* necessitated by *allocative efficiency*, the last stage of *demand-management*. It is a good example of a case where the combined logics of constrained water supplies, continuing population increases, and just demands for better lives end up: In gigantic challenges for the *capacity of the state to undertake structural change*.

The fact that Egypt instead seems to be set on carrying out the New Valley project, at almost any internal and international cost, could be taken as corroboration of the enormous difficulties of even contemplating the most rational solution. The end result of these difficulties may be an ultimately *less than optimal use of the scarce water resource*, necessitated by the bottlenecks of *social resource scarcity*.

(*Source*: Ohlsson 1999, Environment, Scarcity, and Conflict)