On the Verge of a New Water Scarcity

In spite of the fact that physical water scarcity is a dire reality for millions of people, it is still not properly understood nor recognised in many front-line discussions. An unfortunate confusion regarding growing physical water scarcity distorts policy formulation and effective action programmes. The scale and magnitude of the challenge imply that "water scarcity is everybody's business." This policy brief, "On the Verge of a New Water Scarcity: A Call for Good Governance and Human Ingenuity," looks closer into the issue, offers a set of distinctions and concludes with structured policy suggestions.

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A policy brief for central governments in developed and developing countries, sub-sovereign national bodies, universities and research institutes, community organisations, banks and private investors, aid donors, multilateral financial institutions, UN agencies and other international organisations.

On the Verge of a New Water Scarcity

A call for good governance and human ingenuity

SIWI

Note to the Reader:

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Confusing Debate – Back to Basics

Is physical water scarcity an overlooked problem?

The 2006 Human Development Report, "Beyond Scarcity: Power, Poverty and the Global Crisis," (United Nations Development Programme 2006) considered water scarcity from two points of view: (1) as a crisis arising from a lack of services that provide safe water and (2) as a crisis caused by scarce water resources. It concluded that the world's water crisis is not related to the physical availability of water, but to unbalanced power relations, poverty and related inequalities.

The focus now being placed on the importance of governance makes clear the importance of issues such as unfair power structures, and weakly defined roles, rights and responsibilities. These, it is felt, exacerbate natural water scarcity. This way of thinking has been useful in that it has increased our understanding of the need to *manage demand* as well as to *increase supply*.

However, while governance remains a key challenge, we also need to better understand the issue of 'water crowding' – as increasing pressure is being placed on finite, erratically available and vulnerable water resources. Recognising this is the key to proper policy formulation.

Rather than addressing management/governance problems, many countries still instinctively reach for supply-side solutions such as desalination or the use of reservoirs and other large-scale infrastructure. Such an approach is often the most politically feasible option within the context of a country or region's water problems.

In certain situations, supply-oriented approaches are of course needed. However, the sensible approach to greater physi-

Recommendations for Policy Makers

- Before attempting to boost water supplies, decision makers should first seek to better manage demand. Ways forward include decreasing losses in water supply and irrigation systems, cutting subsidies to agriculture, and putting in place realistic water-pricing measures.
- When water scarcity is population-driven and demand management in place, policy decisions on reallocation of water resources need to be taken.
- Forward planning is essential in areas where water scarcity is caused by seasonal changes and year-to-year variation. This means taking action to store water and food in good years.
- In arid areas where not enough rain falls, policy should promote efficient farming practices that make the most of all available water.
- On a global scale, policy decisions which reduce food losses should be taken.
- Policy makers must ensure that water governance is flexible enough to make the best possible use of all the water resources accessible.
- Stricter controls need to be put in place to curb water pollution, as this will make more clean water accessible to users.

For a fuller discussion of the recommendations, please see page 14.

cal water scarcity is to adopt a range of demand-management measures before undertaking supply-side solutions. Examples of such management measures would include decreasing water losses in systems, reconsidering the volumes of water allocated to agriculture, and reducing water losses from soils.

The World Bank is presently raising people's awareness of the increasing levels of water scarcity being seen in the Middle East-North Africa (MENA) region (World Bank 2007). This problem will only worsen as competition for limited or degraded resources intensifies. In fact, up to two-thirds of the world's population will be affected by water scarcity over the next few decades (Rijsberman 2006). But, improved water governance and demand management could effectively address many of the water scarcity problems faced by various regions – including MENA.

Massive global change is adding new dimensions

Various global changes are affecting water scarcity. Climate change is influencing the physical availability of water. So too is the massive increase seen in the world's population, and the growth of the water-hungry bioenergy sector, which is being driven by our awareness that oil stocks are limited.

Physical water scarcity will involve massive challenges for the developing countries located in semiarid regions, as these have to cope with rapidly expanding populations, and the need to eradicate poverty and improve people's quality of life. So, to what degree might water scarcity delay the socio-economic development of such countries? Examples such as Israel (which lives with a high level of water shortage) suggest that water scarcity does not in itself have to limit economic growth. In fact, Israel has overcome this issue using methods which take us somewhat outside the water sector – demonstrating that economic diversification and the ability to adapt socially can overcome issues of water availability *per se* (Allan 2001).

However, in many poor developing countries, agriculture is the backbone of development and poverty reduction efforts – and such agriculture is a large-scale consumer of water. It also needs to be remembered that, while physical availability is to a large degree a product of climate, demand is dictated by the size of the water-dependent population, the sectors of society competing for it, and the level of water productivity that has been achieved.

Climate change may make water-short regions even more water-short

On a global scale, climate change will probably increase precipitation on average – though it is difficult to predict this accurately or incorporate it into future water scenarios (Alcamo et al. 2000). However, the dry subtropical zones like MENA are likely to become even drier. It's also thought that, worldwide, population growth and economic development will cause greater water shortages and water stress than climate change alone (Vörösmarty et al. 2000; Wallace 2000).

We can't be certain how much warming to expect in different regions. However, we do know that, as the climate becomes more

Photo: Mats Lannerstad

variable, both droughts and floods will become more common. Brown and Lull (2006) recently suggested that water scarcity due to average hydroclimatic conditions should be addressed through water management and institutional measures ('soft' methods), while scarcity due to variability will often require the construction of additional storage ('hard' methods).

Time to prepare for multiple water scarcity?

We are on the verge of a new and more serious era of water scarcity, and it is clear that we will face increasingly complex challenges. Water supply to different sectors will become more challenging as supplies of *blue water* (e.g. water in rivers and aquifers) become overstretched, while a scarcity of *green water* (e.g. water in the soil) will limit food and biomass production. Evidently water governance will have to be flexible enough to allow the best possible use to be made of all the water resources available.

Water professionals, policy makers and politicians need the answers to a range of key questions. Will water scarcity ultimately stall economic development? How large will the food production problems be? How can different sectors' competing needs for water be managed? Through 'more crop per drop' approaches and 'more money/value per drop' approaches? What barriers will obstruct efforts to manage demand? By how much can water productivity realistically be increased? How could changing consumption patterns affect water scarcity? What regions will suffer food production problems as a result of water shortages? What are the prospects for food trade and thus a trade in the 'virtual water' needed to produce that food? And, how will the massive global changes that are expected to occur influence future water scarcity?

Water Deficiency – Symptoms and Scale

Scarcity of what?

Experience suggests that water scarcity complicates economic development and limits the amount of food that can be produced. But, what is 'water scarcity' exactly? Is it simply the fact that there is not enough water?

Water scarcity does not only result from a physical lack of water. It is often also a sign of difficulties in mobilising more of the freshwater resources available. Such difficulties include cost, infrastructure-related challenges, and the size of the population competing for the resource. Lack of social resources can also act as a bottleneck, preventing the water that is available from being efficiently mobilised and used (Ohlsson and Turton 1999).

Lack of water in relation to water requirements is another issue that needs to be addressed. This can be caused by increases in demand, droughts, land degradation, population growth, pollution, emerging sectors of additional demand, etc.

Soil water deficiency has limited rural livelihoods in rainfed regions

The fresh water available to us is provided by rainfall, which should therefore be considered the ultimate water resource. In that sense, water availability is to a large degree climate-controlled. Water in the soil (*green water*) is formed by infiltrated rain, and water in the rivers and aquifers (*blue water*) by the rainfall that escapes evaporation. Areas vulnerable to water scarcity are primarily low latitude areas where the water evaporates very quickly (Fig. 1).

Insufficient soil water (green water scarcity) can lead to crop failure, hunger, starvation and under-nutrition. As a result, the problems of poverty and hunger tend to be largest in arid regions with a savanna-type climate, as characterised by unreliable rainfall, monsoons and high evaporative demand (Fig. 2).

Blue water scarcity – growing competition for water in rivers and wells

The symptoms of blue water scarcity are different from those of green water scarcity. Blue water scarcity can lead to water supply collapses, crop failure in irrigated fields, the closure of river basins, and increased infrastructure costs (to make more water accessible for economic use). Other symptoms include stakeholder disputes and higher levels of water pollution (because less water is available to dilute contaminants).

Consumptive/depletive uses of water contribute to blue water scarcity (Lannerstad 2002; Falkenmark and Lannerstad 2003). Cropping is one example of such a consumptive use, because water is lost through evapo-transpiration. Such consumptive use has been expanding, and in many regions no more surplus water is available. This means that, as populations continue to grow, more pressure will be placed on the blue water resources available – as there will be more people sharing each flow unit of water.

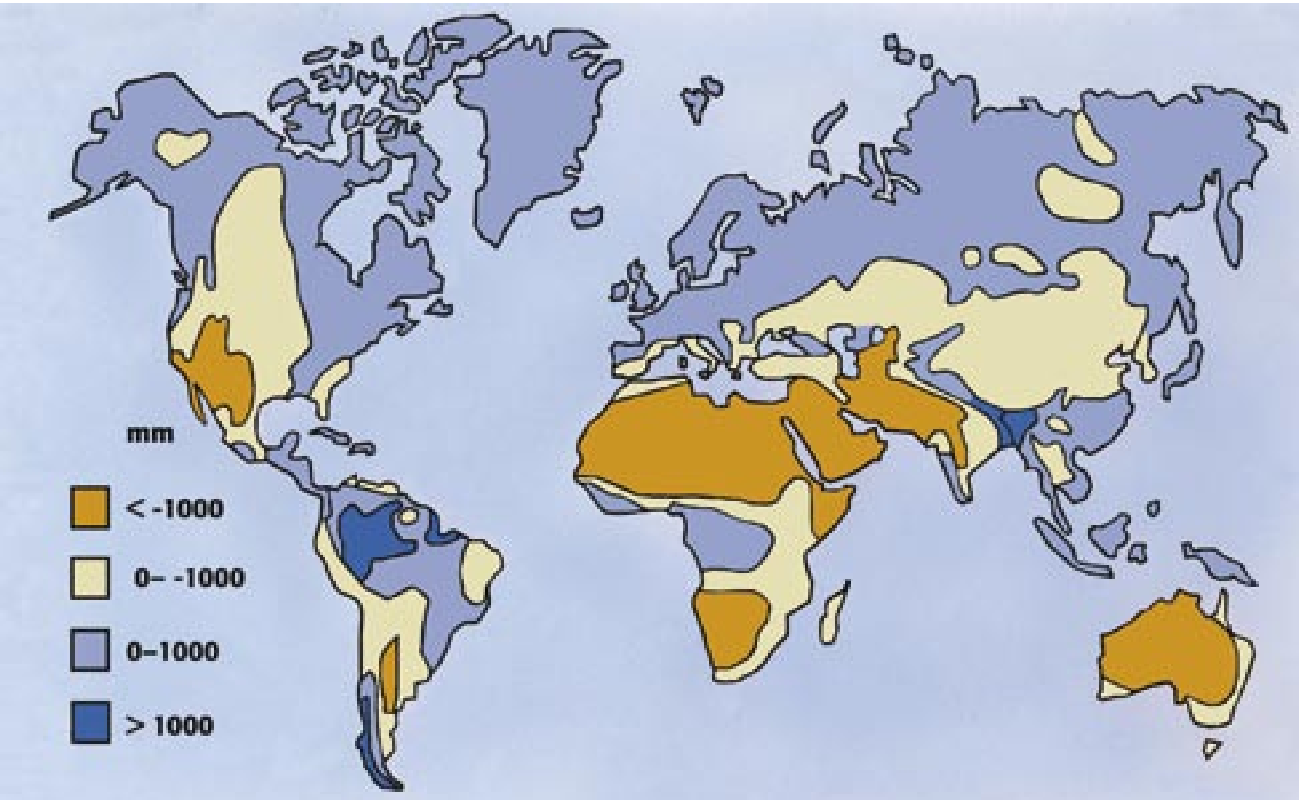


Fig. 1. World hydroclimate shown as the surplus of annual precipitation over evaporative demand. Red colour indicate arid climate.

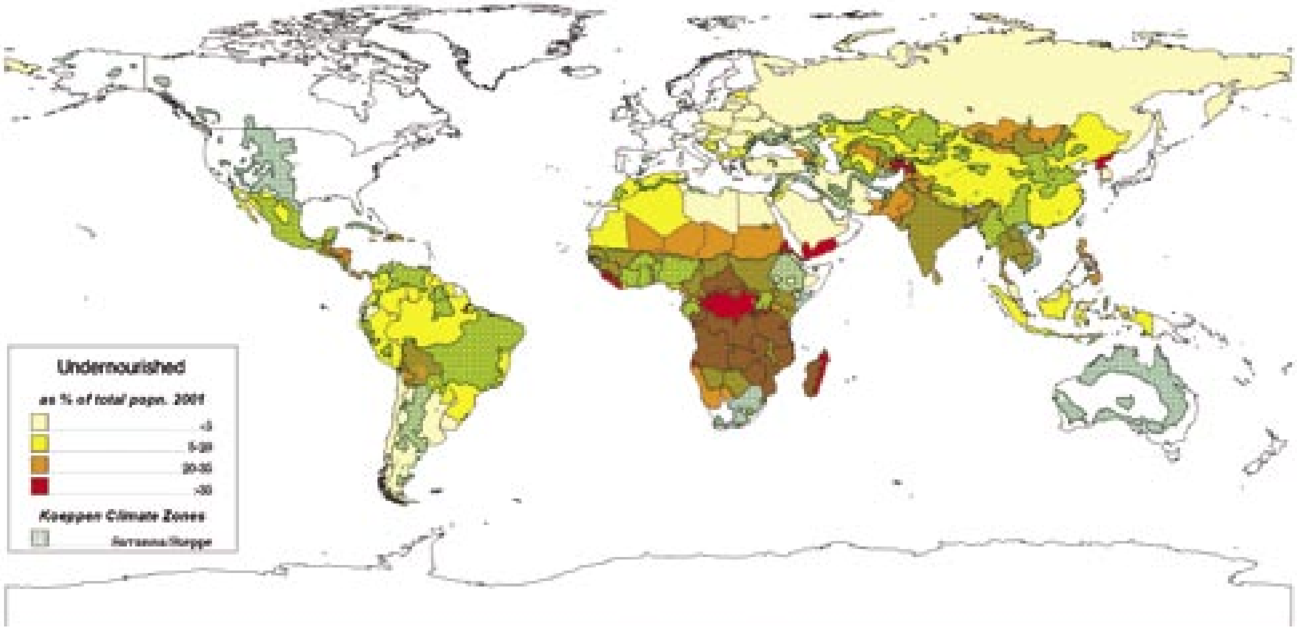


Fig. 2. Undernutrition is to a large degree concentrated in the region with savanna and steppe type hydroclimate.

Many rivers are already going more or less dry before they reach their outflow (known as *closure*). Environmental disasters like the drying of the Aral Sea may therefore be duplicated in many regions unless the problem is properly analysed and countered. At the Third World Water Forum in Kyoto, the International Water Management Institute, World Conservation Union and World Resources Institute jointly presented a map showing that too much water was already being removed from rivers in a broad belt stretching from north east China to Mexico and the south west USA (Smakthin et al. 2003).

In terms of the number of people who will be affected by blue water scarcity in the future, predictions do vary (Oki and Kanae 2006)– as seen in Fig. 3, which compares different scenarios of climate change and population growth. By 2075, the number of people in regions with chronic water shortage are estimated to be between 3 and 7 billion; those in regions with high water stress between 4 and 9 billion, depending on the scenario. The combination of massive population growth and climate change foreseen cannot therefore be ignored.

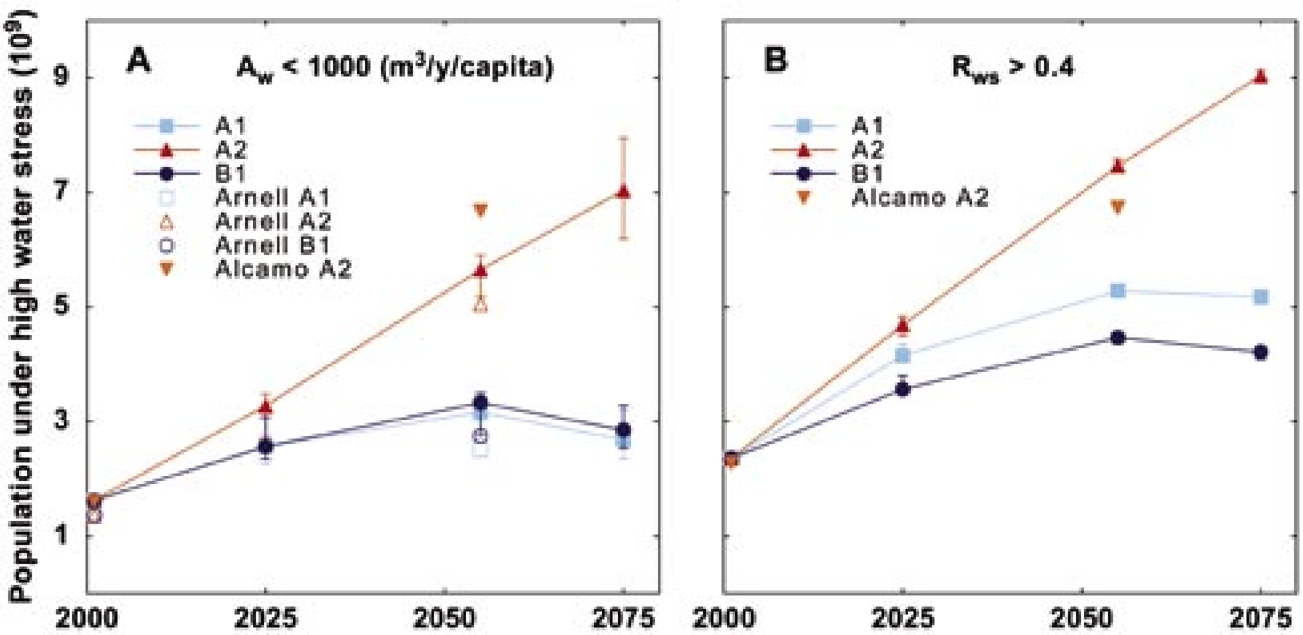


Fig. 3. Current and future projections of the number of people (in billions) living under conditions of chronic water shortage (left) and high water stress (right) under six different climate scenarios (A1 to Alcamo A2). From Oki and Kanae 2006.

Causes, Prospects, Implications

Water for plants and water for people

As already noted, the term 'water scarcity' can refer to both a scarcity of water in rivers and aquifers accessible for direct use (blue water), and to a scarcity of water in the soil for crop and bioenergy production (green water). Both of the problems can be either *climate-driven* or *human-induced*.

Water scarcity can roughly be divided into two categories:

> "Apparent" – when there is plenty of water, but it is perceived to be scarce because it is being used inefficiently and wastefully with many losses.
>
> "Real" – when insufficient rain is falling or because a large population is having to depend on a limited resource. These are the situations seen in arid climates and closing river basins.

In addition, water scarcity can also be categorised as 'temporary,' when it occurs for only part of the year as a result of the variability or seasonality of the water resource.

Green water scarcity – the classic cause of famines

Green water (the water in the root zone of the soil that controls plant growth) can be scarce for several reasons. Some of these reasons are climate- and soil-related, while others are related to people's activities. Reasons include:

- Too little rain to allow plant production
- The evaporation of all rainfall, leaving soils dry
- Problems with infiltration, so that rainfall runs off the soil's surface and doesn't soak in
- Soils with poor water holding capacity, which means that water percolates through the soil into the groundwater.

Green water scarcity occurs in different areas for different reasons, as shown by the maps of Africa provided in Fig. 4 (Falkenmark and Rockström 1993). It can, for example, result from natural causes such as arid climate and a high evaporative demand in an area, which results in very little surplus being available to infiltrate the soil. It also occurs naturally in areas with a monsoon climate, where rain falls at particular times of the year (map 2). This typically occurs in the Sahel region and in southern Africa for instance. However, it can also be caused by people's activities, as causing soil degradation (e.g. soil compaction), that can prevent water soaking into the root zone of plants (see map 4).

Blue water scarcity is indicated by map 5, showing the limited amount of runoff generated (centimetres per year). Map 3 shows the climate variability in terms of drought frequency linked to El Niño and other atmospheric disturbances.

The congruence between the zone with severe famine during the 1984-85 drought (map 1), green water scarcity (maps 2 and 4), blue water scarcity (map 5), and drought vulnerability (map 3) suggests that a complex water scarcity situation severely complicates both local food production and other kinds of economic development in the rural parts of Sub-Saharan Africa.

Photo: Annika Börje, SIWI

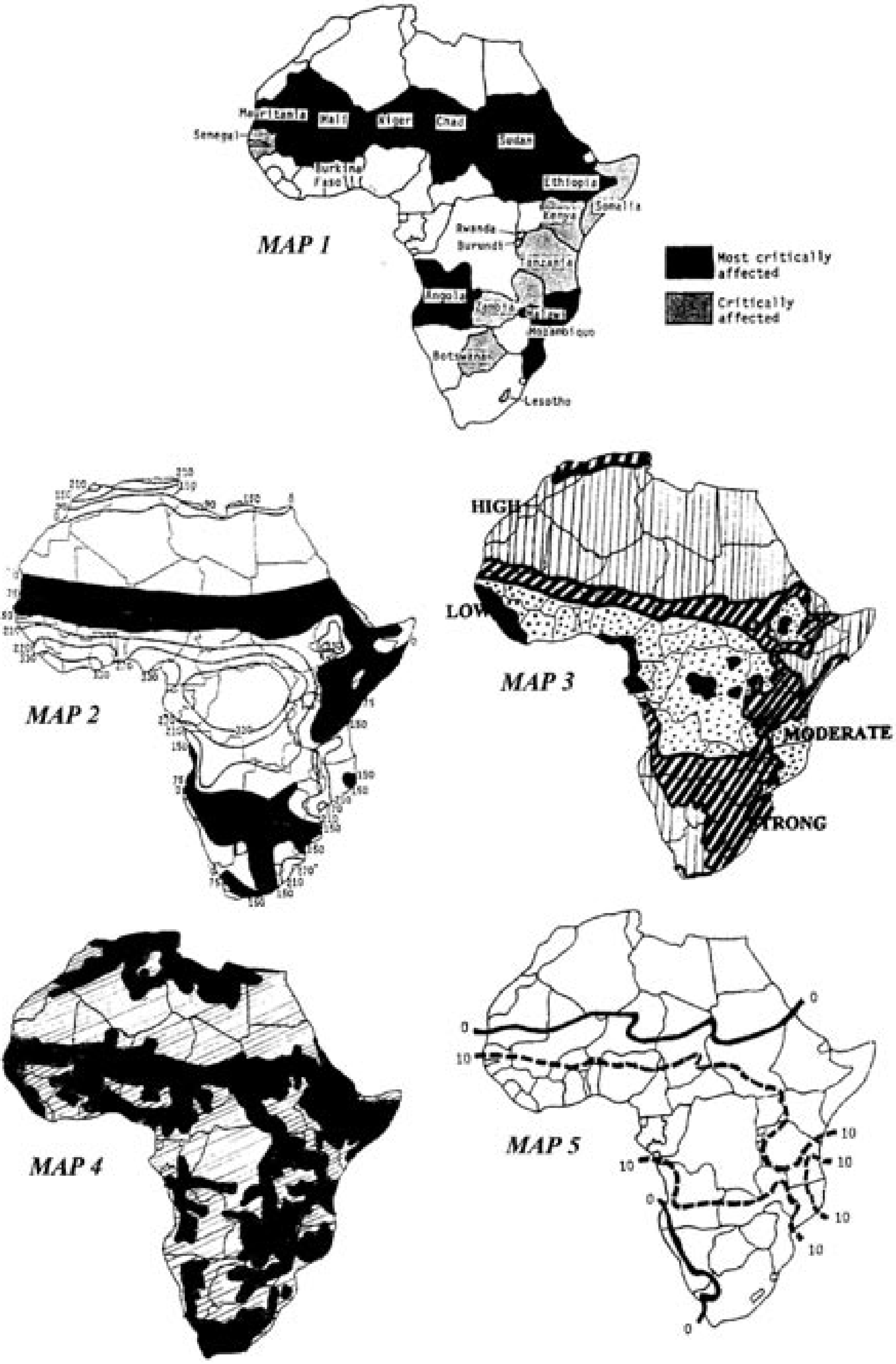


Fig. 4. Linkages between Sub-Saharan famine during the 1984-85 drought (map 1) and complex water scarcity situation, composed of both green water scarcity (maps 2 and 4) and blue water scarcity (map 5). From Falkenmark and Rockström 1993.

Photo: Mats Lannerstad

Apparent versus real blue water scarcity

The causes of blue water scarcity can be divided into four categories:

Demand-driven blue water scarcity – when demand is high in relation to the amount of water available

Population-driven blue water scarcity – when high population levels place pressure on the amount of water physically available, leading to per capita water shortages.

Climate-driven blue water scarcity – when insufficient rainfall means limited runoff (see Fig. 4, map 5)

Pollution-driven blue water scarcity – as water quality can degrade to the point that it is unusable

The concepts of demand-driven 'apparent' scarcity and population-driven 'real' water scarcity tend to dominate debates on blue water, as discussed below.

Demand-driven apparent scarcity can be measured by examining how much water is being withdrawn from rivers and aquifers (known as the *use-to-availability* indicator). In line with this, in its 1997 Comprehensive Assessment of the Freshwater Resources of the World, the UN set the withdrawal of 40 percent of the resource as the line that distinguished the situation of 'high' water stress from that of 'low-to-moderate' water stress.

Population-driven 'real' water shortages are related to the number of people that have to share each unit of blue water resource (known as the *water crowding* indicator). Nearly two decades ago, it was observed that population levels higher than 1000 people per flow unit of the resource (1 million cubic meters per year) indicate chronic water shortages (Falkenmark 1989).

Techniques to improve water productivity have improved over the last 20 years, so these figures probably need to be revised upwards now. However, they remain useful, and are still widely used in campaigns to raise awareness of water scarcity – because they are simple and easy to understand (Rijsberman 2006). Plus, combining the two indicators (*use-to-availability* and *water crowding*) gives us an idea of the degree of blue water scarcity in a country or basin (see Fig. 5).

The figure also shows the number of people in the different water scarcity intervals according to Falkenmark and Molden (2007). Altogether 1.4 billion people live in overexploited river basins in the sense that more than 70 percent of the resource is already being allocated – the remaining 30 percent should have been saved for the aquatic ecosystems (the so-called

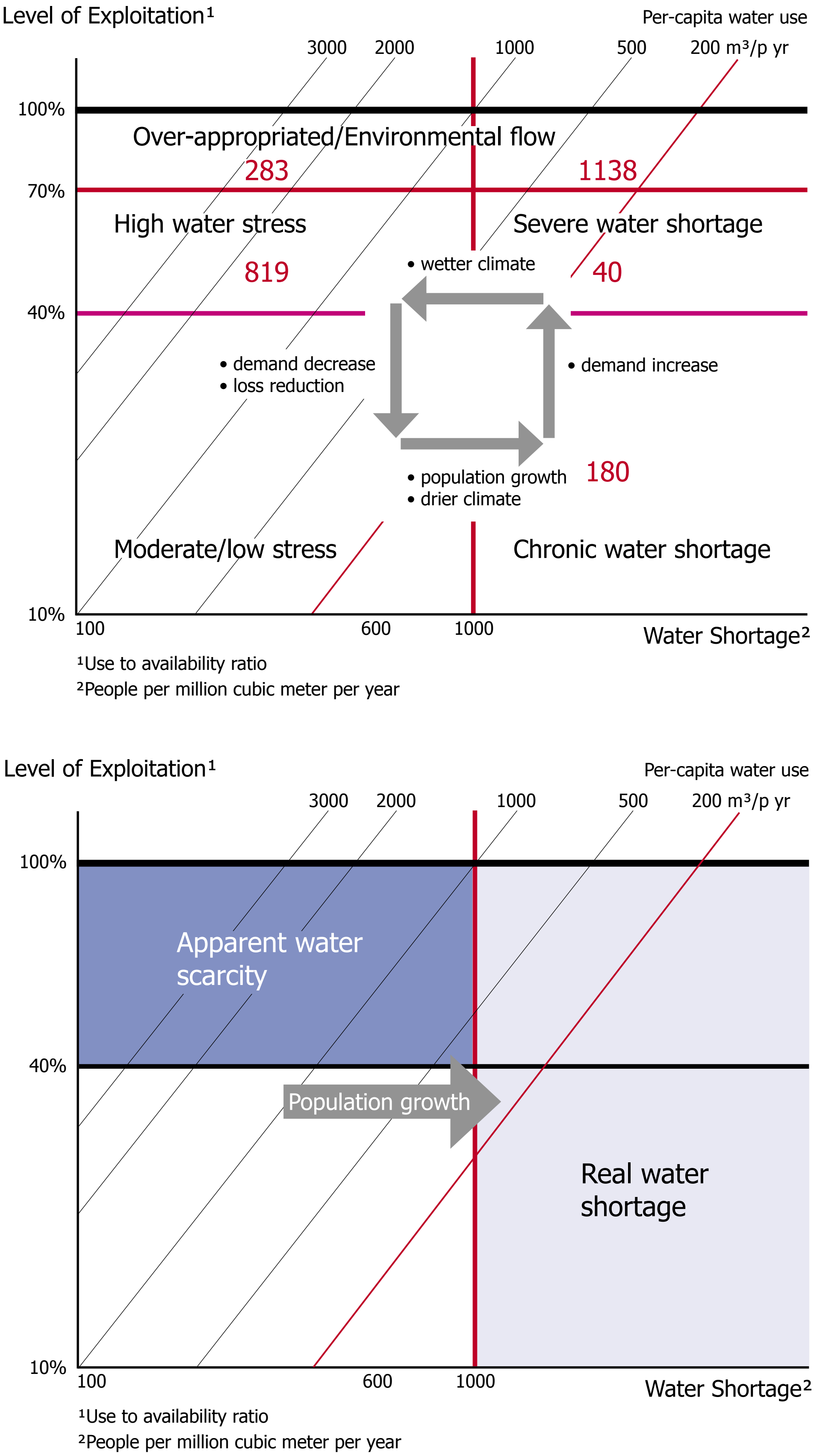


Fig. 5. Two types of blue water scarcity with their indicator intervals. (Logarithmic scales on both axes.) Diagonal lines show per capita water use. Top figure: The grey arrows indicate how the position in the diagram would change with demand reduction or increase, population growth, and climate change. The red numbers indicate population in millions (from Falkenmark and Molden 2007). Bottom figure. Clarification of the differences between apparent water scarcity and real water shortage.

environmental flow). Most of these 1.4 billion are in fact in basins with severe water shortage.

Wasteful use or large population? Blue water examples

If water scarcity is caused by large water losses or highly wasteful water demands, addressing it can be fairly straightforward. Based on river basin data from the International Food Policy Research Institute (IFPRI), Fig. 6 shows a number of river basins in China (blue), India (green), Africa (red) and the USA (black). The Chinese basins are reported to face only a moderate level of demand (500 m³ per person per year). Per person per year use in India and the USA, however, is much higher (700 m³ and 1000-3000 m³, respectively). This indicates that in India and the USA people are using water wastefully, a situation that could be addressed by demand management.

As populations grow, so too will the demand for water. Because only finite amounts of blue water are available, there is a limit to the amount that can be used for irrigation. Once that threshold is reached, any extra agricultural activities will have to rely on rainfall.

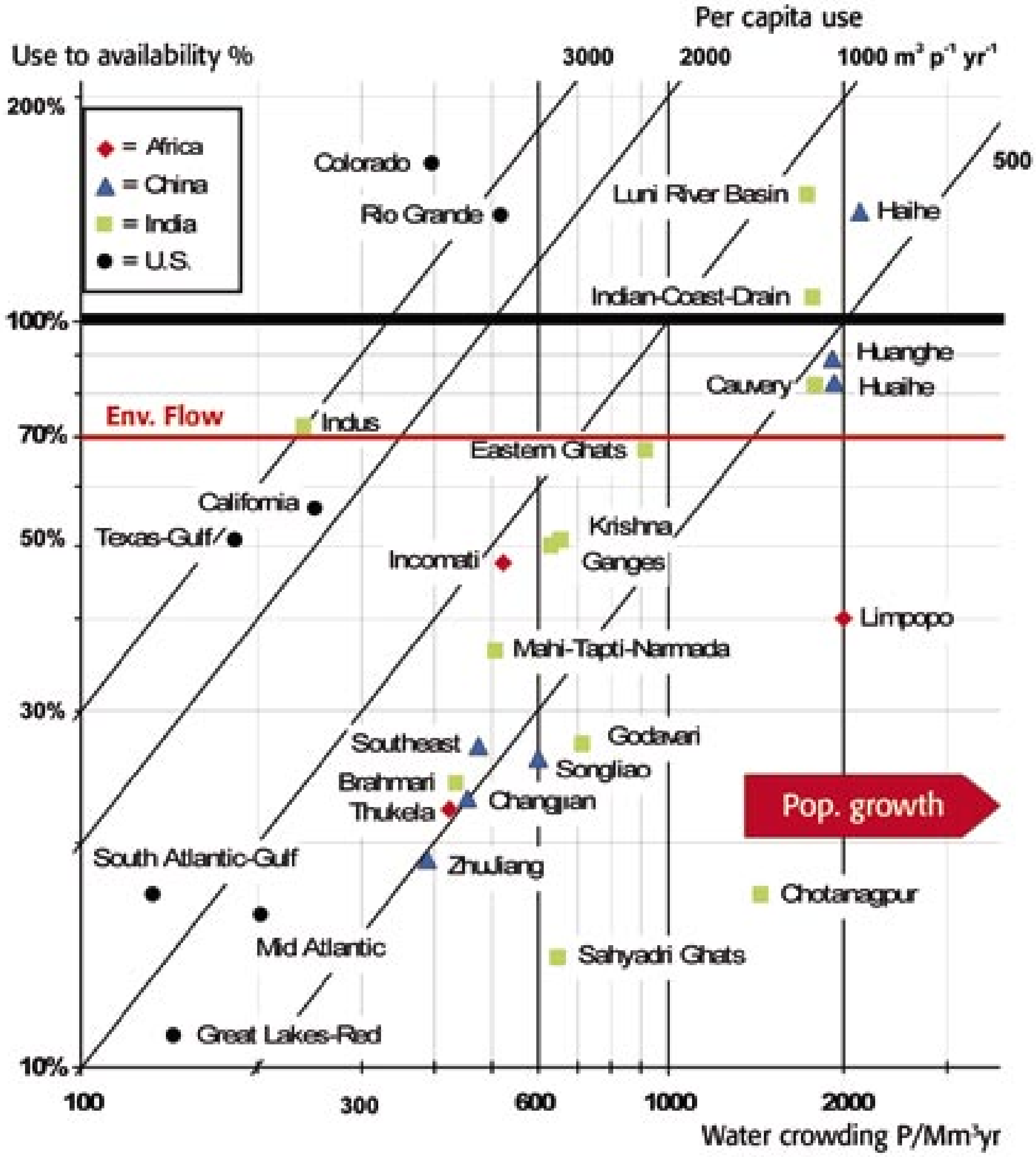


Fig. 6. Diagram relates “withdrawal to availability ratio” in percent (vertical axis) and “water crowding” in people per flow unit of 1 million m³/yr (horizontal scale) for a number of river basins. Diagonals show per-capita water use. Beyond 70% withdrawal level basins are closed and no degrees of freedom are left. (Adapted from Falkenmark and Lannerstad 2004. Data: China, India and U.S., year 1995, data source IFPRI (2002). Africa, recent years, various data sources.).

Photo: Manfred Matz, SIWI

Apparent green water scarcity

Apparent green water scarcity is also a problem, particularly in the semiarid tropics, again as the result of large water losses. Figure 7 shows a situation typical of smallholder farming in the semiarid zone of sub-Saharan Africa (Rockström and Falkenmark 2000). On this smallholding, rainfall actually provides about 90 percent of the crop's water requirements. However, only about 1 ton per hectare is being produced (shown in the red square), because 60 percent of the water that falls is lost.

Poor infiltration is one cause of this water loss, as some of the rain runs off in flash floods. The poor water holding capacity of the soil is another, because the water that does infiltrate it is not held in the root zone. Instead, it percolates through and gathers as groundwater. And, these problems are compounded by the fact that dry weather has dam-

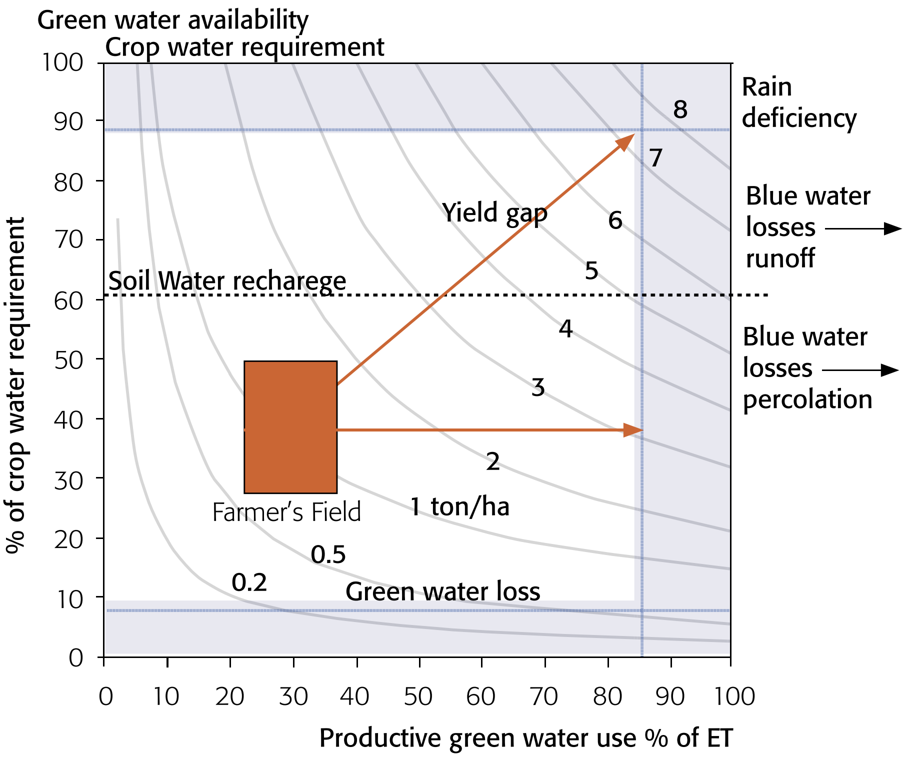


Fig. 7. Water deficiency and losses for a typical smallholder farmer in semiarid Africa. The arrow indicates the gap between current yields (the small square) and potential yield without water losses. Adapted from Rockström and Falkenmark 2000. ET = evapotranspiration.

aged the roots of the farmer's plants – limiting their ability to take up water. As a result, a lot of water simply evaporates from the soil without benefiting the farmer.

All of these water losses could be avoided by applying some simple management techniques. Soil conservation measures, for example, could be used to improve infiltration and the water holding capacity of the soil. Similarly, dryspell-related root damage could be avoided by protective irrigation using locally harvested and stored rainwater – which could boost yields to 3 tons per hectare. Plus, if all run off could be avoided it might be possible to increase the farmer's yields to 7 tons per hectare if the soil is not nutrient-deficient. However, stopping all run off might lead to conflict with downstream users who rely on it as a water supply.

Meeting exploding water requirements for food and bioenergy

Food. As populations increase, more food will have to be produced using both rainfed and irrigated agriculture. But, because blue water resources have been overused in many countries, irrigated agriculture will only be able to contribute a limited amount to this, especially if a minimum amount of water is allocated to protect and support aquatic ecosystems.

Researchers recently calculated the amount of water that crops will require by 2030 and 2050 in order to alleviate hunger in 92 developing countries (see Fig. 8). They concluded that blue water resources will only be able to supply around 15 percent of the amount needed (Rockström et al. 2007). Most will have to be met by rainfed agriculture – which means reducing the huge water losses currently occurring (see Fig. 9).

The study also concluded that for developing countries to become self-sufficient in food production based on current practices, their cropping areas will have to expand by 50 percent by 2050. Of course, doubling the cropping area is not the only way forward. As well as trading for food with better water-endowed regions, such countries could also reduce post-harvest losses, and ensure that food is better distributed throughout society.

A recent global study on economically driven diet changes stresses that a rise in food production is not necessarily related to a greater use of water. The potential for such *decoupling* does exist. In fact, one recent study showed that reducing post-harvest losses by 50 percent might vastly reduce or even negate the need for additional water to grow more food (Lundqvist et al. 2007).

Bioenergy. Future water requirements will also increase because there is likely to be a huge demand for biomass for energy production. In fact, it is estimated that the amount of additional water required for bioenergy production will be of a similar order of magnitude to that required by the agricultural sector (Berndes 2002).

There is no way to determine exactly how much biomass will contribute to energy supply in the future. It has been estimated, however, that somewhere between 3900 and 12,000 km³ per year will be needed – a figure that already excludes those food crop residues that could also be used (Lundqvist et al. 2007). If 15 percent of this water were to be contributed by irrigation, the demand for blue water would rise by another 1200-3500 km³ per year.

Also the use of food crop residues as bioenergy is a difficult issue, as such residues are also used to add organic matter to soils. This is particularly important in the case of vulnerable tropical soils. If all post-harvest residues are used to produce bioenergy, there will be nothing left for soil amelioration.

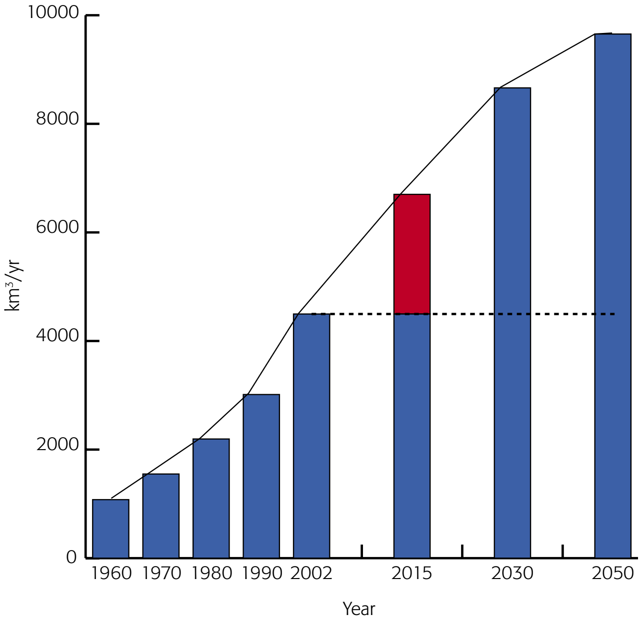


Fig. 8. Water requirement (present water productivity levels) to produce a standard supply of 3000 kilocalories per person per day (20% animal protein) in 92 developing countries to first achieve the 2015 Millennium Development Goal target, and then eliminate undernutrition. From SEI 2005.

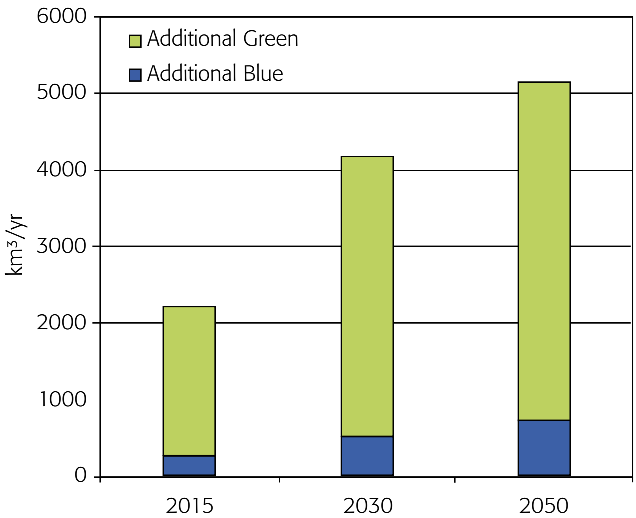


Fig. 9. Blue and green water contributions to hunger alleviation. From SEI 2005.

Policy Responses for Coping with Growing Water Scarcity

Water scarcity categories differ in terms of typical policy response

This section will identify some of the main policy approaches available to combat water scarcity, and will consider both *blue* water scarcity (relevant to conventional water uses such as domestic water supply, industry, irrigation and wastewater dilution), and *green* water scarcity (relevant to cropping, forestry and the production of food).

It must be remembered here, however, that blue water scarcity can be either *demand-driven* (use-to-availability) or *population-driven* (water crowding). *Demand-driven water scarcity* refers to situations involving large-scale water losses or highly wasteful water use, and can be applied to both blue and green water. *Population-driven water scarcity*, on the other hand, occurs either naturally because resources are lacking due to climatic conditions (causing most rainwater to evaporate, for example), or as a result of human actions that lead to consumptive water use and cause rivers and aquifers to become depleted (often as a result of ineffective irrigation). It can also result from high population pressure (*per capita*-related water shortage).

Water scarcity can also occur temporarily. Such *temporary* scarcity results from climatic variation (as there are practically no years with 'normal' rainfall and streamflow). It may also occur where river basins are closing, where dry season flow has vanished in response to depletive water use (mainly irrigation).

Demand-driven blue or green water scarcity can be addressed by putting in place measures that bring down water demand. Examples of such include the use of economic 'disincentives' like lowering the subsidies available for irrigation, which encourages more productive water use.

When water scarcity is population-driven, and in those cases where demand management is already in place, society has to adapt by reallocating resources, avoiding unnecessary water demands, and finding alternative ways of meeting the needs of the water-dependent sectors of society. This means, for example, the use of desalination, the importing of water and food, and the harvesting of rainwater. When water scarcity is temporary and linked to seasonal changes and climatic variation between good years and bad, the natural solution is to "take out insurance" through steps such as storing water and food.

Photo: Mats Lannerstad

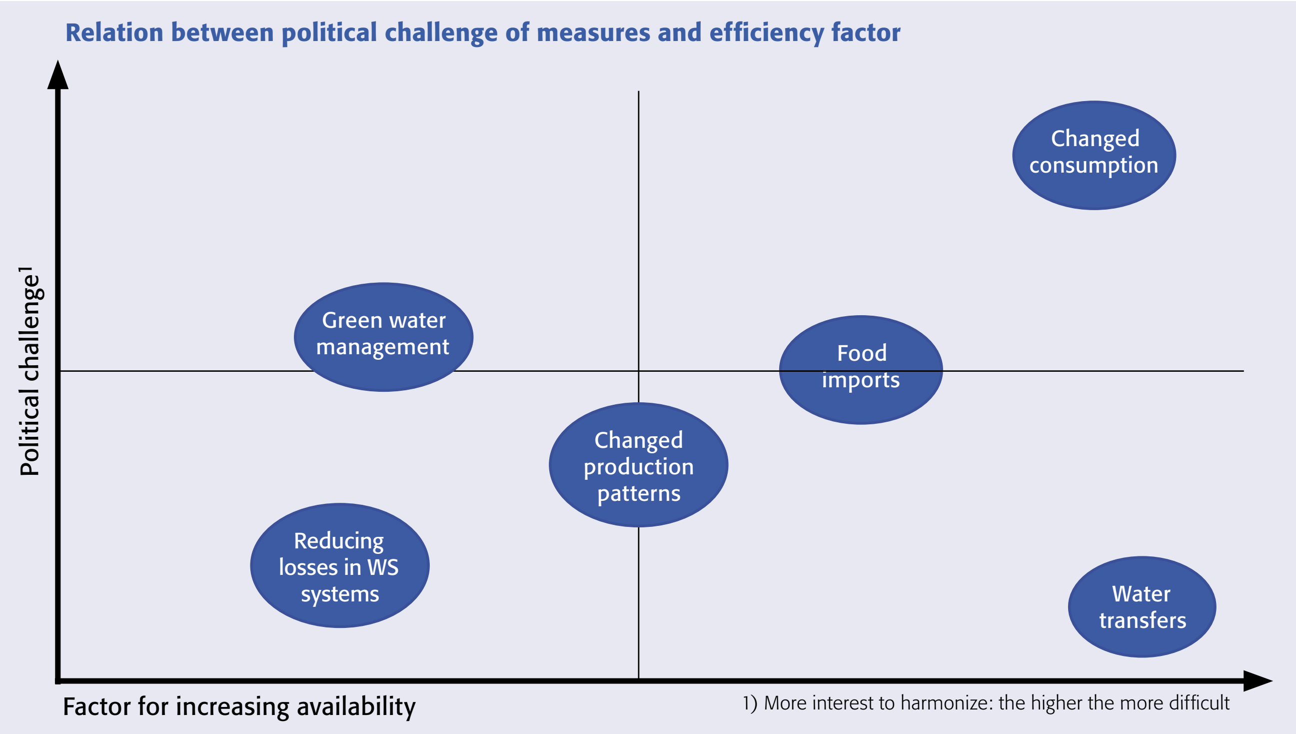


Fig. 10. Different measures for increasing water availability, in terms of their efficiency and the political challenge associated with their use. The political challenge increases from the bottom to the top of the scale, because there are more interests to harmonise, and thus the measures are more difficult to implement. WS system = Water supply system.

It must be recognised, however, that policy makers are not always in a position to simply choose the policy option they think most rational. The political context in which they work largely determines what is politically feasible. Figure 10 highlights some key governance options and indicates how easy or difficult they are to implement. It represents the situation in a specific country. However, it can be adapted so that it reflects the situation in other countries – providing decision makers with an analytical tool they can use when developing an approach for improved water management. In this way, it should help the user identify the easiest-to-implement and most efficient measure that does not compromise economy and ecology, as this is the measure that should be prioritised.

Overcoming blue water scarcity through demand management, reallocation and water imports

Demand-driven blue water scarcity can be overcome by, for example, reducing wasteful water use, cutting leaks in water supply systems and losses in irrigation systems, and by reducing exaggerated household water use and pollution (which frees up more clean water).

Population-driven blue water scarcity, on the other hand, is typically met by reallocation, raw water transfers from other basins, the desalination of sea water, the use of groundwater through pipelines, and bulk water imports.

Temporary blue water scarcity, by the same token, is best tackled through water storage, resource allocation, rainwater harvesting and the use of terracing in irrigated agriculture.

Policy makers need to be aware that a step-by-step approach should be taken when adopting the different policy measures needed to meet blue water scarcity. An example of such an approach would involve focusing first on *managing demand*. This can be done by decreasing subsidies to agriculture, putting in place realistic water-pricing measures, and reallocating water to sectors which give higher economic returns per water unit used. Other methods include supporting more efficient agricultural techniques such as drip-irrigation and greenhouses for local food production (as these minimise evaporation losses), and relying more on virtual water imports.

Increasing supply (the second step) should only be undertaken after strict demand-management measures have been implemented. Once this has been done, however, methods such as desalination and bulk water imports can be used to increase the amount of water available.

Overcoming green water scarcity through increasing water productivity, land care and food imports

Tackling 'apparent' green water scarcity

When green water scarcity occurs despite the fact that sufficient rain is falling (known as *apparent green water scarcity*), it is the result of soil problems related to infiltration, land degradation, crusting and a poor organic matter content.

The obvious action in such cases is to implement soil conservation measures such as conservation tillage in tandem with mulching (to improve the soil's water holding capacity). Terracing and the building of 'diguettes' (stone mounds) along contour lines will also help to slow water running overland, resulting in more infiltrating the soil. In semiarid regions where intermittent dryspells damage the roots of crops, protective irrigation using water gathered through local water harvesting and stored in farm-scale water tanks can improve yields considerably, especially when adequate amounts of fertiliser are provided. In regions where smallholder farming is practised, extension services will play a fundamental role in encouraging farmers to use such techniques.

Tackling 'real' green water scarcity

Where green water scarcity is 'real' and the result of aridity and lack of rain, crop and vegetable production will have to rely on irrigation. Policy measures to combat such problems should include the promotion of efficient farming practices, and measures that encourage people to waste less food and to eat less water-hungry foods. Agricultural measures (such as covering with mulches) will also be needed to avoid soils drying out.

Increasing green water productivity will require the use of governance mechanisms such as extension services and action to address land rights issues. It will also require the implementation of a land care system that encourages society as a whole to protect the productivity of the land that is available.

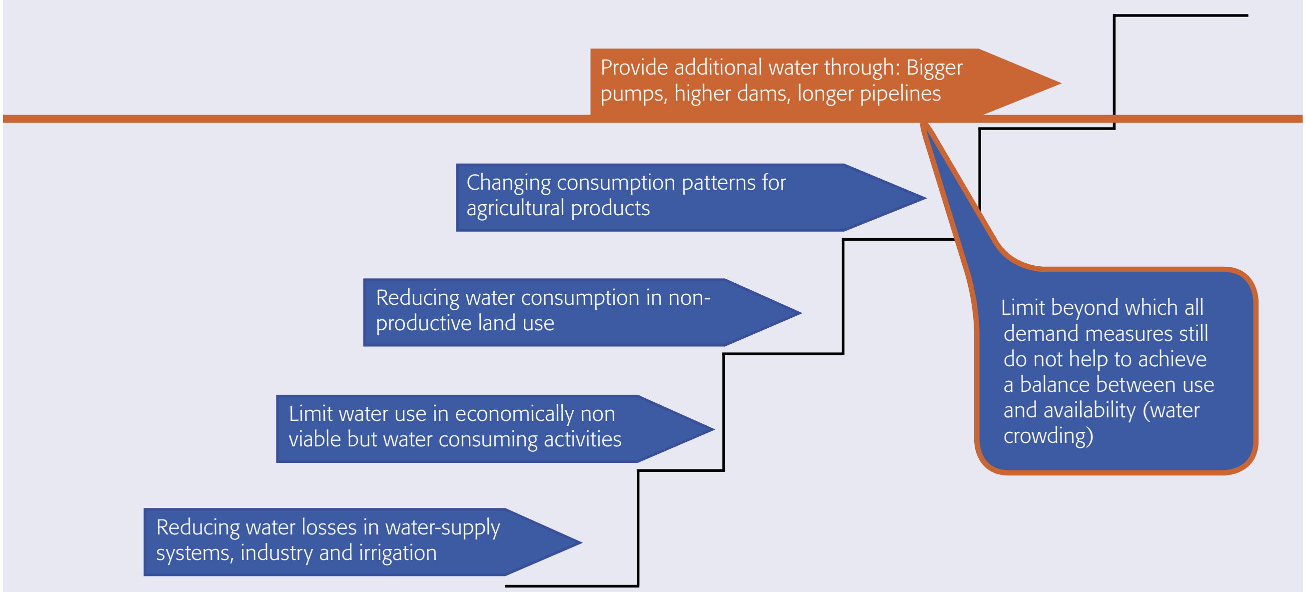
Addressing the need for bioenergy

Demand for bioenergy will increase both because oil reserves are limited and because policy makers are seeking more climate-friendly energy sources. Adequate policy action is necessary, however, because bioenergy production has the potential to be a large-scale consumer of both blue and green water. This means incorporating bioenergy production into socio-economic national planning. New policy should therefore aim to curb energy consumption by, for example, putting caps on emissions or improving energy efficiency.

Overarching governance components

A range of different governance options are needed to address the water scarcity problems outlined above. Governance measures should make it easier to make the best possible use of the basic water resources, by undertaking blue and green water management, and by increasing re-use in a water-scarce region.

Policy responses also need to include measures to reduce water losses in sectors such as irrigation and industry. They should also re-think water allocation based on economic principles ('more money per drop'), weighing such measures carefully against social and environmental considerations. Other key steps include making more use of green water, improving its management, and changing consumption and production patterns. In certain cases, action should also be taken to put in place and use large-scale water infrastructure and desalination options, in order to cope with chronic water shortage.



Box 1

A step-by-step approach to managing water scarcity is illustrated here. Each step represents the most logical action to take first. Actions should be taken in order, starting from the bottom of the ladder. But, remember that this only an example – political and social realities may mean that some measures cannot always be put in place.

Photo: Manfred Matz, SIWI

Studies indicate that climate change will probably result in less rainfall and higher temperatures in the world's tropical semiarid and Mediterranean climate zones (IIASA 2002). Thus, on a regional scale, climate change may be a key driver for change in biomass production for food and energy, with this both affecting and being affected by available water and land resources. (A comprehensive review of recent scientific material on the consequences of regional climate change on water resources and food production was recently presented by Stern 2006.)

Decision makers must incorporate such foreseeable water scarcity implications into the socio-economic national planning system, paying due attention to comparative advantages of different sectors. Such planning should incorporate long-term allocation of water. This should take account of both rural needs such as food and bioenergy production, and employment/income generating activities on the one hand, and urban needs on the other. Examples of such urban needs would include health and income raising activities, especially through domestic water provision and the provision of water for industry. They must also consider the option of reusing water where possible.

Policy makers will also have to take care to ensure that adequate amounts of water are allocated to both up- and downstream water users. Adequate water (minimum streamflow) will also have to be set aside to provide for the needs of aquatic ecosystems. Decision makers also need to bear in mind that in many areas blue water sources (including groundwater) are shared between two or more countries.

In the MENA region, water scarcity issues are already high on the agenda – and this will soon also be the case in Southern Africa. This is because they form an integral part of the larger political context (Turton and Ashton 2007). In many areas in various regions, including the MENA region, transboundary water relations are a complex part of a wider web of political relations linking water and issues of security – sometimes known as the Hydropolitical Security Complex (Schulz 1995). Action to address both political and water scarcity challenges in basins that are highly volatile politically requires the sustained support of the international community.

Such international support is particularly relevant to institutional development, which must develop a 'level playing field' that allows less powerful water users to negotiate a fair share of the resource (Jägerskog 2003). Those living in a river basin need to strive to share the potential benefits that can be derived from a rational use of the water available in a basin. It is however recognised that in those basins in which the political actors are preoccupied with security considerations the prospects for effective benefit sharing are slim (Phillips et al. 2006).

Efforts to balance land use, water use and the health of ecosystems would be helped by a broad application of Integrated

Water Resources Management (IWRM) that incorporates issues of land use, creating Integrated Land and Water Resources Management (ILWRM).

Concrete policy steps

When taking concrete policy steps, decision makers should first focus on managing demand – efforts to increase supply should be secondary to that.

In this context, policy makers should work to translate the following key recommendations into a clear and culturally applicable legal and administrative framework.

Decrease water losses and increase productivity by changing water use patterns. This can be achieved by

- using stricter demand-management techniques to effectively reduce agricultural, industrial and domestic water losses
- improving green water management by, for example, increasing rainwater harvesting
- increasing pollution abatement measures and water reuse
- increasing the use of modern agricultural techniques such as drip-irrigation and greenhouses, which minimise evaporation losses.

Incorporate water into socio-economic national planning. This should be done by

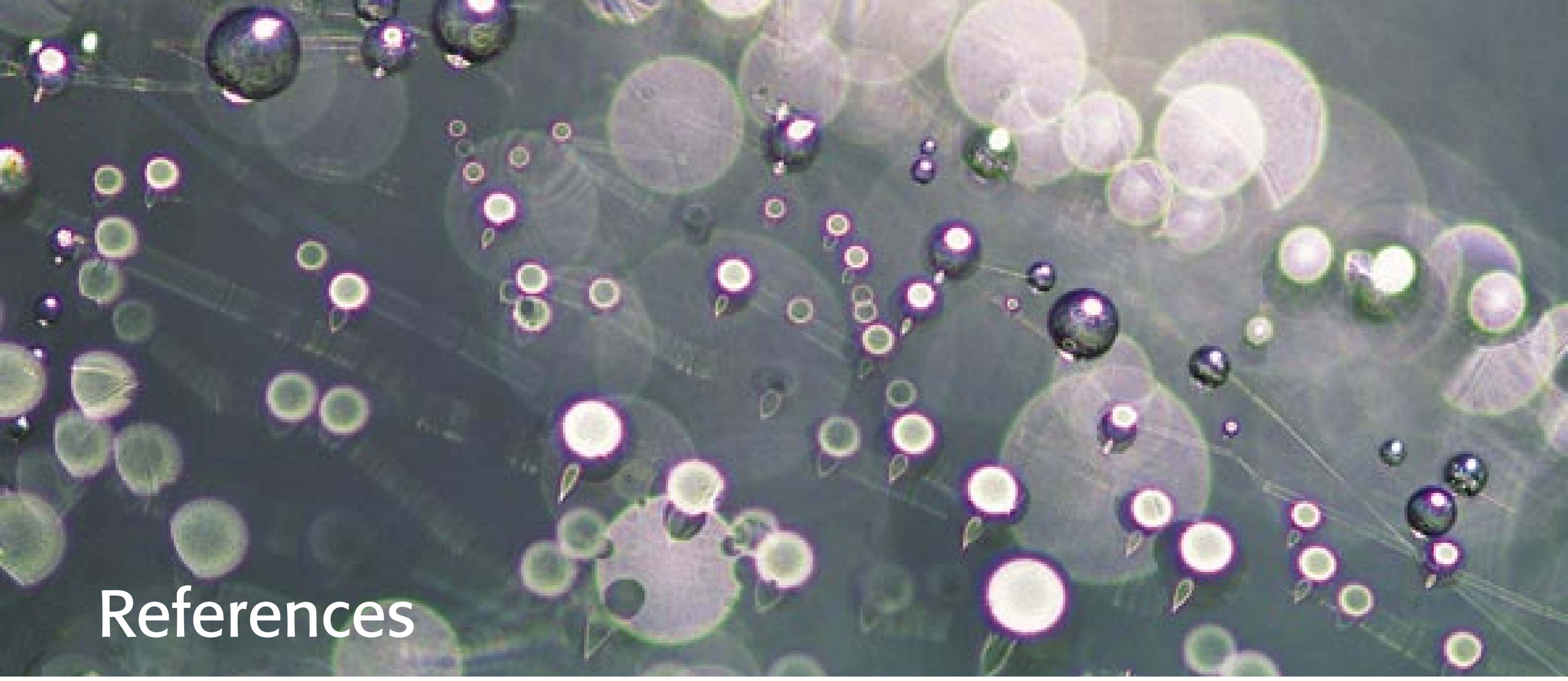
- re-allocating water to sectors with higher economic returns
- establishing clear land and water rights systems
- decreasing the subsidies given to irrigated agriculture, thus encouraging more efficient water use
- planning imports of water-demanding goods, especially foods (i.e. by considering virtual water)
- adopting measures that will encourage people to eat foods that require less water to produce
- planning for future bioenergy-generated water demands
- improving energy efficiency to curb climate change and decrease the amount of green water used to produce bioenergy
- adopting measures that will improve transboundary water relations, allowing countries to share the benefits that would be reaped from the rational use of resources.

Photo: Getty Images

Identifying the point at which optimum use has been made of available resources and then producing additional water by

- building desalination plants
- using pipe-lines to transport water.

Photo: Manfred Matz, SIWI



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