A primer 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.

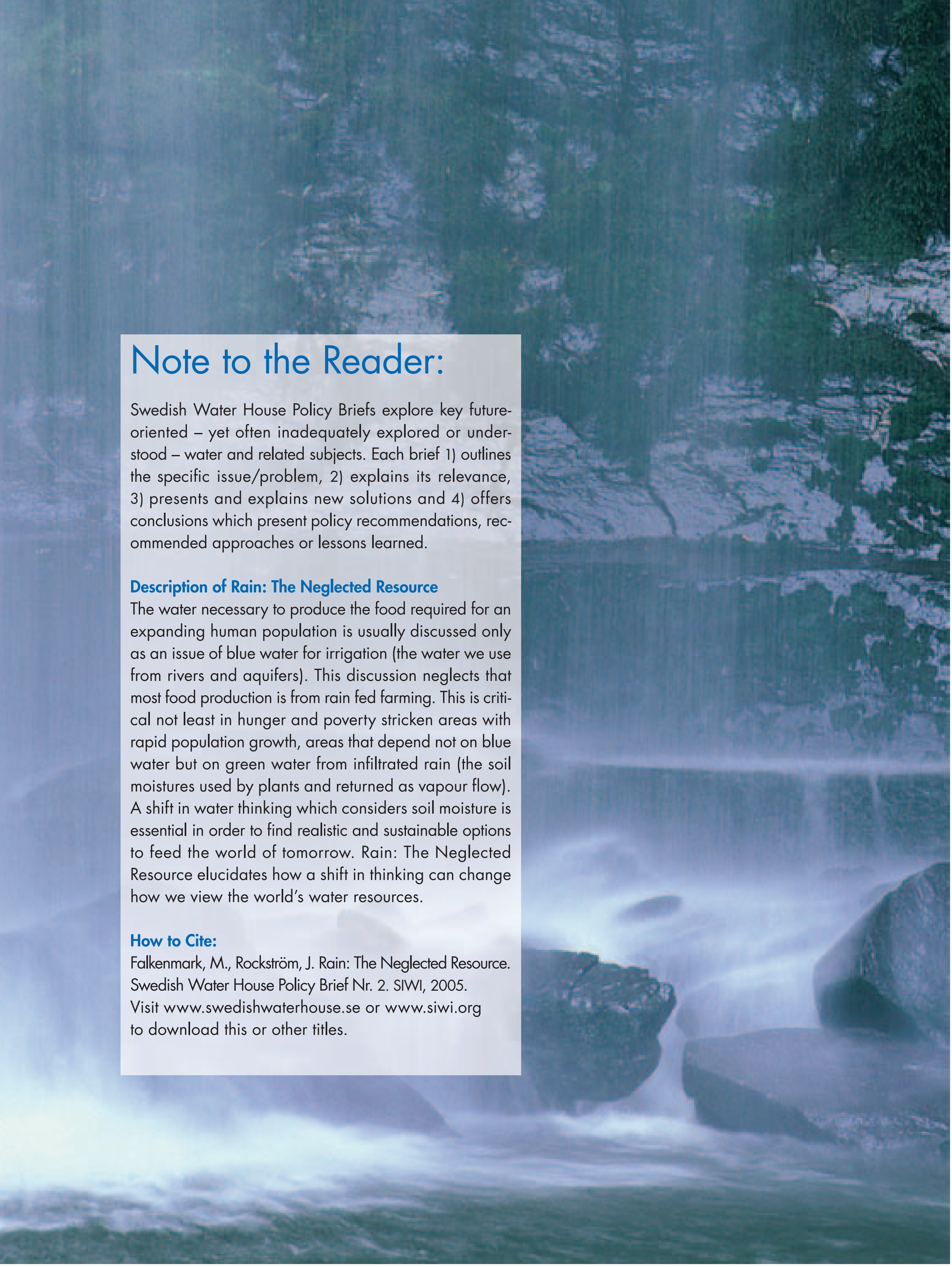
RAIN: THE NEGLECTED RESOURCE

Embracing Green Water Management Solutions

SWEDISH WATER HOUSE

SEI STOCKHOLM ENVIRONMENT INSTITUTE

SIWI



Note to the Reader:

Swedish Water House Policy Briefs explore key future-oriented – yet often inadequately explored or understood – water and related subjects. Each brief 1) outlines the specific issue/problem, 2) explains its relevance, 3) presents and explains new solutions and 4) offers conclusions which present policy recommendations, recommended approaches or lessons learned.

Description of Rain: The Neglected Resource

The water necessary to produce the food required for an expanding human population is usually discussed only as an issue of blue water for irrigation (the water we use from rivers and aquifers). This discussion neglects that most food production is from rain fed farming. This is critical not least in hunger and poverty stricken areas with rapid population growth, areas that depend not on blue water but on green water from infiltrated rain (the soil moistures used by plants and returned as vapour flow). A shift in water thinking which considers soil moisture is essential in order to find realistic and sustainable options to feed the world of tomorrow. Rain: The Neglected Resource elucidates how a shift in thinking can change how we view the world's water resources.

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Feeding the World

Shift in Thinking is Needed from Blue Water to Green Water

Fighting global poverty and reducing hunger are at the heart of the global development effort, as seen in the Millennium Development Goals (MDGs). The bulk of future population growth occurs in developing countries, also home to most of the close to one billion malnourished people.

Of the world's poor, 70% live in rural areas and are often at the mercy of rainfall-based sources of income (rain fed agriculture). Freshwater availability is a key limiting factor in food production and livelihood improvement, since some four tonnes of water (4,000 litres) are needed per human being per day to generate healthy diets.

Meeting the MDGs is therefore particularly challenging in poverty-stricken, water scarcity-prone regions such as the semi-arid and dry sub-humid savanna regions in Africa, South Asia, parts of Latin America and South-east Asia. Competition in these parts of the world for a limited water resource continues to increase; food production is water-constrained and degrees of freedom are continuously shrinking. Future environmental sustainability needs a wise balancing of water needs for human livelihoods, for food and for ecosystems.

Under the pressures of population growth, development aspirations and a growing knowledge of the importance of ecosystem support and services, water is increasingly understood as a key factor in socio-economic development. This will require a broadening of the global water debate from its current concentration on managing blue water resources in rivers, lakes and aquifers, and its current focus on the provision of potable water, the financing of such provision, and whether more water for irrigation can solve the world's food challenge.

A sustainable water future needs to incorporate the water from infiltrated rain and the water-consuming vegetation systems which provide life support to humans and nature:

- Huge amounts of water are needed to feed humanity, and today nearly three time more water is used in rain fed agriculture than in irrigated agriculture, with a total

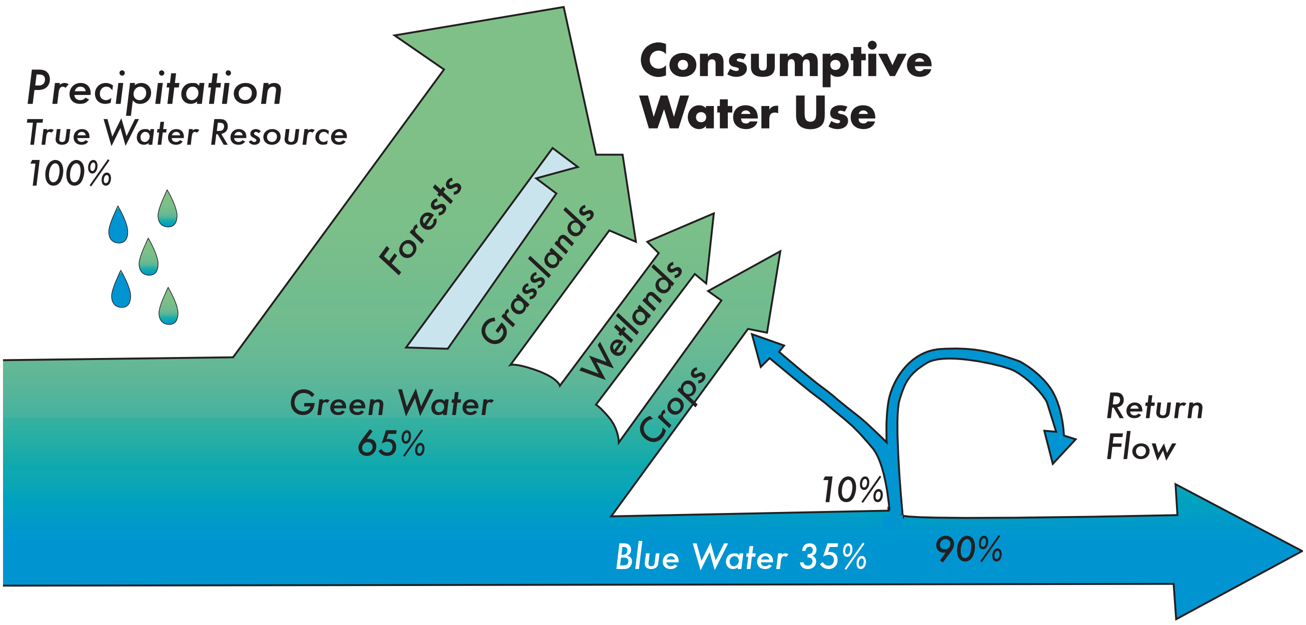


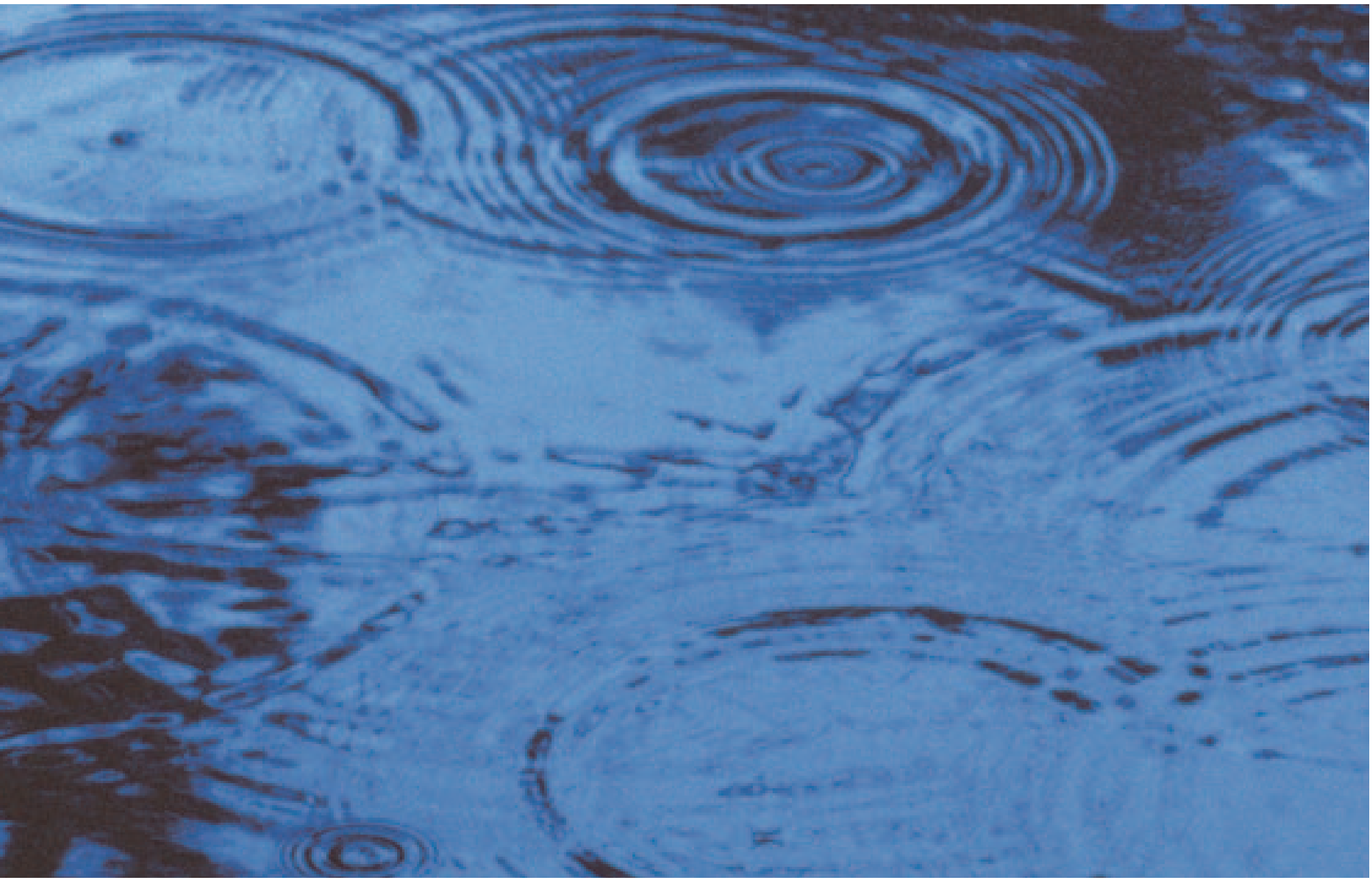
Figure 1: Green water is a significant water resource, much larger volume-wise than the water replenishing streams, lakes and aquifers (blue water). For more information on the green water resource, see page 6. Source: [1]

global consumption of 7,000 km^3/year. In short, 50 to 100 times more water is needed to produce food for one person than the amount needed on a household domestic consumption level.

- Water is of central importance in other sectors: industry production, forestry and fibre production, fisheries, etc.
- Upstream land use and water management determines the volumes, patterns of flow and quality of water for downstream use, making upstream land use for forestry, rain fed farming and grazing (all of which consumes freshwater) a determinant of blue water availability downstream.
- Huge volumes of blue water flows are required to sustain aquatic ecological functions in rivers, lakes, riparian zones and estuaries.
- The world's largest freshwater consumption is required to sustain biomass growth in terrestrial ecosystems, supporting key ecological functions such as biodiversity, carbon sequestration and anti-desertification.
- Water supply for various sectors of society is getting increasingly complicated as water contamination escalates, and awareness grows among water users of the links between upstream polluters of water with downstream water users.

The need for a broadened approach to water will increase as populations grow in regions that are water scarce due to their climate and as the rural to urban migration continues. Projected increases in water withdrawal may trigger a massive ecosystem collapse and cause social unrest, especially in downstream coastal areas [2]. Similar problems exist with land degradation. Some 70% of the world's savannas (often defined as drylands) in agricultural use are degraded, and drought and desertification threaten the livelihoods of over one billion people. Further, there is a risk that the low attention paid to water pollution abatement together with the projected increases in water withdrawal and use will exacerbate the water pollution problem. Conflicts between competing sectoral uses of water, and between land use and terrestrial ecosystems upstream and water use and downstream aquatic ecosystems, are becoming more common and threaten both the internal and external security of many nations.

All this will make a successful socio-economic development dependent on the capability to cope with increasing water crowding, water pollution and needs for water-dependent raw materials. Climate change will challenge this daunting task tremendously by exacerbating the element of uncertainty and surprise, with increased frequency of water-related events such as dry spells, droughts and floods.



The ability to adapt strategies to water shocks will be of increased importance, where attention will also be needed on water that supports resilience-building functions in landscapes.

This policy brief focuses on sustainable and integrated ways to manage water in all its major facets as a fundamental natural resource, a livelihood element and an ecosystem component, and calls for a corresponding paradigm shift in conceptual understanding.

The brief explores the green water-blue water nexus by providing its relevance in the context of the 21st century, explaining future scenarios and providing recommendations. It will also show how the water necessary to produce the food required for an expanding human population is usually discussed only as an issue of blue water (the water we use from rivers and aquifers). That neglects the food produced from rain fed farming, which is critical in hunger- and poverty-stricken areas with rapid population growth and areas that depend not on blue water but on green water (the soil moisture used by plants and returned as vapour flow).

This brief aspires to contribute to the shift in water thinking which is needed and essential in order to find realistic and sustainable options to feed the world of tomorrow.

Key Recommendations

- Raise awareness of the distinction between blue water in rivers and aquifers and green water in the soil.
- Accept in scientific, management, political and other circles the fundamental fact that there is not enough blue water left to meet competing food, water and environment needs for the future in large regions.
- At the same time realise that proper management of the green water in the soil represents a large potential for global food production.
- Analyse the linkages between global trade regimes and different strategies to attain national food security.
- Introduce a green water dimension and incorporate land-use into IWRM and adequate governance activities.
- Further clarify the linkages between global poverty, hunger and shortage of green and/or blue water.
- Raise awareness of the improvements possible in the livelihoods of communities – particularly those in water-scarce regions – through a broadened approach to water.
- Further clarify the linkages between rain fed agriculture and both green and blue water.

For more on the recommendations, see page 15.

Green Water as a Key Driver for Socio-economic Development in Poorer Regions

There is a disturbing geographical and hydroclimatic correlation between the water-endowed regions with temperate climate, where most of the industrialised countries are located, and the water-short regions where most of the developing countries tend to be located. In the former, vegetation is basically energy-constrained, while vegetation in the latter is water-constrained. Securing poverty and hunger alleviation in line with the MDGs therefore is an issue of successfully coping with highly challenging hydroclimatic preconditions in regions largely dominated by savanna ecosystems. *Figure 2 a,b,c.*

In savanna regions, most rainfall evaporates and generates only minimal amounts of groundwater and streamflow. This hydroclimatic correlation invites concern since conventional wisdom has it that water for socio-economic development depends on the liquid (blue) resource, which should be managed to supply water for humans, industry and irrigated agriculture. This narrow focus on blue water as the only water resource leads us to believe that agriculture uses 70% of the world's freshwater (the remaining being used by industry, households and municipalities). Actually, this view is highly erroneous, as it falsely says that only 4% of the global terrestrial precipitation of 110,000 km^3/yr is the freshwater resource linked to human livelihoods and socio-economic development. This focus thus concentrates mainly to around 4,000 km^3/yr, withdrawn from rivers and aquifers for these three purposes, and mainly to issues of water quantity. A separate, but related blue water issue is water quality. It has more or less been subject to "wilful neglect" through rampant pollution, particularly in developing countries [4].

It is extremely important to realise that the huge water requirements to feed humanity by 2015 and beyond will involve a continuously growing competition for this resource, and that the massive water quality deterioration around the world has to be actively abated. Population in poor countries will increase for several decades even as the fertility rate decreases. The Millennium Development Goals aim to increase welfare in poor countries in the South, but alleviating hunger and allowing income generation is intimately linked to increasing water needs and increased waste production. This means that more and more water has to be incorporated in socio-economic planning and management and that the water management perspective has to be broadened considerably. Where will this water come from?

Need for Broadening the Perceptions

The need for a broadened approach to water resource management is further emphasised by the serious failures of the past, reflected in depleted rivers, land degradation, water quality deterioration and overpumped groundwater aquifers. The Comprehensive Assessment of Water Management in Agriculture highlights a whole set of hot spot areas in the

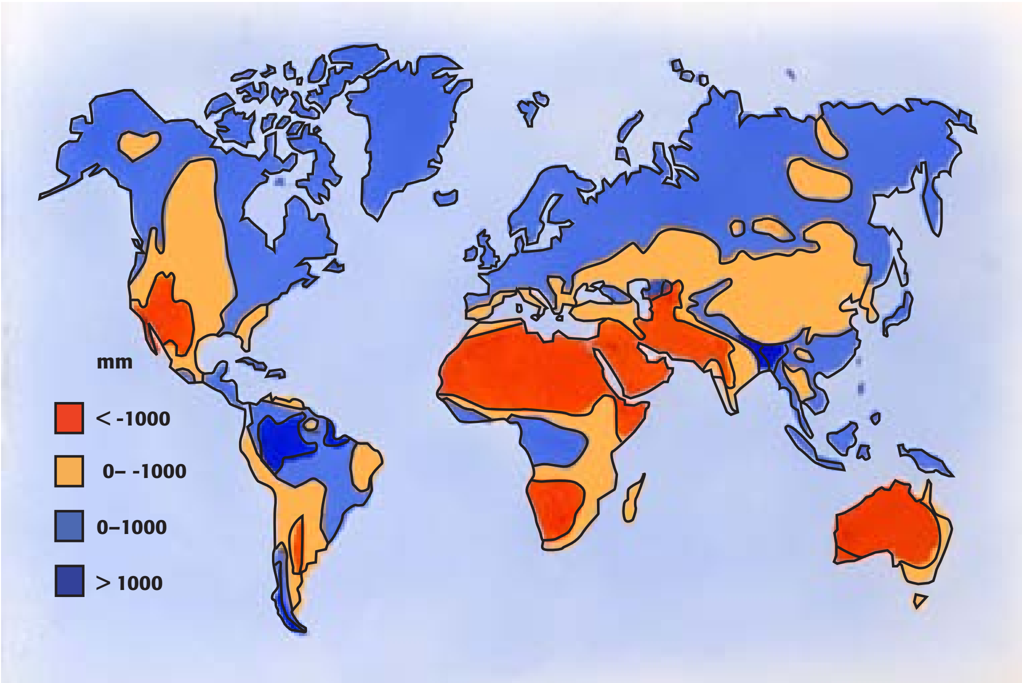


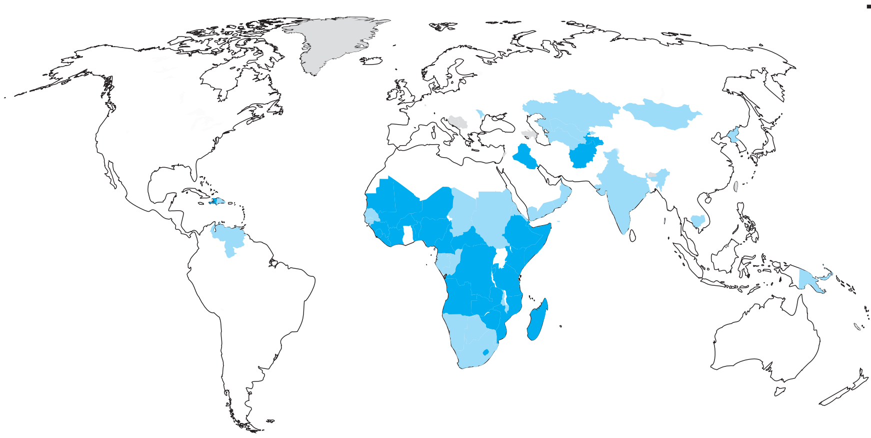
Figure 2a: Around the world, differences in hydroclimate determine if a hydroclimatic water deficiency or water surplus exists. The orange and red areas show where a water deficiency exists, since evaporative demand exceeds precipitation. The blue areas show the reverse circumstance, i.e. a water surplus. Source: [3]

regions which have rapid population growth, large-scale hunger and poverty. Unless a broadened and integrated approach is taken to land and water resources management and to water quantity and quality, serious societal problems can result.

Moreover, as Figure 3 shows, the large-scale water over-appropriation of water flow beyond the needs for aquatic ecosystems over altogether 15% of the continents inhabited by 1.4 billion people, leaves us with a very limited degree of freedom for sustainable blue water development in the future. Many large rivers are already closed or closing in the sense that there is no more or only very limited amounts of blue water (rivers and aquifers) that can be allocated to meet rapidly growing water needs in broad areas through large-scale irrigation-dependent agriculture.

In reality though, these basins may not be as closed as they seem, since current thinking excludes the options available of developing vapour or green water management. Generally, runoff flows are less than 10% of the rain, whereas 50% or more of the rainfall is lost to the atmosphere as non-productive green water flows (direct evaporation). There are promising options to reduce this loss through "vapour shift strategies" in favour of productive green water flows as transpiration, in upstream biomass production, for timber, staple foods and market food products.

While much more food will have to be produced to feed a growing humanity, the possibilities to expand irrigation are evidently limited and aquatic ecosystems have to be better protected from streamflow depletion. Most global crop production is, despite prevalent misconceptions, rain fed, even in poor water scarcity prone regions,



Top and high priority countries

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	Top priority countries	*High priority countries*
Sub-Saharan Africa	25	13
East Asia & the Pacific	0	4
South Asia	1	1
Arab States	3	3
Latin America & the Caribbean	1	3
Eastern Europe & the CIS	1	4

Figure 2b: Priority countries for human development. Source: [5]

and there are proven prospects for upgrading rain fed crop production. Therefore, today's limited perspective on liquid blue water will not be good enough to eradicate hunger. We need an approach that pays adequate attention to the huge amount of water that is exhaled during plant growth and literally consumed in crop production. The plants do not mind whether soil moisture accessible to roots originate from naturally infiltrated rain or supplied irrigation water.

The poverty, water and MDG links needs to be more clear. since the bulk of future freshwater needs for food production will have to come from green water management. This will affect downstream water availability. See figure 4.

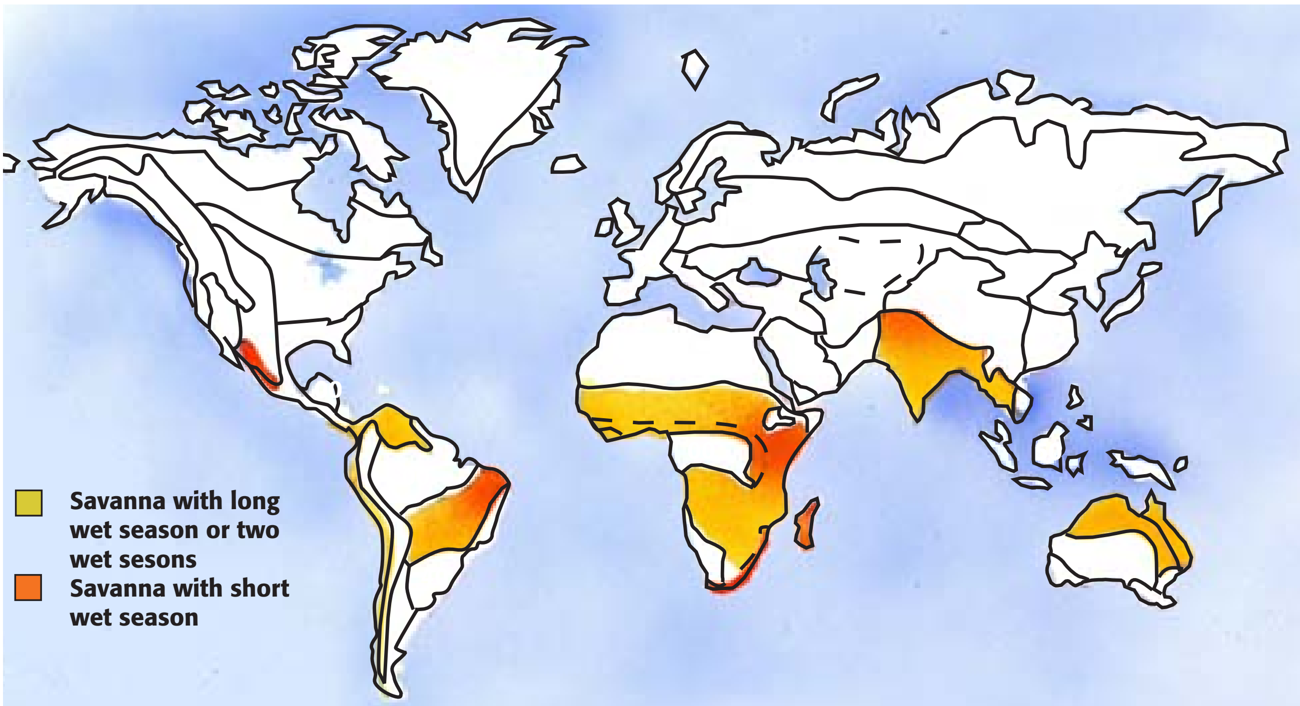

Figure 2c: In savanna regions, most rainfall evaporates, leaving little to regenerate groundwater resources or streams. This hydroclimatic reality has hindered socio-economic development in savanna regions, though better use of the soil moisture (green) resource can help mitigate for this lack of liquid (blue) resource. Source: [6]

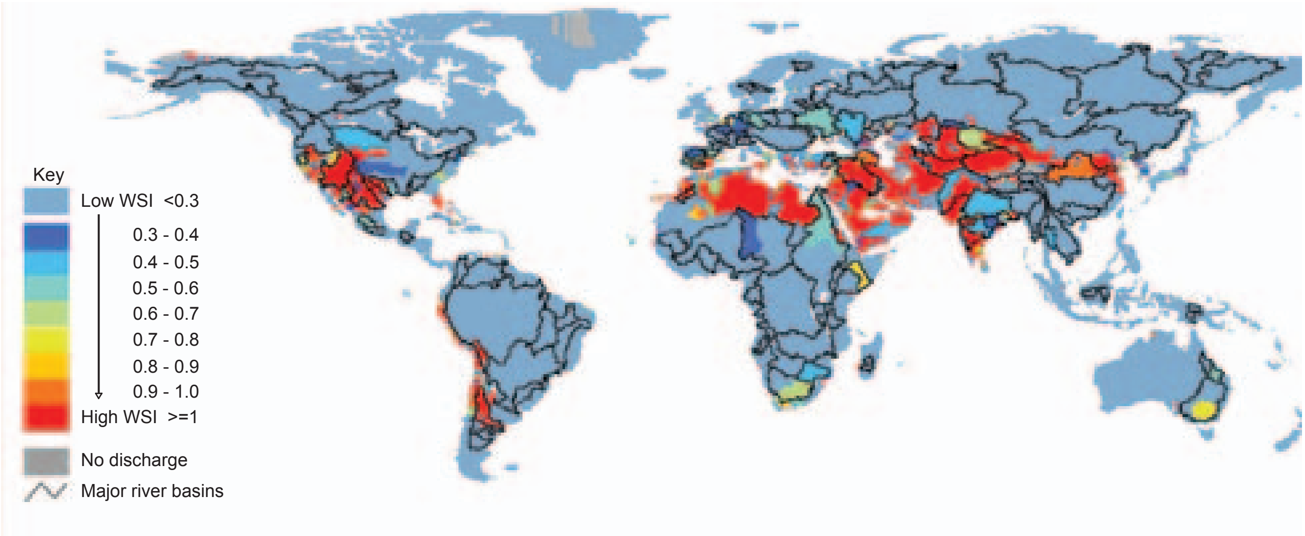

Figure 3: Water withdrawal in relation to blue water availability. Beyond a water withdrawal level of 0.7, the environmental flow has already been overappropriated (yellow and red areas). Source: [7]

All of this means that water resources planning and management must move past its "tunnel vision" of concentrating on only liquid blue water. Two essential key elements are missing in conventional water management: the evaporative demand involved in plant production, and the naturally infiltrated rainwater, available to meet that demand in a more productive way if more systematically managed.

A fundamental step to being able to wisely manage the basic freshwater resource, which is the rainwater resource, is the new distinction between blue water flow of liquid water and green water flow of water vapour.

Fundamental Conflict of Interest

This distinction makes possible a water accounting and more organised allocation of the basic rainwater resource between

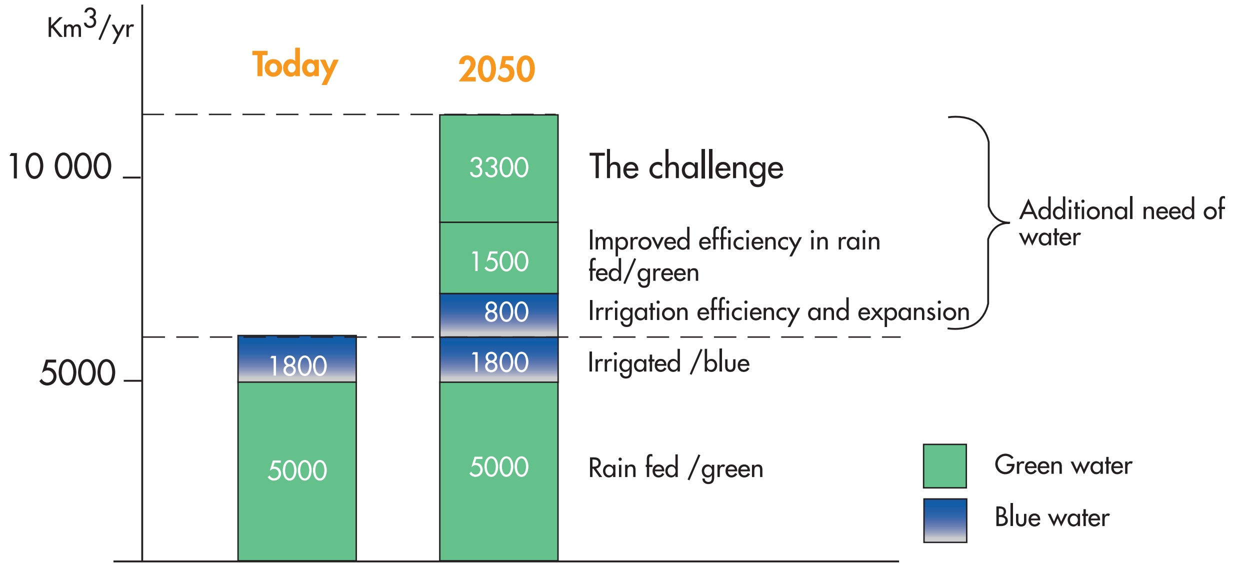

Figure 4: Today's food production involves a consumptive water use of altogether 6800 km^3/yr (out of which 1800 are supplied from blue water resources). To feed humanity by 2050 on 3000 kcal per person per day will require an additional 5600 km3/yr, out of which a maximum of 800 will come from blue water resources. The 2050 column shows that the remaining 4800 have to be contributed from new green water resources (e.g. horizontal expansion) or from turning evaporation into transpiration (vapour shift). Source: [8]

consumptive green water uses, rainwater surplus generating blue water (streamflow and groundwater recharge), blue water withdrawals for throughflow-based uses, blue water return flows carrying pollutants and drained back to the water system, and water for natural ecosystems, terrestrial as well as aquatic.

There is one unavoidable conflict that will have to be wisely managed in the future in order to secure an environmentally sustainable society. This is the fundamental conflict of interest between water-consumptive crop production, on the one hand, and the legitimate need of streamflow to maintain downstream societies and aquatic ecosystems supporting their livelihoods, on the other. This conflict exists because, in plant production, huge amounts of water evaporate through photosynthesis and transform to vapour while leaving the area. Thus, it is not available for reuse downstream.

In addition, as stressed by the Global Environment Facility [2], "the crises related to land degradation, food security, water quality deterioration, ecosystem decline, water insecurity, poverty and economic losses from extreme hydrologic events are all interlinked ... the root causes stem from government policy failures, and both the North and the South have much work to do to address the issues." It is therefore getting increasingly essential to address the land/water linkages – in other words the blue/green linkages – because land-use decisions are water-use decisions, and because rural areas must be sustained for poverty reduction and food security. Changes in land use affect green water flows and determine the available blue water flows further downstream.

Green Water Benefits Many Sectors

With a broadened approach to water management, the conflicts of interest – be they land use/water use, quantity/quality or upstream/downstream conflicts – will stand out much more clearly. At the outset, planning and management of freshwater for sustainable development needs to incorporate the allocation of green and blue water flows to sustain human and ecosystem water needs. Green water needs can be entered into an overall balance of legitimate claims on the basic water resource, irrespective of whether the water input is provided from the atmosphere over the country or by inflow from an upstream country.

In the long term, green water will be even more important for an organised socio-economic development than the blue water that now attracts all the attention of planners and policy makers.

Taking first a global outlook of what happens to the atmospheric water input to the continents *(Figure 1, page 3)*, it turns out that the green water branch dominates. Two-thirds of the water input is consumed, literally, in plant production, most of it by the forests. Altogether 6% is consumed in the production of food grains. Out of this, two-thirds originate from naturally infiltrated rain and one-third from blue water added by irrigation. Agricultural production is, thus, mainly rain fed.

The blue water branch contains only one third of the atmospheric input, which passes as liquid water flow through rivers and aquifers. Most of that flow passes rapidly as flood flow, while only some 10% of it is currently withdrawn for direct use to supply water for households, industry and irrigated agriculture. As already indicated, this corresponds to less than 4% percent of the total input.

So, there is plenty of water. The core issue is what functions water supports, not only directly for human needs but also indirectly for ecosystem support, and how water is managed.

Rain fed Crops Provide Most of the Food

Past approaches to water and food have focused solely on irrigation, but today 60 to 70% of global food production is produced in rain fed agriculture, and 80% of the world's countries today produce more than 60% of their food through rain fed farming, as *Figure 5 indicates*. Most of Sub-Saharan Africa stands out as dominantly rain fed (over 95% of the agri-

cultural land is rain fed). That is because the African continent lacks the enormous water flows that, for example, feed South Asia with water coming down from Himalaya.

Future food production thus cannot be addressed unless rain fed production is incorporated, and incorporated more effectively. When analysing how to meet the water needed to produce enough food to feed humanity on an acceptable nutritional level, we will have to switch from a supply-oriented approach, focusing on withdrawing more water for additional irrigation, to a water-requirement oriented approach, seeking alternative ways to meet the increased requirements by green or by blue water.

The challenges of water for food, and trade-offs between humans and ecosystem needs are so great, that nothing less than a green-green revolution will be required, though even this will not be enough [9]. Freshwater limitations are such that a triple green-green-green revolution (The "G-3 Revolution") will be needed, addressing the farming systems, the environmental impact dimension, and the dimension of radically reducing non-productive water losses in today's crop production [10].

Sustainable Energy Supply will be Increasingly Water Dependent

Besides plant-based food, there are other sectors of society where plant-based products are envisaged to play a central role in the future, primarily related to the energy sector. Climate change is a strong driving force for lessening society's large-scale dependence on fossil fuels through increased use of renewable energy. Such a move will have major implications in terms of increased needs of consumptive water use for biomass-based alternatives.

Hydrogen energy might for example be produced by using renewable biomass as raw material in the process. Calculations suggest that a large-scale expansion of energy crop production, in line with scenarios by the International Institute for Applied Systems Analysis (IIASA) and the World Energy Council [11], would involve *an additional green water requirement of the same order of magnitude as the current water being consumed for food production, whether basically rain fed or irrigated.*

Furthermore, efforts to mitigate climate change by taking CO_2 out of the atmosphere by carbon sequestration will demand more water. Developing countries are envisioned to offer carbon sinks in their forests and grasslands, selling the additional CO_2 consumed as "carbon credits" to developed countries with high CO_2 emissions [12]. Increased carbon sinks will require increased biomass production, and therefore increased green water consumption.

Environmental Sustainability Closely Linked to Green Water

Similarly, one of the world's largest green water-consuming sectors, forestry, has a strong impact on green water use and blue water availability. A central problem in South Africa is, for example, the streamflow losses resulting from the large-scale expansion of alien trees in the forestry sector. These trees were originally introduced by forest companies to produce timber, and have spread profusely over large parts of the country.

In order to gain an additional 10% of blue water flow to facilitate promises of domestic water supply to everyone, a 40-year project, the "Working for Water Programme," has been started by South Africa's government. This is a large-scale, multi-purpose programme which engages some 40,000 local inhabitants in clearing alien vegetation. At the same time, the programme has produced broad social, educational and economic benefits for the rural communities.

The role of green and blue water flows is important also for the resilience or vulnerability of social and ecological systems, although poorly understood at present. What is understood is that the life support function of freshwater is not merely a question of quality and quantity of blue water availability, but also defined by the buffering capacity of social and ecological systems to water shocks, such as droughts and floods.

In a catchment perspective *(Figure 6)*, it should be possible to take a more conscious and knowledge-based approach to Integrated Water Resources Management (IWRM). A balanced approach should be taken to the allocation of the water input to a catchment between green water uses for plant production in croplands and terrestrial ecosystems, blue

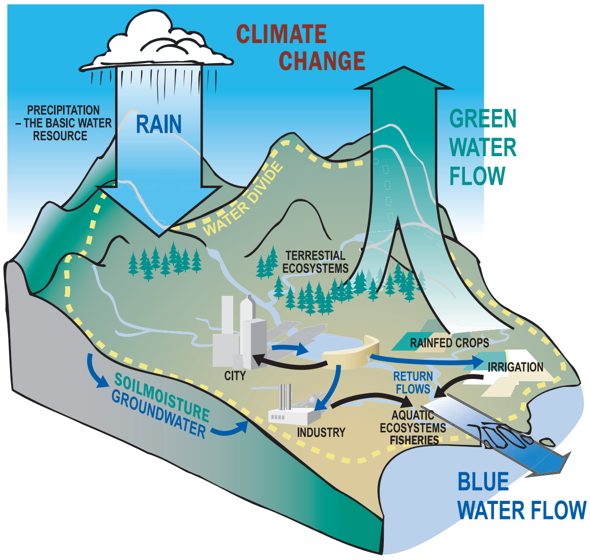

Figure 6: The reality of the big picture is that in a drainage basin perspective, the rainfall over an area is the water resource. Part of the water is consumed in terrestrial ecosystems by vegetation and evaporation from moist surfaces (green water flow), while the surplus recharges aquifers and rivers (blue water) becoming available for societal use and aquatic ecosystems. Naturally, as Figure 2c indicated, the green-blue balance is determined by the local hydroclimate. Source: [14]

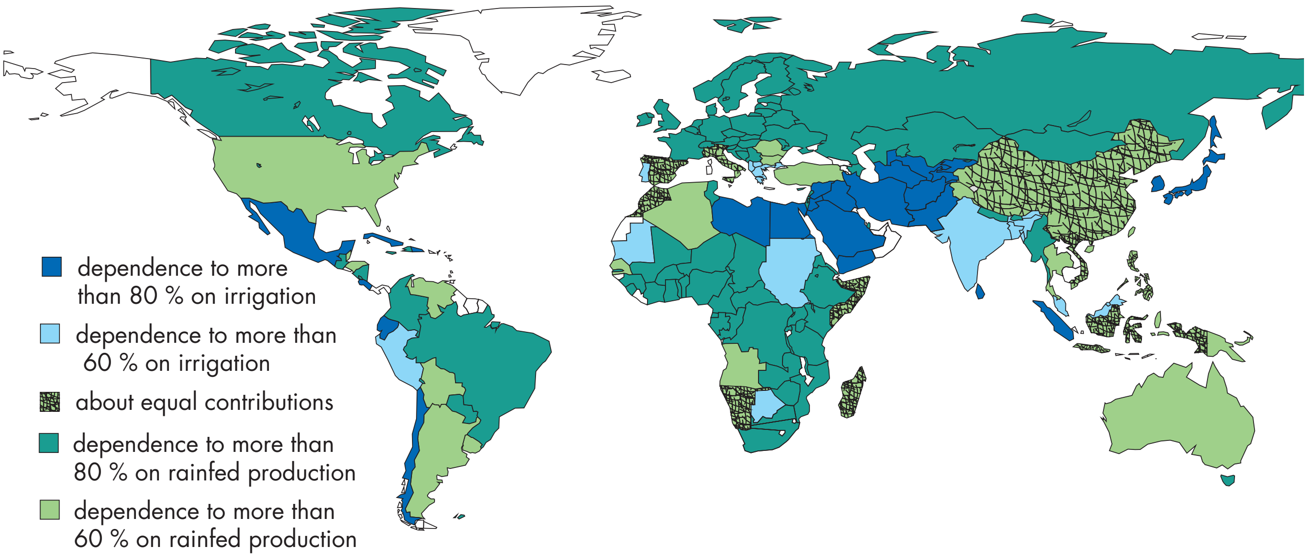

Figure 5. Countries where grain-based food production to more than 60% depends on irrigated agriculture are blue, while those that to more than 60% depend on rain fed agriculture are green. The colour is darker where the food dependence is more than 80%. The map shows that irrigation dominance is limited to a region through S Asia – W Asia – NE Africa – Central and SW South America. Source: [13]

Water Flow Domain Use Domain	Green	Blue
Direct	Economic biomass growth: Rain fed food, timber, fibres, fuel wood, pastures, etc.	Economic use in society: Irrigation, industry and domestic uses
Indirect	Ecosystem biomass growth: Plants and trees in wetlands, grasslands, forests and other biotopes	Ecosystem functions: Aquatic freshwater habitats
	Biodiversity	Biodiversity Resilience

Figure 7. Green and blue water flow domains for human life support, distinguished in direct functions (direct social and economic support) and indirect functions (water for ecosystem support). Source: [15]

water uses for direct societal needs and the blue water left unappropriated for aquatic ecosystems.

Widening the Domain for Water Policy

A new perspective on water resource management for livelihoods and sustainability thus adds new dimensions to water policy and thereby to Integrated Water Resources Management. Today, IWRM is mainly concerned with (certainly important) blue water resource supply for society, energy generation and irrigation, blue water flows for instream ecology (environmental water flows in rivers and wetlands), water demand management, transboundary resource sharing and water security. But, *this leaves out almost 95% of the global terrestrial freshwater resources, and thus the bulk of the water which supports human life and the ecological systems supporting it.*

A new conceptual framework for a widened green and blue water perspective is shown in Figure 7, where green and blue water functions for life support are distinguished in direct functions (today conceived as direct human support functions) and indirect functions to sustain ecological functions.

Introducing Green Water to IWRM

A broadened approach to water is critical for improving the livelihoods of communities (particularly for those in catchments where water is a scarce and unreliable resource) and for understanding more completely what, and where, the world's water resources are. This broadened understanding starts by labelling and understanding, conceptually, the water required by plants, picked up by roots from the soil, and transmitted to the air through photosynthesis. This is "green" water.

Linkages between rain fed agriculture and water need to be clarified. Plants can feed on two types of water: liquid blue water from rivers and aquifers used in irrigation and transferred to soil water, and naturally infiltrated rain water in the soil that vaporises during use and disappears to the air as green water flow. Adding a green water dimension to integrated catchment management and IWRM opens a broader perspective with new degrees of freedom for water use to support both direct and indirect water needs. As stressed by the Global Environment Facility (GEF), there exists after the 2002 World Summit on Sustainable Development in Johannesburg a new imperative to address linkages among the global crises behind poverty, hunger and natural resource depletion [2].

A fundamental dilemma is that there is not enough blue water left to meet the competing needs for the future in large regions. Without pursuing this imperative, food, water and environment insecurity will destabilise several nations and the Millennium Development Goals will not be reached.

The new distinction between blue and green water requirements and resources has been received with enthusiasm as opening new avenues for addressing the issues of the MDGs, while safeguarding environmental sustainability. There is now a growing international interest in advancing the thinking on the role of green and blue water flows in protecting the life support system as a basis for a more robust understanding of the role of water for sustainable development. This interest is reflected in the research community by several green water-oriented projects (Netherlands, UK, IFAD and Global Water Systems Program). The GEF works towards improved land and water management regimes in catchments and the type of basin-specific hydrosolidarity needed to achieve sustainable development. *Land use, thus, has to be incorporated in IWRM; a more accurate acronym would therefore be ILWRM – Integrated Land Water Resources Management.*

Thus, in view of hydroclimatic realities, the Millennium Development Goals involve the particular challenge to improve livelihoods in catchments where water, because of climate, is a scarce and unreliable resource. The consequence of all this is that vapour flows can no longer be ignored, and that *the close links between land use and water have to be more widely acknowledged and translated into adequate governance activities.* It is fundamental to work towards a more robust understanding of the role of freshwater for achieving a sustainable development.

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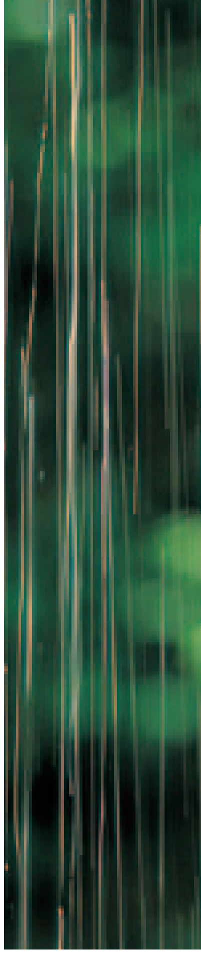
Ten Key Points

- Rain is the global water resource. How well we capture and manage it will determine if we can feed the planet's 9 billion inhabitants by 2050.
- Green water is the soil moisture, exhaled during plant growth as vapour flow from land to the atmosphere.
- Blue water is the liquid water in rivers and aquifers.
- The narrow focus on blue water as the only water resource leads us to believe that agriculture uses 70% of the world's freshwater, industry 20% and domestic use 10%. In reality, this is not the case.
- A sustainable water future needs to incorporate the green water-consuming systems, which are generally much larger and which provide life support to humans and nature.
- Of the world's poor, 70% live in rural areas and often depend on rainfall-based sources of income.
- The bulk of future freshwater needs for food production will have to come from green water management. This will affect downstream water availability.
- The planet will need an additional 5,600 km^3/yr of water to feed itself by 2050. The most optimistic irrigation projections show that no more than 800 km^3/yr could be contributed by blue water by expansion and efficiency improvement of irrigation.
- The future conflicts of interest will be over land use-water use, water quantity-quality, upstream-downstream availability, and humans-ecosystems.
- Climate change is a strong driving force for lessening society's large-scale dependence on fossil fuels through increased use of renewable energy, though such a move will increase consumptive water use for biomass-based fuel alternatives.



The Swedish Water House
(www.swedishwaterhouse.se) is an initiative that stimulates co-operation and networking among Swedish-based, internationally oriented academic institutions, consultants, government agencies, NGOs, research institutes and other stakeholders. SWH is funded by the Ministry for Foreign Affairs and the Ministry of Sustainable Development and administered by the Stockholm International Water Institute (SIWI).

The Stockholm International Water Institute
The Stockholm International Water Institute (SIWI) is a policy institute that contributes to international efforts to find solutions to the world's escalating water crisis. SIWI advocates future-oriented, knowledge-integrated water views in decision making, nationally and internationally, that lead to sustainable use of the world's water resources and sustainable development of societies.

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SEI (www.sei.org) is an independent, international research institute specialising in sustainable development and environment issues. It works at local, national, regional and global policy levels. The SEI research programmes aim to clarify the requirements, strategies and policies for a transition to sustainability.

The Swedish Water House is administered by SIWI.

Stockholm International Water Institute, SIWI
Hantverkargatan 5, SE-112 21 Stockholm, Sweden • Phone +46 8 522 139 60
Fax +46 8 522 139 61 • siwi@siwi.org • www.siwi.org