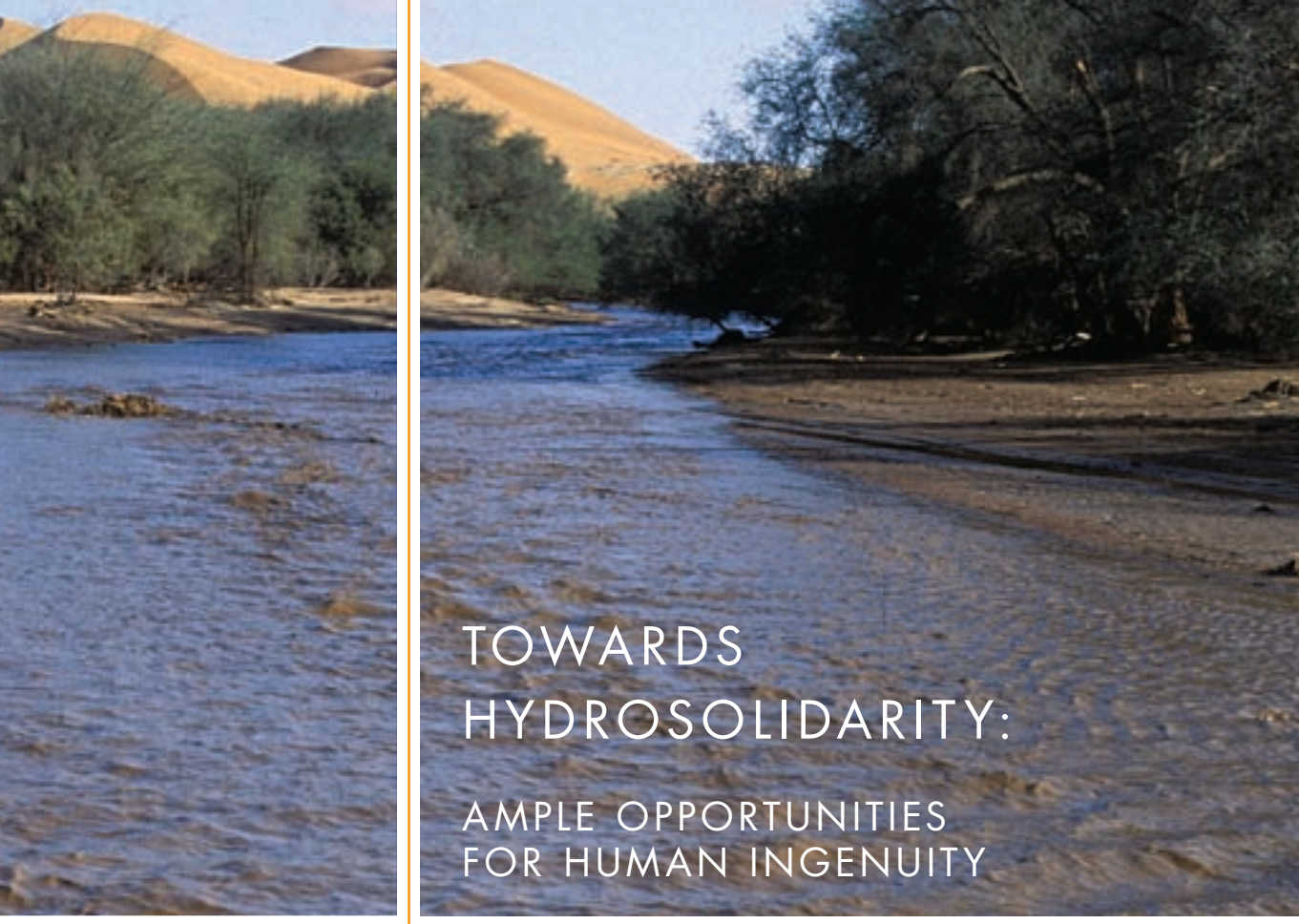

TOWARDS HYDROSOLIDARITY:

AMPLE OPPORTUNITIES FOR HUMAN INGENUITY

Fifteen-Year Message from the Stockholm Water Symposia

By Professor Malin Falkenmark
in co-operation with the Symposium
Scientific Programme Committee

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Contents

Foreword

Over the past 15 years, the Stockholm Water Symposium has made its mark as the leading future-oriented, interdisciplinary and intersectoral water meeting. It has cemented its role as a fertile breeding ground for ideas and practices that affect and integrate management, policy development, scientific research and technology as they relate to water, ecosystems and human development.

The Stockholm Water Symposium does not compete; it complements. Other meetings may be larger, focus more deeply on a single topic or take place within the confines of official intergovernmental processes, but since 1991 only the Symposium has provided the forum for a meeting of a multiplicity of minds to ask some very fundamental questions: where are we, where do we want to go and how do we get there?

Many of the issues addressed and disseminated during the years have later surfaced in other processes and activities, from the local to the global levels. Many of the solutions proposed are now being tested and implemented in national legislations, in development co-operation projects, and in policies and practices of local water management. Other important, influential organisations have been "born" during the Symposium. Even our vocabulary has been enriched – and made more accurate – i.e. through the introduction or development of terms and concepts which help us understand water better ("blue" or "green"), give us a guiding ethic ("hydrosolidarity") or warn us of the consequences of inaction ("hydrocide").

In a way, the fundamental appeal of the Symposium for so many individuals and organisations is that it brings us back to the basics: it has shown that water is key for social and economic development, and for quality of life, but also that human use of water alters the natural cycling of water through the landscape: quantities, pathways, seasonality and quality of freshwater are all changed.

The Symposium has also shown that a fundamental dilemma is that humans need clean water in order to be healthy, but they pollute water while using it. Industrialisation has generated incomes and provided wealth, but often at the cost of widespread water pollution. The Symposium has emphasised that food is a water issue: its production consumes huge amounts of water that vaporise during photosynthesis, and that consumptive water use has led to large-scale streamflow depletion of rivers in regions depending on irrigation.

The Symposium has also reminded us that the water cycle is the bloodstream of the biosphere, and that ecosystems share the same water as we do. When water moves down the catchment, from the watershed to the river mouth, above and below the ground, ecosystems suffer from the outcome of freshwater alterations.

In reminding us of these non-negotiable truths, the Symposium has retained an optimistic tone. It is possible, given the opportunities available from implementing human ingenuity, to overcome obstacles and achieve a better world for us and our children.

For their efforts both through the years and with this publication, the Stockholm International Water Institute would like to extend heartfelt thanks to Professor Malin Falkenmark and the members of the Scientific Programme Committee.

Anders Berntell
Executive Director
Stockholm International Water Institute

The Stockholm Water Symposia

2005 **Drainage Basin Management** – Hard and Soft Solutions in Regional Development

2004 **Drainage Basin Management** – Regional Approaches for Food and Urban Security

2003 **Drainage Basin Security** – Balancing Production, Trade and Water Uses

2002 **Balancing Competing Water Uses** – Present Status and New Prospects

2001 **Water Security for the 21st Century** – Bridge Building Through Dialogue

2000 **Water Security for the 21st Century** – Innovative Approaches

1999 **Urban Stability Through Integrated Water-Related Management**

1998 **Water:** the Key to Socio-Economic Development and Quality of Life

1997 **With Rivers to the Sea:** Interaction of Land Activities, Fresh Water and Enclosed Coastal Seas

1996 **Safeguarding Water Resources for Tomorrow:** New Solutions to Old Problems

1995 **Water Quality Management:** Heading for a New Epoch

1994 **Integrated Land and Water Management:** Challenges and New Opportunities

1993 **Integrated Measures to Overcome Barriers to Minimizing Harmful Fluxes from Land to Water**

1992 **A Holistic Approach to Water Quality Management: Finding Life-Styles and Measures for Minimising Harmful Fluxes from Land to Water**

1991 **Water Resources in the Next Century**

Proceedings from 1991–1999 are freely available at www.siwi.org. Proceedings from 2000–2004 can be ordered from the International Water Association at www.iwapublishing.com.

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Photo: Mats Lannerstad

Water – Catalyst for Development

Water was one of five priority issues at the 2002 World Summit on Sustainable Development in Johannesburg. It is recognised increasingly as an essential component in the dynamics of poverty; poor water management can indeed create and perpetuate poverty. Not only is secured access to water essential for poverty alleviation, but water development is closely linked to food production and hunger alleviation, and to energy development.

Stockholm Water Symposia

These symposia are a set of annual meetings concentrating on future-oriented, interdisciplinary, intersectoral issues. They have concentrated the debate on selected themes for a set of years to explore what is known, the opportunities for action and the barriers which hinder action. The themes are:

1) Minimising harmful fluxes from land to water (1991–1997)
2) Water – the key to socio-economic development and quality of life (1998–2002)
3) Drainage basin security – prospects for trade offs and benefit sharing in a globalised world (2003–2007)

Three Management Failures and Four Principles for Action

In the year 2000, for the 10th symposium, three main sets of water management failures were highlighted, summarising the results of the first ten years [1]:

1) The remarkable neglect of water pollution abatement measures. Although enormous lip service was paid to water quality management, the pollution abatement issue suffered almost a "wilful neglect". Absent in the debate around the many negative impacts was the question of the usability of the water in polluted rivers and aquifers. The question was raised: where does one go when the groundwater – thought to be clean and safe water source – is polluted beyond potability and safe use limits?

2) Urban water supply and sanitation: the large achievements in improved urban water supply coverage had, however, been overtaken by urban population growth. In the sanitation field much less had been achieved. It became evident that the world cannot rely solely on governments for water supply and sanitation but has to look for additional actors: this brought attention to both private sector involvement and self-help solutions.

3) Water management and administration had been far too simplistic and fragmented. The consequences for water of societal activities in general had been largely neglected. This had led to a misuse of the resource and the build up of an enormous environmental debt, which is left to the next generation to cope with. Many administrative water structures were heavily sectorised, inflexible and unable to handle the complexity of water issues. There were also massive manpower deficiencies, largely complicating advances in water resource management.

The following year, for the Johannesburg Summit, four principles for recommended action were issued [2]:

- Water users must be involved in the governance of water resources
- The link between economic growth and water degradation must be urgently broken
- Urban water and sanitation services are crucial for urban stability and security
- Policy, planning and implementation must be based on integrated solutions.

Water – Catalyst for Development Towards Sustainability

This publication offers an integrated overview of a set of key challenges for the future based on the outcome of the Stockholm Water Symposia from 1991 to 2004:

- Securing water for global food supply
- Securing safe domestic water supply and sanitation
- Securing water pollution abatement
- Securing catchment based balancing of water-related activities
- Overcoming water management complexity.

It is built up as cumulative summaries of contributions and conclusions, adding some future-oriented reflections of what we know, what we need to know, and what to do.

Photo: Mats Lannerstad

Securing Water for Global Food Security

Photo: Mats Lannerstad

The State of Globalisation

The symposia have highlighted that there are large regional differences, and that the processes of globalisation are complex and have different effects on different world regions [3]. Two distinct forms of globalisation exist. One is a fast, market-driven and powerful globalisation which works to integrate countries into the world economy. The other is a slower, weaker one, where global linkages emerge from issues of environmental degradation, poverty and armed conflicts. In those regions, which are not attractive to international investments, tremendous problems produce marginalising forces. Sometimes, both forces are at work, producing a mix of modern urban regions and poor, marginal rural regions and internal divisions and instability. Most major developing countries experience this mixed type of globalisation.

Water Scarcity Dilemma

Since basically two orders of magnitude more water is needed per person to produce the food on an acceptable nutritional level than the minimum amount needed for water supply on the household level (50 l/p d) Figure 1, water for food security will be an important issue for future socio-economic development and quality of life, especially in the marginalised areas globalisation leaves behind [4].

Differences in hydroclimate are reflected in large differences in terms of both human livelihoods and the dominating vegetation patterns. A major factor is the evaporative demand of the atmosphere and how it relates to precipitation. In fact, precipitation over populated agricultural regions in the temperate climate zone does not differ very much from the situation in corresponding areas in the tropics. What is different is the evaporative demand. The implications are illustrated for three different hydroclimatic situations in Figure 2 [5]:

- The temperate region is least complicated, as there is enough precipitation, moderate evaporative demand and therefore a precipitation surplus left to generate runoff.
- In the semiarid tropics, the rainfall is similar but the evaporative demand returns almost all

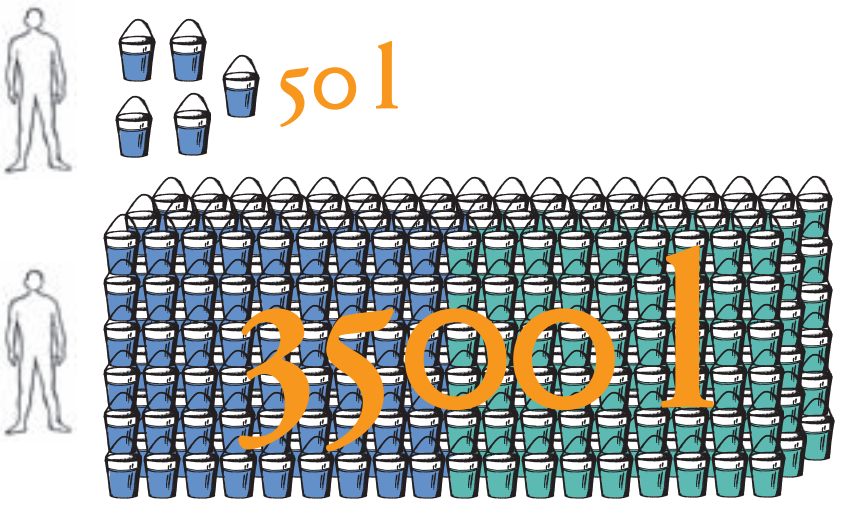

Figure 1: While 50 litres of water per day per person is the recommended minimum for household use, 70 times as much is needed to meet the consumptive water use for producing a projected human diet for one person based on a kcal consumption of 3000 kcal/day. Source: [4]

rainfall to the atmosphere, leaving only a minimal amount to generate runoff. This complicates irrigation in areas devoid of rivers entering from remote mountain regions.

- In the humid tropics, both rainfall and evaporative demand are high, but there still remains a large surplus generating runoff.

The semiarid tropics have highly vulnerable ecosystems but also rapid population growth, poverty, hunger and undernutrition [6]. Land use is generally a base for life support activities. Many of the top/high priority countries with a low Human Development Index are located in this region, as are many of the countries marginalised through globalisation.

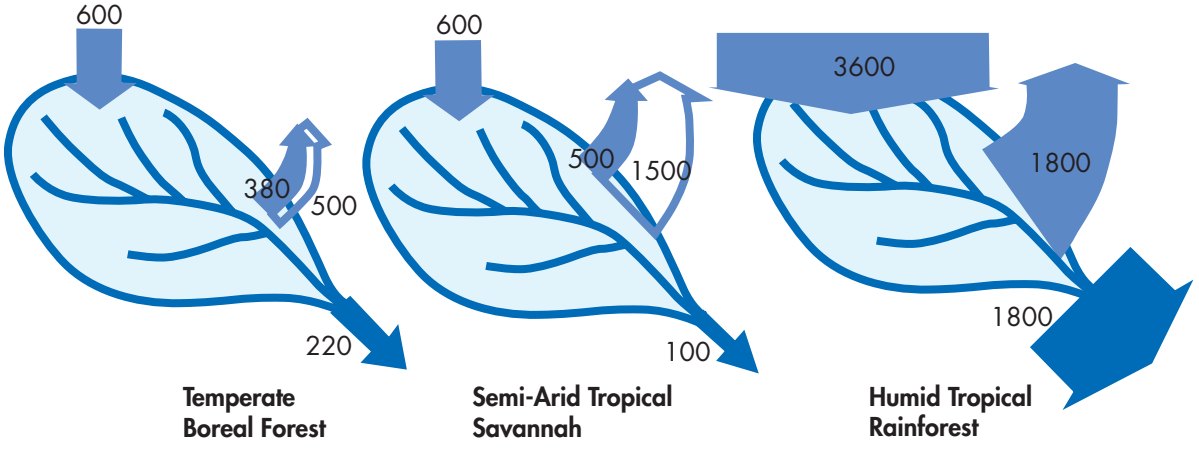

Figure 2: Livelihood contrasts due to regional differences in hydroclimate: typical relations between precipitation, potential and actual evaporation and runoff generated. Source: [5]

Therefore, the semarid tropics are global hot spots for hunger alleviation challenges.

While large parts of this region are often referred to misleadingly as 'marginal drylands', the term savanna better reflects the fact that these drylands are not as dry as often perceived. There is basically enough rainfall to support crop production during the wet season. Crop water requirements being climate-controlled implies constraints to socio-economic development, which have to be entered into macro-economic models to secure necessary awareness among national planners. In poor, drought-prone countries, the traditional approach has been supply-oriented: "bring water to the people" to help them out of the poverty and hunger trap [7]. In more developed regions where societies have been successfully overcoming water scarcity challenges, the strategy has now changed into the opposite: secure best possible use of the available water, "more crop per drop", food import, and water use for value-added purposes.

Overexploitation of Rivers and Aquifers

Irrigation has helped alleviate poverty in several developing countries, including India [8]. Water accessibility contributes not only to crop security but also to opportunities for multiple cropping, mixed cropping, and agro-forestry systems of land use. Irrigation has also a multiplier effect on employment both at the production and post-harvest phases of agriculture.

Large consumptive water use in irrigation-dependent areas has caused widespread streamflow depletion, reducing river flow, in some cases from perennial to intermittent flow [9]. That one can walk across the lower Yellow River in China during the dry season illustrates the dilemma. Dropping river flows may imperil societal development, increase competition between upstream and downstream users, and threaten freshwater and coastal ecosystems. The consequences are particularly evident in closed lakes – the most well-known examples being the Aral Sea, the Dead Sea and Lake Chad. Where water inflow to marshes is reduced, a complete drying out may occur, causing considerable damage to wetland habitats, flora and fauna.

Also, groundwater is widely depleted, as manifested in decreasing water tables [10] wherever withdrawals in irrigation-dependent areas have exceeded the natural groundwater recharge. Significant declines have been noted in several Indian states, Midwestern USA (the Ogallalla aquifer) and in Northeastern China. Here, one of the world's largest aquifers has contributed to large socio-economic gains, which in turn has resulted in a massive and continuing water table decline, hundreds of thousands of dry wells, sea water intrusion, land subsidence over vast areas and groundwater salinisation.

Green Water in the Soil – The Neglected Resource

Since conventional water resources are to a large degree overappropriated in irrigation-dependent regions, and since it is out of reach for many poor subsistence farmers in Sub-Saharan Africa and South Asia, interest has grown in upgrading rain fed agriculture [11].

However, conventional water resources assessments, with their focus on liquid (blue) water in rivers and aquifers, have highlighted only a partial reality. They have concentrated all interest on only one third of the overall water resource, excluding all water involved in production based on green water (naturally infiltrated soil moisture). The green water in the soil is the main water resource involved in rain fed crop production and in biomass production in natural terrestrial ecosystems [12]. Therefore, one urgent shift in thinking is to move from seeing only blue water as the economic resource to also seeing green water as a resource.

At the same time, soil conservation has to be given adequate attention [13]. What can be questioned, however, is the one-sided focus in recent decades to soil conservation per se. Although it contributed beautifully to erosion control, it has turned a blind eye to the water in the root zone, which is the entry point for crops to take up nutrients and grow to produce good yields. What is needed is an integrated soil/water conservation.

The basic freshwater resource is therefore the precipitation over a river basin. This is the water that has to be shared between the water consumed in plant production and returned to the atmosphere, not available for immediate reuse, and the surplus left,

Photo: SIWI

recharging aquifers and rivers and put to direct societal use. A remarkable window of opportunity exists in semiarid rain fed agriculture [14]. The perceptional change from blue water only to blue and green water together therefore offers a foundation for considerable hydrooptimism as compared to the past blue – and largely technical – perspective focusing on a vanishing resource. Even marginalised semiarid areas have generally enough rainfall for a crop harvest during the rainy season, and the yield can be doubled, even quadrupled in small-scale agriculture if dryspell damage can be mitigated and nutrients added.

The Salinisation Problem

Salinisation is a major water quality degradation issue confined primarily to dry climate regions, especially in the 25 percent of the continental land area where the climate is arid to semi-arid, but occurs also in sub-humid areas, raising the salinity hazard to one third of the land [15].

Salinisation of water resources is the outcome of a continuous mobilisation and redistribution of inland salts, mainly in regions with less than 750 mm rainfall/yr, i.e. the region where evaporation is larger than precipitation, which means that it belongs to the category of "arid zone surprise". There are two main groups of salinisation of water [15a]:

- Natural or primary salinisation, where salts are retained in closed basins and accumulating for long periods due to lack of drainage to the sea. The result is the development of salt lakes, the total volume of which are of the same order of magnitude as the freshwater lakes.
- Man-made or secondary salinisation, which may be of different origins and include clearance of deep-rooted vegetation, return water from irrigation schemes, saline intrusion from the sea, and brine discharge from mining activities.

The development of salinisation is closely linked to the water balance between precipitation, evaporation and runoff generation. In a humid climate, the salts carried by the rivers are discharged into the sea. In closed drainage basins in the dry climate regions, however, the rivers empty in closed lakes where the salt load remains, increasing the lake water salinity

with time. When water salinity gets beyond 1 g/l, the water is generally useless both for agriculture, domestic use and for industry. The arid and semiarid regions subject to salinisation problems include the regions of Central and South America, Southwestern North America, the Middle East and Central Asia (with half a billion inhabitants and rapidly growing populations) [16].

Water for Global Food Security

Food production is fundamental to reducing poverty. Agriculture will need huge amounts of additional water beyond the consumptive water use from today's agriculture. Since water is now the number one food production limiting factor in many parts of the hunger prone regions of both Asia and Sub-Saharan Africa, it can safely be foreseen that water for agriculture will be developing into a big issue in coming decades [17]. Indeed, it already is, although not widely recognised as such.

A crucial question for poverty eradication is how rain fed crop yields can be improved by supplementary irrigation based on local water harvested from rainwater or flash floods and stored in small tanks. The traditions in India and Sri Lanka teach us much, as do more recent efforts in China and Japan. "Greening the village" by water harvesting has enormous potential and may have very positive effects also on employment and income [18]. This link between water, hunger and poverty makes it essential to combine the implementations of Agenda 21 and the Social Summit Agenda – not to work with them independently.

Moreover, innovative approaches and precision farming in small-scale agriculture are in fact considered possible [19]. A crucial component is – besides conservation tillage and more water-efficient crops – protecting plants from damage during the frequent dryspells that are typical for the semiarid climate. Several islands of success have been reported from Sub-Saharan Africa, India and China. The question has been raised, however, about why the potential upgrading of small scale rain fed agriculture was not reflected, for instance, in the Vision on Water for Food presented in 2000. There seems to remain a remarkable communication gap between different groups of scientists. Many success stories have been reported – the bio-villages in India, for example – where activities based on local resources of rainwater, material and energy are being systematically integrated with strategic support from external facilities [20].

Thus, it has been shown that simple technologies, appropriate for small-scale agriculture, exist that would increase the delivery of moisture to the root zone during irrigation or rainfall [21]. Crop yields can be increased at this level. There is no best practise, however. Instead of searching for best available technology, it is wise to look for technologies that can be adapted to local circumstances. The big challenge is to establish the educational programs and incentives needed to help the small farmer implement the available technologies. Small-scale rain fed agriculture is viable with intelligent utilisation of harvested rainfall. Conservation and recycling of water should be an operating principle to the small farmer.

Community led programmes for the conservation and sustainable use of genetic resources, land and water will need local level institutional structures which can be operated by local women and men with the help of micro-credit. [22]. In addition to a community based land care movement, the village community could organise four different banks – field gene bank, village seed bank, village water bank and grain bank – as shown in Figure 3 [23].

Food Security by Importing Virtual Water

It should at the same time be clear, however, that these small operations at the local level could not solve the whole large-scale problems of food production for a fast growing world population. Trade has to be a complementary solution.

Due to the high consumptive water use behind food products, a country's food import may save water for other purposes. According to world statistics, seven out of ten food importing countries are water short, and a similar proportion of food exporting countries are water rich. Assessments of the scale of water involved in producing this flow of food products indicate that the "gross water flow" is somewhere between 700 and 1100 km^3/yr, a sizeable amount [24]. Trade liberalisation could double this flow.

Thanks to differences in water use efficiency between exporting and importing countries, there may also be a net global water saving, giving food trade a win-win character [25]. The importing country avoids a large consumptive water use and in the exporting country, the consumptive use involved in the production stays in that region and gets recirculated by atmospheric feedback. In that sense, the phrases "embodied water" and "virtual water flow" are in fact somewhat hydrologically misleading.

Many different rationales may stimulate virtual water trade. Virtual water transfer is an alternative to transfer of bulk water in water transfer projects [26]. Upstream food self-sufficiency would generate downstream river depletion and therefore cause predictable conflicts. A downstream country may also chose to import food from an upstream country to compensate for loss of water in other ways, such as deficient access due to what is seen as "poor agreements". Import of virtual water may in other words be a mechanism to abate conflicts in a region, adding options for negotiations on transnational river basins.

Concluding Reflections

What we know:

- many irrigation dependent areas are not sustainable due to large overappropriation of rivers and aquifers
- huge economically marginalised regions have in common a savanna climate, rapid population growth and large-scale undernutrition
- there are good possibilities for upgrading rain fed agriculture after dryspell mitigation, possibly doubling the yields

What we need to know more about:

- why huge gaps between actual and potential yields are not being closed
- why the knowledge of how to increase crop yields does not spread more rapidly
- trade implications of global food security
- how to understand environmental sustainability and ecosystem security
- how to reduce the very serious salinisation problem

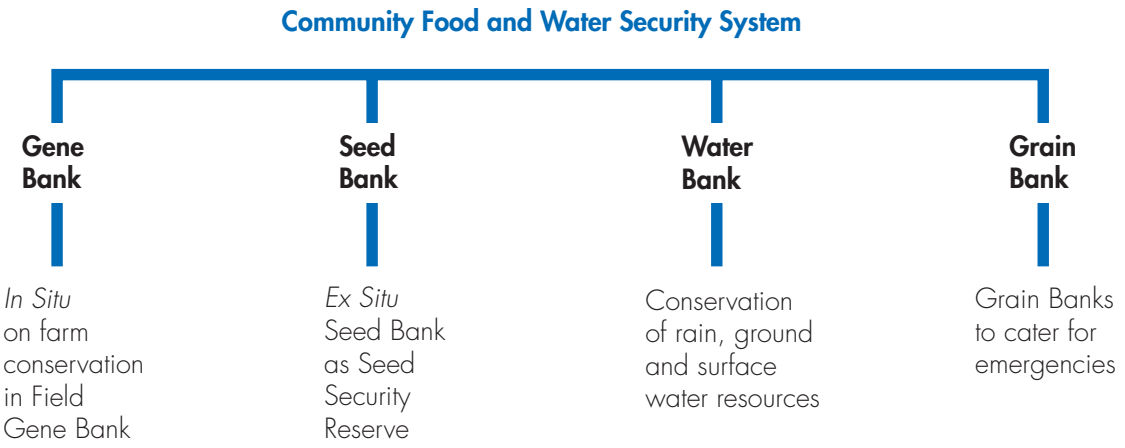

Figure 3: A suggested community-level food and water security system in India, involving a gene bank of local crop varieties, a seed bank to have good seeds available when needed, a village water bank to have water available when needed, and a grain bank to have staple grains available to the poor at affordable prices. Source: [23]

Household Water Supply and Sanitation

Photo: SIWI

Rural Water Supply

Safe domestic water supply and sanitation are absolutely basic needs when striving towards socio-economic development and general quality of life. Both have to be provided to unlock the productive activities of poor people; this is the very starting point for poverty alleviation and achievement of the MDGs (Millennium Development Goals).

Social access to water and cohesion and co-operation in the harvesting, storage and use of water may help enormously to strengthen water security. The power of social action has been demonstrated by the case of the village Jaisalmer in the Thar desert. With an annual rainfall of 100 mm only, the village had enough drinking water during summer due to rain water harvesting structures called kinds, which were established by local communities. Cherrapunji, another village with an annual rainfall of 15,000 mm, on the other hand, faced acute water shortage during summer months [27].

Urban Water Supply and Sanitation

A technical flow of water through a city is a necessary condition for the survival of its inhabitants, but also for the functioning of industries, hospitals and other city components. There are principal differences in the urban problematique between "walking cities", where everything including wells, drains and cesspools is within walking distance; "transit cities", where water supply and sanitation are based on "big pipes in, big pipes out"; and "auto cities" where the size has increased while the linear pipe solutions are reaching their limits [28]. In contrast, the "sustainable city" is based on rainwater harvesting, storm water retention, recycling of piped water and periurban reuse of nutrients. Such solutions radically reduce the need for large pipes.

The major wave of urbanisation is taking place in small- and medium-sized cities in developing countries, where human and institutional capacities are needed to provide liveable and sustainable conditions [29]. Water service coverage and quality are deteriorating often due to inadequate water govern-

ance systems and population growth. Studies show that poor people living in un-regulated areas are those most severely hit by floods and lack of water-related services. The competition for water and related services is increasing both within the urban centre itself and between urban and rural water uses – a competition that can cause tensions and conflicts, but which can also inspire co-operation.

In terms of urban water management, the advantages and disadvantages of both public and private ownerships have been extensively discussed, concluding that both models can be inadequate: public-private partnerships could be an alternative solution [30]. The solutions must be site-specific and address the climatic, economic, social, environmental and cultural conditions of the areas concerned. Transfer of experiences, technology and management practices from developed to developing countries have not proven to be as effective as initially expected.

Institutional governance and regulatory matters are also important in the establishment of efficient and sustainable water services. There needs to be clarity of responsibilities at country, province and local levels with separation of policy, regulation and delivery. Costs of services have to be recovered. There need to be economic and other incentives for consumers to value water and use it wisely. General subsidies, which result in low water prices, can encourage proliferate use of water and lack of maintenance of the infrastructure. The aim should be full-cost recovery through charges but with targeted subsidies for the poor. There are benefits in the integration of water and wastewater utilities, both in optimising on use and re-use of water, and through combined billing of services. The latter provides the basis for full-cost recovery on wastewater leading to environmental improvements.

Photo: Mats Lannerstad

Sustainability of Urban Water Provisioning Systems

A crucial issue is the future sustainability of water provision systems [31]. The question is, of course, where to find the water required in rapidly growing cities: what water sources to rely on, for how long, in which basin to find the next generation of raw water sources, and what drainage basin interests to compete with. To reach sustainable solutions, it will be essential to avoid pollution of future raw water sources.

In developing countries, a challenging problem is the number of illegal connections with which invasion slums try to manage their daily water needs. Moreover, financing of the city system is the very backbone of a sustainable system but remains particularly tricky, not the least because of widespread corruption on different levels and donor imposed conditionalities, which are constraining. There has to be a clear separation of policy, regulatory and service delivery functions.

A low level of water provision services is reflected i.a. in intermittent water supply which tends to affect poor people most. All consumers have to carry costs to cope with such conditions, either by storage tanks and/or alternative supplies, or by time spent in queuing at public taps or private vendors. Strikingly, consumers' coping costs to private water vendors tend to be higher than payment to the water utility and can be used as a proxy to willingness to pay for more effective water services [32].

Sustainable Sanitation

While it is well-known that proper sanitation reduces the risk of water-related diseases, the Third World in large parts still lacks it – even though the barriers to improved health through better sanitation and water management are more social and political than technical. Success stories include pit latrines, urine separation and dry sanitation based on dehydration or decomposition (thus feasible in high-density peri-urban areas).

Sanitation is on the march and ecosanitation is gathering increasing interest and acceptance [33]. But in cities with water-carried sanitation, micropollutants that escape wastewater treatment and purification continue to raise increasing concern, especially in view of the potential effects on human fertility. In urban areas, there is no single solution that fits everywhere. The common issue is that reuse must be implemented in most places to be able to reach a sustainable water supply and sanitation. Many places already have some technical infrastructure. When planning new systems it is vital to take into consideration what already exists and not to make unnecessary investments. Sewage treatment plants may be reconstructed in a cost effective way so as to fulfil high standards and low energy use.

To close the enormous sanitation gap in the developing world, where several billion lack safe sanitation, water-borne sanitation has to give way for dry sanitation [34]. Dry sanitation is a tested and valid alternative consisting of urine-separated toilets, with no or little water added. It is an elegant way to minimise water use and to create usable fertilisers both from urine and solid faecal matter, which are rich in nutrients. Ecological sanitation thus might have dual benefits, not only for poor developing countries but also for developed countries. At present the potential risks involved are not understood well enough. Interesting developments might be foreseen also in traditional systems, including the development of recirculation and packaging of urine. Human faeces can be seen as a resource that can be safely reused after reduction of pathogens and heavy metals. At the same time, poorly planned latrines – where insufficient

Photo: Dr. Katrin Teubner

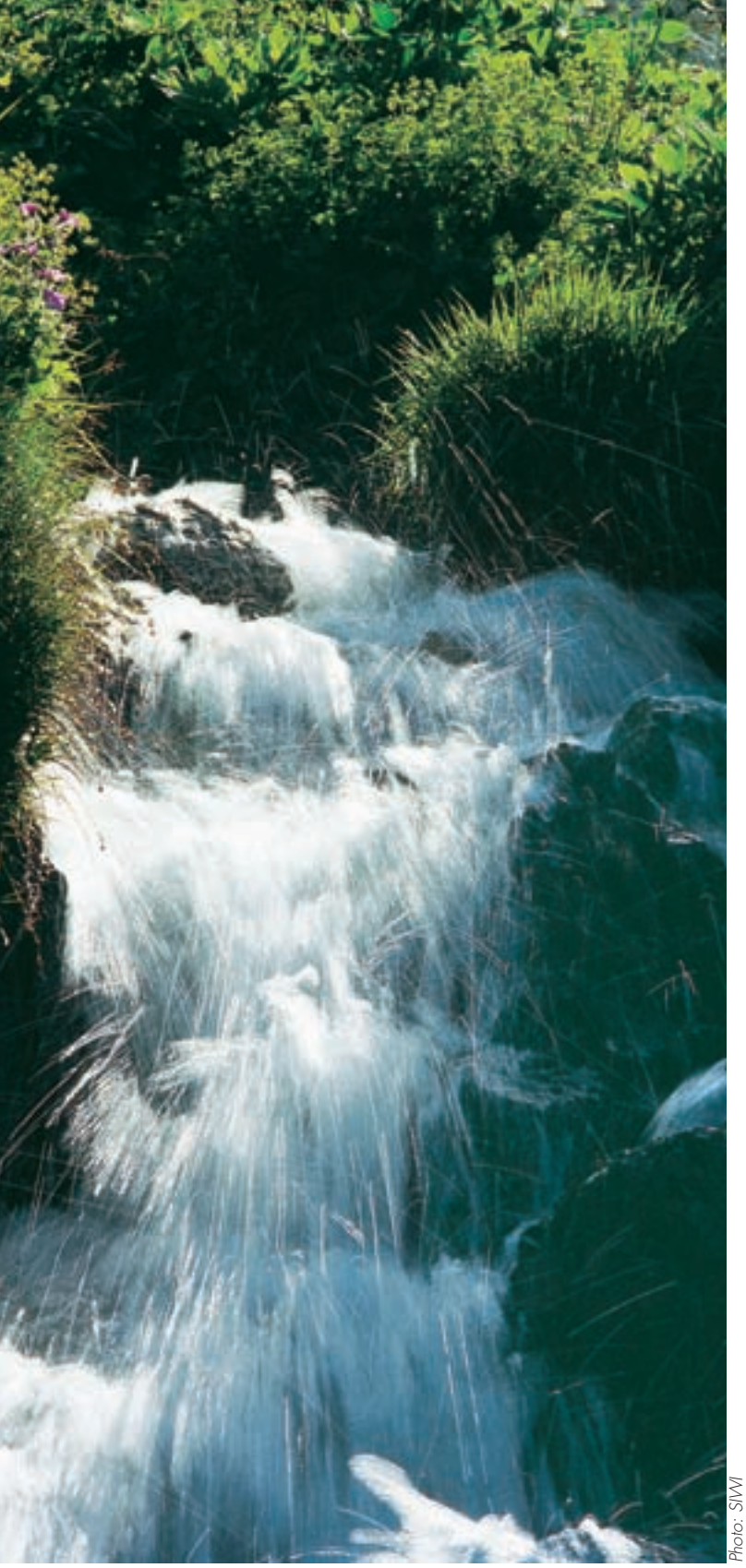

Photo: SIWI

attention is paid to hydrologic conditions – may pollute groundwater and make the city unsafe and insecure for habitation.

To reach the goal of safe sanitation to everybody by 2025, 0.5 billion additional individuals will have to be served every day for 20 years. The sheer scale of this endeavour makes water-based large-scale piped solutions from rich temperate zone cities unrealistic. Instead, ecological sanitation will have to expand rapidly. It is generally understood and accepted world-wide that human health depends on proper sanitation and hygiene. While hygiene is water based, sanitation could be either water borne or dry. In the latter case water supply and sanitation should not be mixed. In such situations, water supply and sanitation (WSS) would turn into water supply/dry sanitation (WS/DS). The sanitation issue can be solved without water, but not the hygiene issue.

Concluding Reflections

What we know

- clarification of responsibilities and institutional separation of policy making, regulatory power and service delivery will make a major contribution to improve water supply
- safe water supply and sanitation is a key to socio-economic development and quality of life
- sustainable sanitation technologies, including ecological sanitation, are readily available
- under increasing water scarcity, WSS will have to turn into WS/DS

What we need to know more about

- clarify differences between actors organising WSS and how to cover WSS costs without compromising affordability to poor people
- clarify why available sanitation technologies and safe recycling of human waste is not applied on a larger scale

Water Pollution Abatement

Photo: SIWI

Wealth Pollutes

Already, water pollution is rampant. In particularly bad cases, the river has been referred to as a sewer and even a murderer. A fundamental dilemma is that wealth generation itself generates huge amounts of pollution load, which increases quicker than the population and the GNP: while the population doubles, the load may increase 5–10 times, even more in some cases [35]. There is broad evidence that water quality destruction is already threatening economic development and long-term urban water security in places like Sao Paolo, Delhi and Mexico City.

The wilful neglect of water pollution and the export of industrial models developed in temperate climates, with plenty water available in the rivers to dilute the polluted wastewater, to regions with a long dry season in tropics and subtropics, has been a major mistake [36]. Cities growing rapidly often destroy their own water sources, with the new sources further away and more expensive to get [37]. This makes water reuse within the city an interesting alternative.

Water pollution may be particularly serious in certain "hot spot areas" because of amount, density or nature of local pollutant loads. Such areas include megacities, major mining and smelting areas, certain industrial areas. Unfortunately, economical, legal, administrative, and cultural barriers often stand in the way for water pollution minimisation.

Today's River Pollution Syndromes

Pollutants tend to build up in a water body with limited water exchange. The build-up continues as long as the input of pollutants is larger than the outflow plus the biodegradation. The build-up therefore depends on i.a. water exchange characteristics of the receiving water body.

The outcome of all interactions by which water gets polluted has been described as river syndromes, with each syndrome defined by a set of symptoms and causes [38]. Seven syndromes relate to water quality change:

- salinisation in arid and semiarid regions as a result of additional salt loads and high evaporation where surface waters are gradually getting concentrated

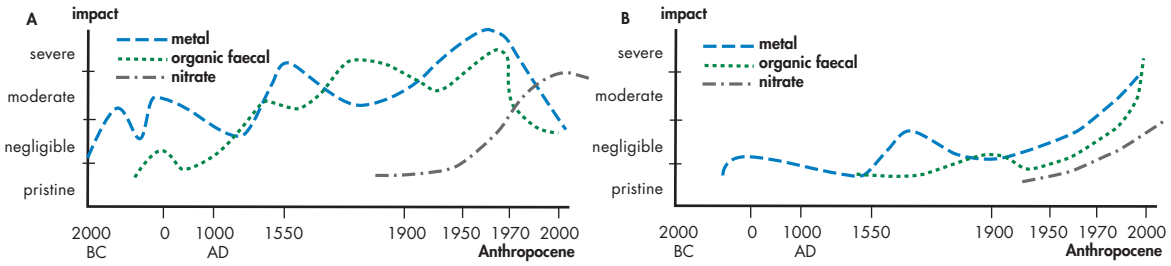

Figure 4. Water pollution syndromes look quite different in regions with slow economic development (a) as opposed to regions with rapid development where many pollution problems tend to coincide in time (b). Source: [39]

- chemical contamination, encompassing oxygen depletion, metals and agrochemicals
- acidification involving decrease of pH, increased Al and loss of biotic diversity vulnerable due to crystalline bedrock
- eutrophication involving nutrient increase, silica decrease, high algal biomass and changes in algal distribution
- microbial contamination related to high faecal coli and related pathogens
- radionuclide contamination.

Reconstruction of the evolution of some of the syndromes at the regional scale clarifies fundamental differences between a slowly developing region as compared to a fast developing one, see Figure 4 [39]. In the former case, as for Southwestern Europe, the impacts from Roman mining 2000 years ago accelerated with the industrial revolution. Organic and faecal pollution rose with population growth. More recent issues are eutrophication, nitrate pollution and the most recent pollution by PCBs and pesticides. In fast developing regions in parts of Africa, South America and Asia, however, the water pollution issues almost coincide in time, severely complicating efforts of water pollution abatement.

River pollution is particularly serious in the developing world, especially in densely populated areas with vibrant industries [40]. In China, water pollution is now recognised as one of the most serious challenges to further social and economic development. Pollution is serious also in India. One illustratative example is the Yamuna River, from which Delhi gets its drinking water. It has been described as a cocktail of poisons, added from both agricultural, industrial development activities and domestic effluents. However, "what Harayana (the upstream state) does to Delhi, Delhi then calmly does to the cities downstream" [41].

In poor countries, medium and small-scale industry poses severe problems: they are fundamental to raising incomes, but too small to manage pollution control techniques developed in the West. In India, they are essential socially and provide non-farm employment. Today, such industries are responsible for 60 percent of total manufactures exports of India [42]. They generate 40 percent of the total industrial wastewaters, and generate upstream-downstream conflicts in many rivers. The river Bhadar (Gujarat), with 1200 sari dyeing and printing units in Jetpur is one example; the rivers Bhavani and Noyyal (Tamil Nadu), with some 800 dyeing and bleaching units in Tiruppur, are another. The situation is equally bad in China, where township and village industrial enterprises play an important role in rural development. In 1995, 45 percent of the wastewater generated by these units originated from paper companies, more than half in the eastern provinces.

Groundwater Pollution Underestimated

In groundwater, two contamination processes dominate: salinisation through water balance disturbances, and leaching of pollutants through lack of groundwater protection. Salinisation processes are due to inadequate irrigation management and lack of drainage, mine drainage or petroleum reservoir exploitation [43]. The North China Plain is an example of serious groundwater salinisation caused by overexploitation of groundwater which has resulted in serious salinisation and land subsidence in some places. There is

even a serious risk that saline water from the upper aquifer may be drawn down to the lower high quality aquifer now containing water that was recharged 10,000 to 20,000 years ago.

Anthropogenic pollution through inadequate protection of aquifers is more widespread than currently understood. Use of subsoil to attenuate water pollutants adsorption and/or elimination through biodegradation, is in widespread use as a potentially effective way for safe disposal of human excreta and domestic wastewater [44]. Not all soil profiles are, however, reliable in this sense, due to the existence of preferential pathways. In Denmark polluted water did not get the expected attenuation in the upper soil due to preferential channels of biological (root chammels, worm holes) or physical origin (cracks, fissures) [45]. These so-called macropores offered "express routes" to the infiltrating contaminated water, losing the retarding buffering capacity of the unsaturated zone.

The pollution potential of groundwater is a factor of mobility and persistence – many pesticides are degradable with soil half-lives from 10 days to a few years, but the attenuation in the deeper subsurface may be much slower. In addition metabolites may be equally toxic.

Certain tendencies of groundwater pollution have been identified, in particular the widespread quality deterioration of shallow vulnerable aquifers in areas of rapid urbanisation and agricultural intensification. Small-scale industries in developing countries may generate significant contaminant loads and liquid effluents discharged to the ground. Also, groundwater quality reflects the radical evolution in agronomic practise in many regions which has involved ever-increasing quantities of inorganic fertilisers and pesticides. In many countries the principal recharge areas of lowland aquifers are now almost completely used for intensive crop cultivation, making groundwater vulnerable to contamination. Pesticide compounds pose a significant health hazard.

A fundamental memento is that the slow groundwater flow rates and very large storage volumes have important implications; since many groundwater sources were recharged before recent land-use changes, modern pollution may not have yet reached them but is on its way [46]. Moreover, the deterioration is a slow gradual process that may not be recognised until large volumes are affected.

Hydrocide – The Long-Term Threat

After three decades of efforts, the inability all over the world to halt water pollution remains a serious failure. The crisis is increasing steadily in the developing world. A "hydrocide", where downstream stakeholders are left increasingly without usable water, is an approaching reality in these countries [47]. Action is urgent before the water supply and quality destruction makes it impossible to get out of the poverty trap in developing countries.

The scale of water pollution is huge. A thought-provoking model study demonstrated how the devel-

Photo: Mats Lannerstad

Photo: SIWI

opment of persistent pollutants (PCB, DDT, dioxin and hundreds of others, many of them hormone disruptors) might spread through water-related feedbacks to influence human health through i.a. drinking water and food [48]. The pollution may even have dramatic impacts on world population. The study's most extreme scenario indicated a disastrous outcome if no extra wastewater treatment were added and only river dilution was relied upon for reducing pollutant concentrations. The result would be a dramatically reduced world population culminating around 2040. In other scenarios, the effects of different degrees of water pollution abatement efforts were analysed. Assuming a doubling of current wastewater treatment, and the addition of dilution water through desalination, the population shock around 2040 was reduced so that world population would stabilise after recovery at around 6 billion, as Figure 5 shows [49].

These scenarios suggest that persistent pollutants are a fundamental, global-scale issue for the 21st cen-

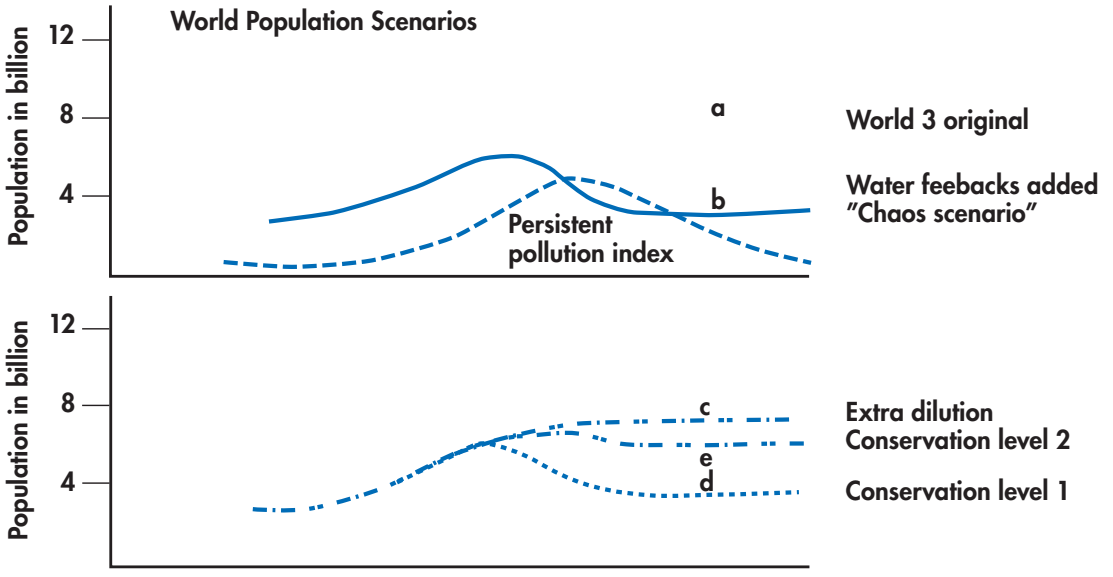

Figure 5. Persistant pollution may seriously impact world population unless decisive efforts are made to bring down the water pollution levels. The figure shows four scenarios: the water blind model of the Club of Rome (a, World 3 original); the outcome when water feedbacks have been added to that model and relying only on river dilution (b, "Chaos scenario"); if all the dilution needed is added through desalination (c, extra dilution); and for two alternative levels of water reuse and and wastewater treatment (d, conservation level 1; e, conservation level 2). Source: [49]

tury and must be dealt with soon in order to avoid a threatening hydrocide in coming decades. Solutions are known, such as treatment at the source, clean production, water reuse, wastewater treatment, and banning of persistent organic pollutants.

Even if extreme, the study signals that pollution abatement is urgent. Other sources concur that persistent pollutants can be magnified million of times in the food web, that humans are feeding at the top of the food web, that the pollutants accumulate over time in body fat of living creatures, that male sperm counts have diminished dramatically since the 1940s and that women transfer pollutants stored for many decades to their fetus/children during gestation and breast feeding [50]. These substances are found everywhere – even in the Arctic – and disintegrate extremely slowly. Fish contamination with hazardous chemicals through food chain processes is for example a major concern of the Japanese [51]. Anti-fouling paints for boats and aquaculture nets have been shown to generate reproductive abnormalities with strange sex ratios of sea snails sold on the seafood market. The Global International Waters Assessment reports that persistent pollutants are already widespread [52]. Severe persistent chemical pollution is reported from seven hot spot water regions and moderate pollution from another 34 water regions.

The Water Pollution Abatement Challenge

The developed world has concentrated much of its efforts on wastewater treatment but has not been able to stop pollution from agricultural chemicals. Eutrophication is therefore widespread. In the developing world, the crisis of water pollution is steadily increasing. Radically improved water pollution abatement is therefore fundamentally important if safe water supply for all is to be achieved in the next few decades [53]. The hydrocide threat has to be averted by a combination of knowledge and opportunity. The buttons to push to avoid widespread toxification of the water are not only in the public and private sectors; there are also strong components of ethics. Mutual respect between different catchment stakeholders is essential.

The importance of decoupling economic development and water pollution cannot be overemphasised [54]. It is well known that in the industrialised countries "common sense ain't common". The most common strategy involves mixing different contaminants and waste streams, relying on dilution and causing degradation. In the decoupling process, polluting industry and agriculture must both contribute – they are both crucial. While several major multinational firms have now entered a pollution abatement process, the developing world's dynamic, small- and medium-scale industries pose enormous problems.

In some cases wastewater could be seen as a resource for both water and nutrients that could be marketed after reclamation [55]. Urban wastewater can be reused both in the city and in the periurban area as a potential resource for food production, both for farmers themselves and for the urban market. An alternative approach for cities and settlements may involve separate treatment of different sources close to the source and conversion of waste to valuable substances. This would involve a decentralisation and recycling of both water and waste products in small units.

While water scarcity is helping to drive expanded wastewater reuse, its expansion towards reuse of water and nutrients in combination should be analysed to bring the nutrients back to the soil. The water reuse

Photo: SIWI

is particularly welcome since an increasing number of river basins are already overcommitted and no uncommitted water remains to meet expanding water demands. Different cases have demonstrated that alternative water sources for urban areas include rainwater and desalination – the latter now becoming increasingly realistic in terms of production costs.

Minimising Industrial Pollution Load

Since the costs of a ruined water resource may be considerable, positive action is occurring in the developed world [56]. A Global Compact has been formed for multinational industry in co-operation with the United Nations. A European Water Framework Directive, constituting a new legal instrument, and prescribing clean water bodies and aquifers by 2015, was recently adopted by the EU Parliament and the EU Council.

Water pollution abatement initiatives in small- and medium-scale industry can be complex [57]. A typical situation in India may involve several hundred tanneries along a small river, for which a common effluent treatment plant was the original idea proposed. Even if public awareness was high and expectations great, the financial and institutional dilemmas are difficult. A typical situation in China may necessitate closing down more than 10,000 units to achieve a substantial reduction of industrial wastewater, but problems remain because of low environmental awareness and a polluting economic structure of industry (such as paper, leather and breweries).

In facilitating compromise-building, mutual respect between different catchment stakeholders is essential. In this process, polluting industry and agriculture must contribute. While several major multinational firms have now entered such a process, the developing world's dynamic, small- to medium-sized industry remains at arms-length. The link to poverty eradication and higher incomes through large-scale employment from a multitude of small-scale industries poses enormous problems [58]. There are cases of court-ordered closures of such industries that cannot be enforced due to a lack of societal acceptance – they are counteracted by a soft political and regulatory system. Even where court orders have sentenced closure of heavily polluting industries, they may reopen silently for economic and employment reasons. The situation may lead to spontaneous social mobilisation, where citizens start marching up the river looking for the offending industrial polluter.

Water Quality Regulation Challenges

A proactive approach is needed to water quality deterioration – streams can no longer be seen as sewer pipes. Experience shows that fees for point source pollution may reduce loads by encouraging use of best available technologies. In the agricultural sector, practices are needed that reduce the discharges and leakage of nutrients and hazardous chemicals, but pollution fees are not appropriate on a global basis. In looking for solutions for mediation of the looming world water crisis, the social and political sciences have an important part to play, not only engineering and environmental science. An interdisciplinary approach is therefore imperative.

The polluter pays principle should be complemented by the Prevention Pays Off principle, PPO [59]. Since it will be in the interest of a downstream city to invest in the life support system upstream that delivers its life blood, the issue of downstreamers offering compensation to upstreamers is now being raised, as are feasible ways for resource transfer and overcoming legal barriers.

Pollution control programs will be difficult to implement unless it is known "who uses how much water and for what purpose, as well as who the wastewater dischargers are and what the quality of their discharge is" [60]. For water users and wastewater dischargers to be willing to accept limitations, they must have legal certainty of their rights to abstract water and release wastewater. This makes water use rights administration a crucial component of water pollution abatement. Experiences in Mexico, Uganda, South Africa and Sri Lanka show the fundamental importance of legislation being "feasible" in the sense of institutional capacity to implement it. These different precautions make regulatory development a lengthy process which leads to a usable tool in the end.

Unfortunately the response time involved in water pollution abatement is extremely long, first due to social barriers, and later to hydrological barriers in terms of slow water exchange [61]. Policy makers, for their

Photo: SIWI

policy development efforts, must be made fully aware of these unavoidable delays in water quality response.

Concluding Reflections

What we know

- the scale of the pollution problem
- large contributions from small- and medium-scale industry in developing countries
- biodiversity decline in aquatic ecosystems
- the long response time of water systems after cutting down pollutant output
- the need to attack the pollution problem at the source
- two modes of pollution abatement are available: forcing and stimulating

What we need to know more about

- credibility of scenarios to the long-term effect of persistent pollution, resilience of human health to water pollution
- the seriousness of the hydrocide threat
- why public pressure to abate pollution isn't stronger
- how to move towards more clean production
- a Prevention Pays mode

Securing Catchment-Based Balancing of Water-Related Activities

Photo: SIWI

The catchment is the battleground in the fight to win clean water [62]. But this will demand new thinking in the minds of people. First of all, the conviction must be clear that change will be inevitable – it is part of the process of socio-economic development. But it is not only in individual minds that new thinking is needed. Water should be seen as the common lifeblood of the basin as a whole. Cities, for their long-term development and sustainability, must see the catchment of its water sources as assets for development to be protected from upstream overexploitation and water quality degradation. Mutual upstream/downstream partnership and solidarity, and protocols for shared water resources are interesting models with confidence-building as a fundamental component.

Urban Areas Viewed in the River Basin Context

The water flow from the water divide down to the mouth links all activities in a river basin. This places urban areas squarely in the river basin context. As cities expand – in the developing world often doubling in 10–20 years only – their traditional water sources become insufficient. An expanding city paves over the land surface, hindering groundwater recharge, thereby complicating water supply based on wells. It also tends to pave over water reservoirs and tanks, forcing the city to seek new water sources from more remote areas. More people also represent a demand for more food, timber and other renewable resources, requiring substantial amounts for the biomass production process.

The basin location influences the water problematique [63]. Upstream cities tend to be groundwater dependent and suffer from groundwater overexploitation of decreasing water table. This raises needs for expensive water transfers from near-by river basins. Midstream cities are vulnerable to floods, silt flow and upstream pollution. Remedial action may include rainwater harvesting from rooftops to get household water, and reforestation of the catchment to protect from silting. Downstream cities may not only suffer from salinity intrusion due to aquifer depletion, but are also highly vulnerable to upstream activities, especially industrial pollution and flooding.

As mentioned, a contributing problem is that upstream polluters lack incentives to avert pollution due to the evacuating ability of the river. What would cause industries not to pollute? The suggested paradigm shift towards Prevention Pays Off, moving towards a philosophy of asset management, is therefore desirable since the catchment provides the lifeblood of all human activities in the catchment [64]. The mutual dependence among the catchment stakeholders is not yet well understood by politicians, since catchments are out of sight and therefore out of mind. Moreover, municipal programs are often judged in a five-year perspective, while the 20-year perspective needed to cope with doubling populations may often be seen as luxury in poor countries.

Hydrosolidarity Through Upstream-Downstream Partnership

Due to the mutual stakeholder dependence, management units for river basins are needed which work towards a long-term goal of hydrosolidarity. One example is the river parliament [65] now proposed in an India strong on democratic tradition as a way to bring upstream and downstream stakeholders together [66].

Catchment dynamics originate from hydrological realities, and cannot be neglected if foreseeable problems are to be avoided [67]. All water-related activities in a catchment have to be orchestrated for compatibility: water-impacting land and water use, water-dependent land and water uses and ecosystems, as well as water-consumptive terrestrial ecosystems and water-dependent aquatic ecosystems. Successful catchment management depends on involvement of all stakeholder groups, which can be difficult to identify comprehensively.

Conflict of interest is the normal state of affairs where water, flowing by gravity, physically links different water sectors and upstream and downstream users and uses [68]. Water managers therefore need to recognise that they are not operating in a vacuum, but rather in a complex political and economical framework. In the long run, water reuse is necessary to break the deadly link between population growth (which ironically is due to

Photo: SIWI

better environment and hygiene) and water shortage. In making compromises socially acceptable, stakeholder participation is central.

To secure this societal acceptance of unavoidable trade offs between interacting water-related interests, successful catchment management needs to find ways to involve relevant catchment stakeholders, a rather difficult group to identify [69]. On the one hand, there are primary stakeholders like polluters, user associations, authorities and local NGOs. On the other, there are groups whose welfare is influenced or at stake by water resources management decisions.

Coping with Hydroclimate Variability

The North and the South (concepts used because of lack of better wording) are faced with completely different realities of risk and security. The South remains involved in the approach of the 'hydraulic mission' [70], i.e. mobilising more water to meet still rising water demands. A person in the North perceives no immediate risk since his basic needs like food and shelter are already secured. In contrast to North America, where water storage per person exceeds 6000 m^3/yr, many African countries have less than one percent of this [71]. Thus, their respective perceptions of the environment and its problems are often quite different, and environmental concern is perceived as a luxury.

On the controversial issue of dams and reservoirs, a remarkable conversion of opinions has occurred in recent years [72]. Today, increasing emphasis is placed on social and environmental aspects. One fundamental difficulty (other than the extensive resettlement often associated with large dam schemes) is that negative impacts are often diffuse and less visible than positive ones, such as increasing economic activities and electrical-grid expansion. Large regional differences between the North and South are evident, with the former talking about dam decommissioning and alternatives to dams, while the latter have to solve the problem of making a yearly rainfall lasting only 100 hours accessible for use during the rest of the year, as Figure 6 illustrates [73]. Multi-criteria approaches are therefore needed to replace the conventional reductionist approach based only on monetary estimations.

Water-energy linkages imply that water storage and regulation strategies have to be flexible to handle the demands both for hydropower and for irrigation water, which together often exceed what is realistic [74]. Although integration of the water and

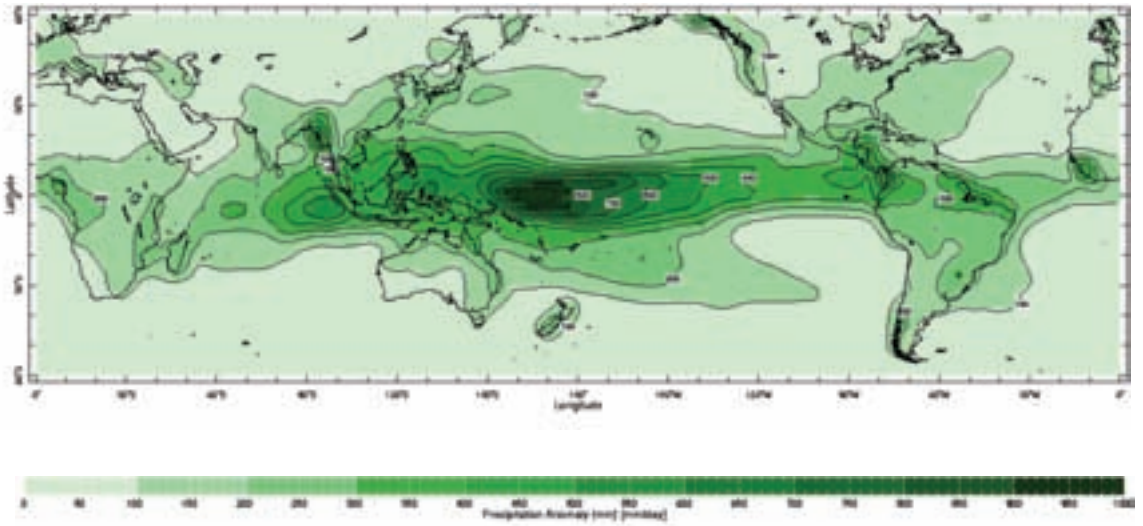

Figure 6. Rainfall is highly unreliable in the tropics as opposed to the temperate zone. The map shows average rainfall anomaly in mm (root mean square of monthly anomalies). Source: [73]

energy sectors would seem self-evident – and a key issue for effective resource management – all that is sensible is not easily implementable.

Coping with Floods

Given the monsoon climate dominating large parts of the developing world, these populations are especially vulnerable to floods [75]. In the general debate, potential linkages are thought to exist between land-use changes and floods. More recent analysis shows, however, that floods are unique in character and caused by extreme meteorological inputs or failing infrastructures. Land-use changes have significant impacts only in small basins and for moderate floods, but are difficult to identify for extreme floods and large basins. At the same time, the impact of floods is often related to changes in land use.

Not only treatment plants in cities but also economic activities in general are vulnerable to floods and inundations, a risk that is likely to increase with the scale of urbanisation [76]. Since floods are unavoidable and part of the climate and hydrology, they have to be coped with. Long-term strategies are therefore needed, and a paradigm shift is occurring from flood protection to flood mitigation. This means a responsible structure must be in place with the capability to forecast, warn and react, but also adequate resources allowing such preventive and reactive response.

Balancing Consumptive Use and Water for Aquatic Ecosystems

There is an evident link between downstream biodiversity and human activities upstream in the drainage basin [77]. This is reflected in aquatic ecosystems being those which have been suffering the largest loss of biodiversity in recent decades. The water that provides habitat of these ecosystems, reflects the integrated result of all human activities upstream: both upstream losses through consumptive water use, pollution loads added and agricultural chemicals leached. Measures to protect aquatic biodiversity, therefore, have to be taken upstream in the drainage basin by, for example, addressing land use and pollution load.

Much work in recent years has examined so-called environmental flows, to indicate the minimum residual

Photo: SIWI

streamflow for downstream aquatic ecosystems. Environmental flow has been suggested to be of the order of 20 percent of the average flow in countries with a definite dry season, and 50 percent in temperate zone countries with less seasonal variations. Although current efforts have basically addressed only water quantity, water quality is probably an equally fundamental determinant behind the 50 percent loss of biodiversity suffered since 1970. Within the European Framework Directive a sophisticated analysis is currently ongoing on translating "good water status" into water quality components [78].

The balancing of humans and ecosystems is also fuelling the interest in needs for priorities and trade offs. The World Wildlife Fund's approach is to focus on particularly valuable ecosystems, based on freshwater ecoregions, and identified as especially biodiverse drainage basins. Altogether 34 such basins had been identified in 2003.

The way to implement a desired balancing between consumptive water use and water for aquatic ecosystems will have to be part of a catchment planning process, starting from the downstream end by defining ecological bottom-lines in terms of the minimum residual streamflow needed and then moving section-wise upstream defining water allocation and quality conditions at each section border – an approach discussed in the Yellow River in China [79].

Photo: SIWI

Competing for Water with Plants

There are widespread misconceptions around the contributions of forests in terms of water flow, dry season flow, reduction of floods, water purification, etc. [80]. Field studies have shown that none of these perceptions are generally true: competing processes are at work, with often quite site-specific results. Some of these misleading perceptions might be due to a confusion between spatial and temporal differences: on the one hand, observations of forests being associated with particular phenomena like more rainfall, higher dry season flow, cleaner water, etc., and on the other hand effects of intentional switches in land use from one vegetation to another (deforestation, afforestation).

This broadened water perspective brings into focus also the rainwater partitioning process on the ground between the vertical green and the horizontal blue water branches, the role of vegetation and soil in influencing that partitioning, and how the partitioning can be managed by clearing, reforestation, afforestation, etc. South Africa has illustrated the potential of vegetation management for increasing blue water availability. The Working for Water programme, a megascale water conservation project involving six ministries, is now ongoing, [81]. The dual aim is to gain another ten percent of annual runoff and to protect biodiversity by a country-wide clearing of invasive alien water-consuming trees without natural enemies, earlier introduced by forest companies. The effort hopes to engage some 40,000 individuals over a 30-year period.

Concluding Reflections

What we know

- the serious scale of river depletion
- the need to balance the interests better between upstream and downstream

What we need to know more about

- how to orchestrate water-related catchment interests for compatibility
- how to arrive at socially acceptable trade-offs between competing interests
- how to arrive at formal accountability of stakeholders and whose interests they really represent

Photo: Rebecca Löfgren

Water Governance and Strategic Actions

Impact of Globalisation

Water management in developing countries is significantly exposed to processes of globalisation, especially the difference between rapidly acting market-oriented changes which are linked to the investability of countries and integrates them into the global economy, and countries with the slow-track globalisation, linked to the emergence of other weaker types of global linkages [82]. The latter types of countries are increasingly marginalised from the world economy and include many African countries with savanna zone climates, where coping with both an escalating water scarcity and an expanding HIV/AIDS pandemic is extremely challenging.

In countries with fast-track globalisation, water management is significantly different from the case in marginalised countries with slow track globalisation, where local communities in rural areas play a larger role than the urban sector.

Urban-Rural Linkages

There are close linkages between water and energy [83], including those between the need for access to water to produce energy, and the need for energy to get access to water and to treat the wastewater. Closer links and integration are therefore essential for a cross-sectoral water and energy management. A dialogue is essential on electricity production and use of water as well as the need of the water sector for energy to function efficiently.

Increased food production to feed a growing humanity will be an issue of both water, nutrients and pesticides, and also incorporate difficult compromise building [84]. In poor countries, the choice between increased food production and food import is difficult, both due to lack of foreign currency and to the need for food security related guarantees. For irrigated agriculture, local water loops are promising where urban wastewater, after treatment and reclamation, can be reused for peri-urban irrigation.

Coping with the Increasing Complexity

Water management must become proactive rather than crisis-driven [85]. The conventional setup of sectoral water management institutions is in itself hardly

capable of coping with the present water problems alone. They demand the ability to take an integrated approach to water, land use and ecosystems on the one hand, and address the role of water for socio-economic development on the other. One key component is the legal system and the rules and roles involved. Rules have to be sound, address key challenges, be accompanied by enforcement and be realistic and doable.

Since water management is increasing in complexity, the next generation of professionals will have to be able to handle such complexity [86]. Among the biggest challenges today is to avoid compartmentalising water management [87]. Thus, a great challenge is to break intellectual and institutional barriers. Catchment area plans are an important mechanism towards this cross-sectoral approach. Events like droughts might act as external forces and help promote an intersectoral consensus. In cases where there is strong distrust in society, this might be a stumbling stone in efforts to trigger the move towards catchment-based planning. Basically, stakeholders need to experience the value of giving up the single sector objectives and vested interests.

Scientists have clear problems in addressing the man-land-water-waste system as a whole, with all its physical and socio-economic interactions. It is not that scientists are unaware of the multidimensional character of landscapes, but more related to the difficulty of addressing practically a complex and dynamic system. Scientists and bureaucrats are generally sitting within their well-defined boxes, looking over a partial reality. Other stakeholders in the basin, on the other hand, have vested interests. In many cases, the problems are well-diagnosed, solutions are known and yet the progress is minimal. What stands out as extremely clear is the strong social science components in terms of

- Driving forces behind water demands
- Barriers that stand in the way when going from knowing to doing
- Incentives to influence the behaviour of stakeholders

Photo: SIWI

Photo: Mats Lannerstad

Fundamental barriers are related to legislation, enforcement, operation and maintenance logistics, infrastructure financing, and inflexible administration paralysed by complexity.

Securing a Socially Acceptable Outcome

Stakeholder involvement is critical to achieving societal acceptance of the outcome [88]. There have to be rules for the participation process to secure legitimacy of viewpoints and legal recognition. Water professionals (expertise with water issues as one of its main focuses) have to assist in problem analysis, and provide easily understandable explanations. Successful cross-sectoral dialogues also depend on access to terminology that bridges the understanding gaps, and on the development of an easily understandable language. An overarching and integrated catchment-based analysis and management does not necessarily depend on the existence of a particular river basin organisation, but could exist under other institutional forms. Institutional arrangements have to allow a crosscutting dialogue, but the form will have to vary between countries. Thus, there is a clear difference between the form and the content.

Actors and stakeholders differ with respect to emphasis on self-interest compared with broader views of community. Participation should not be seen exclusively as a power-game between self-interested stakeholders. A crucial question is how individuals differ in their ability to 'internalise' the interests of others. Less prominent, but still key, stakeholders have to be identified and engaged in the decision-making process. Three aspects need attention: actors (those able to influence the outcome), agenda (priorities, value orientation) and arena (place where actors or stakeholders can meet) [89]. There has to be a 'balanced' participation of various stakeholders, avoiding dominance of 'established stakeholder groups' and industry stakeholders. 'Stakeholder burnout' must be avoided for those who want to participate but feel that their influence on outcomes is small or negligible.

Photo: Mats Lannerstad

Feminisation of Water Management

The World Water Vision 2000 was a global effort to get a government-level breakthrough around the world before the water supply and quality destruction makes it impossible to get out of the poverty trap in developing countries. It aimed at a widely shared vision of the desired world by 2025, and a framework for action how to reach it. It was, however, criticised as representing the efforts of a large community of senior men. In order to represent a "consensus" it would have required a second round of consultations to include also the female half of the world population.

In all water-related activities it is essential to involve women. Men and women tend to see problems quite differently, a difference that society must be able to handle and benefit from [90]. What roles women can play strongly depend on the conditions under which they live, the culture, the traditions and the education level in society. The world is not as homogenous as the water profession often believes; global generalisations often give an incorrect picture. Moreover, the mind-sets of gender specialists are very different from those of senior water managers and decision makers. It is essential to differentiate between women as water users as opposed to women as professionals. In Latin America as in many western countries, women are involved on many different levels already: as decision makers, managers, operators, etc., and the number of female students continues to expand. In urban situations, women may form powerful pressure groups, as in the city of Monterrey in Mexico [91]. In rural areas in the developing world women tend to play the role as main water providers, both for the household and for economic activities.

Women can contribute to transforming the decision-making process through more focus on water as something to share and care about, rather than to fight about. Against a background of policy science theory, a distinction has been hypothesised between a first de-feminised phase during the infrastructure-oriented supply augmentation era [92]. This engineering-dominated phase, with focus largely on infrastructure development, is in certain regions later followed by a water deficit and societal adaptation era. This is a time of re-feminisation, since gaining societal acceptance has become an essential component of

water management. Women have therefore to be consulted on their own water needs as custodians of large groups of users. For this purpose, they must also enter into both the policy making and decision making processes.

Strategic Actions

The concept of water resources management itself is somewhat misleading in the sense that the challenge is rather to both involve and thereby to manage the people depending on, and making decisions about the water. On one hand, there are primary stakeholders like industries, user associations, authorities and local NGOs. On the other, there are groups whose welfare is influenced or at stake by water resources management decisions.

Water governance is a new catchword to highlight the importance of the soft components of water resources management [93]. It stands basically for a combination of policy and management. It includes processes of making choices, decisions, and trade-off evaluation. It covers a whole package of diverse content with the aim of managing the whole nexus between land, water, ecosystems and society: legislation, institutions, stakeholder participation, reallocation, water banking, policy, politics, provision of water professionals, financing, incentives, etc. It includes dialogues in which three main partners will have to be involved – government, private sector and civil society – turning the process into a 'trialogue'. It is essential that governance also gives voice to marginalised people.

The governance concept will have to be unpacked and disentangled to see the functions of its different components: to secure, to avoid and to foresee [94]. This includes:

- Secure socially acceptable and environmentally feasible water supply/dry sanitation, food production, energy production, etc.,
- Avoid hazards from floods, droughts and bacteriological pollutants, and
- Foresee impacts such as those of adding pollution load to the water, reducing both the usability of the water downstream and the biodiversity there, or impacts of increased consumptive use upstream reducing the river flow and its dilution capacity, degrading water habitat and therefore both fishcatch and biodiversity.

Communicating with Politicians and the Public

It is imperative to improve the basic understanding of water issues among politicians and policy makers apart from the public. The simplistic appearance of water issues on the high-level global political agenda is vastly insufficient. It is imperative to generate in the political establishment a shift in thinking regarding water issues and how they may be challenged. Water's deep importance for development is a message of fundamental importance to be propagated at the highest possible political level – a major pedagogical task [95].

In order for water experts to reach decision makers, messages must be framed so that they are easy to understand. Politicians tend to be "prisoners of their voters" and thus can principally best be reached through the latter, although the voters generally represent vested interests [96]. Public awareness through news media is subject to severe constraints due to

Photo: Mats Lannerstad

unwritten collective media rules. Stories have to have local relevance, and preferably be linked to local individuals. A message has to be properly tailored to be interesting, and preferably to be cut into a sequence of short messages.

In order to understand water policies there is a need to be aware of the 'sanctioned discourse' [97] – the prevailing opinions and views that have been legitimised by the political elite and which forms a dominant belief system or 'worldview' [98].

Photo: SIWI

The water crisis cannot be averted without innovations and lateral thinking, involving also women with their different mindsets, without the fresh mind of the young generation and without human ingenuity in general. The professional's task is to find the tools for that change. A key will be social mobilisation, education of the general public, development of adaptive capacity and utilisation of the spiritual values associated with water. This represents a new paradigm of governance and social mobilisation, where the government acts in a facilitating and law-making capacity, while stakeholder representatives are made part of the governance system. Only if water use, management and stewardship is made everybody's business is it likely that a stable, yet dynamic and creative situation is reached.

Concluding Reflections

What we know

- water governance includes processes of making choices, decisions and evaluating trade offs
- stakeholder involvement is critical for achieving societal acceptance of water-related decisions
- rather than managing water resouces, the challenge is to manage people depending on those resources
- women play a central role in water management

What we need to know more about

- how to best achieve a basic understanding of water issues among politicians and the general public
- how integrated water resources decision making may be implemented in practice
- why large groups, such as women, are still to a very large extent excluded from water-related decision making
- how more effective water governance systems may contribute to a more sustainable economic and social development
- capacity needs for application of multi-stakeholder and cross-sectoral processes for water resources management

Final Remarks

Photo: SIWI

Water is linked intimately to development in general [99]. In spite of this, the international policy debate suffers from a tunnel vision centred around one of the Millennium Development Goals, i.e. to reduce to half by 2015 the number of people without safe water supply and sanitation. As the debate tends to remain eddying around this all-but challenging issue, it has tended to turn a blind eye to other issues involving much more water. Thus, while 90 percent of the international policy debate focuses on meeting domestic water needs, food production requires two orders of magnitude more water and therefore deserves at least the same interest. Moreover, water links most of the MDGs, directly or indirectly, due to its many parallel functions.

Besides urban security, an equal interest is now required on the consumptive water needs to feed a growing humanity, on the water requirements of developing biomass energy to replace non-renewable fossil energy sources, on getting out of the deepening problem of polluting the central life elixir shared by both humans and ecosystems and on encouraging clean production.

Unfortunately, the crucial role of water for socio-economic development, especially in arid drought-stricken countries, remains poorly understood by politicians, decision makers and the general public. It is evident, however, that water must become part of the political agenda since it is a key element in poverty eradication, health improvement, nutrition of undernourished people and an army of unborn babies, protection of indispensable ecological services and regional development. It is essential that environmental management strategies properly focus on the interdependence between the environment and socio-economic development. Strategies should clearly visualise how effective water management policies contribute to a more sustainable economic and social development.

In this complex and constrained situation, it is essential that we stay optimistic. We should learn from history and the role that coping with water constraints has had for the development of human civilisation, and the lessons that it carries regarding human ability and smartness. There are ample opportunities for human intelligence. Incentives for change should be linked to personal benefits and hopes for a better life. For this, there is a need to understand what drives people's attitudes and expectations, and the resulting resource demands and the resource problems.

We also need to understand the fundamental differences between North and South in terms of water management needs, practices and processes. One fundamental difference is the difference in rainfall patterns and variability, in other words the water input itself that forms the base for livelihood conditions. While the rainfall in Western Europe is rather uniform over the year, developing countries are largely located in the tropics and subtropics with monsoon climates and long dry seasons. Also, a number of other differences (physical, institutional, legal, cultural, economic) add to the fact that the issue of water management practices in the South can not be identical to that in the North. This is an issue to which the water profession has to give much more attention.

"Globalisation" of the human mind must in other words be avoided – situations, vulnerability and challenges differ considerably between different regions of the world. Diversity in thought has to generate local solutions and alternative approaches and discourage prescribing of simplistic solutions to complex problems.

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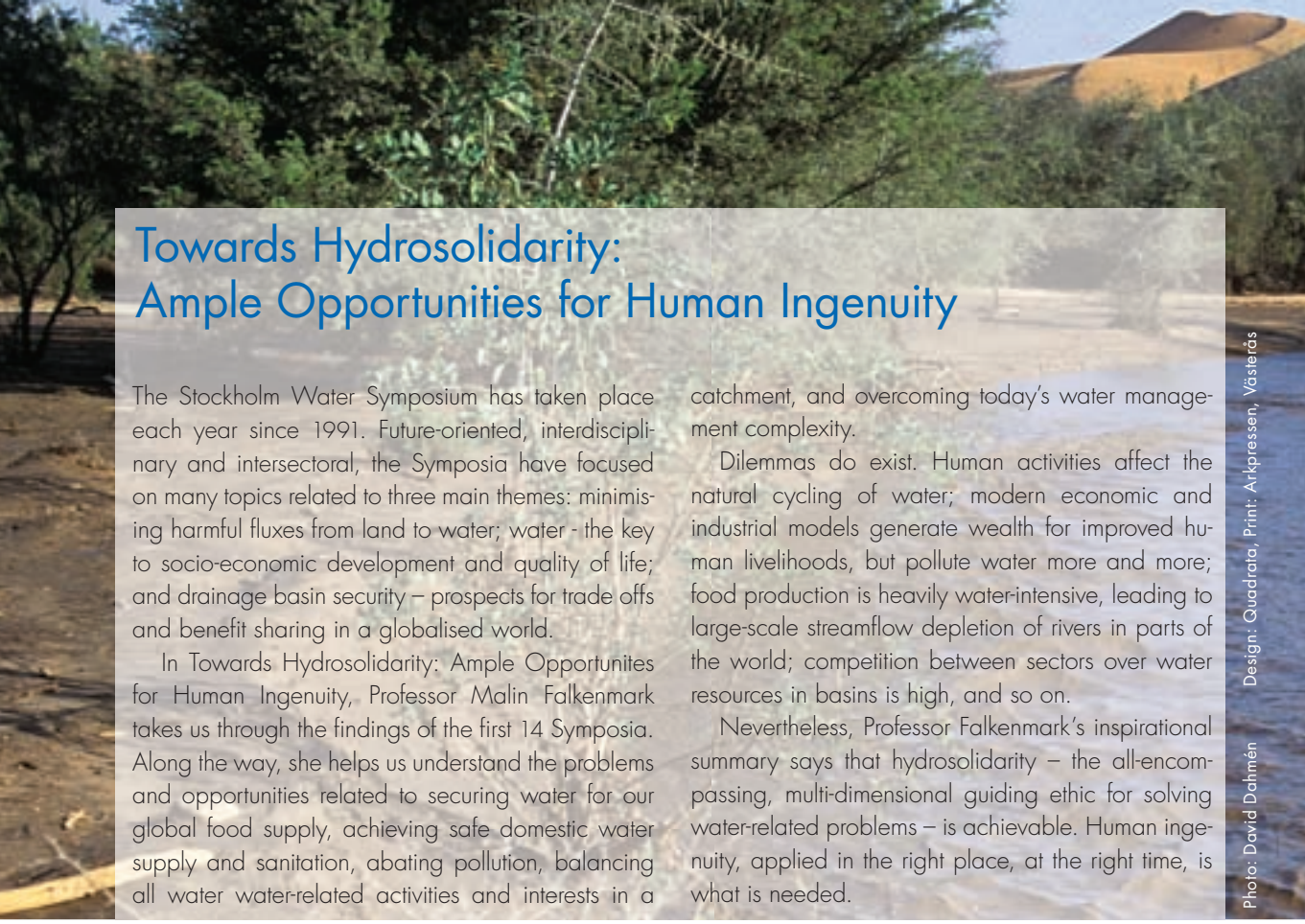

Towards Hydrosolidarity: Ample Opportunities for Human Ingenuity

The Stockholm Water Symposium has taken place each year since 1991. Future-oriented, interdisciplinary and intersectoral, the Symposia have focused on many topics related to three main themes: minimising harmful fluxes from land to water; water - the key to socio-economic development and quality of life; and drainage basin security – prospects for trade offs and benefit sharing in a globalised world.

In Towards Hydrosolidarity: Ample Opportunites for Human Ingenuity, Professor Malin Falkenmark takes us through the findings of the first 14 Symposia. Along the way, she helps us understand the problems and opportunities related to securing water for our global food supply, achieving safe domestic water supply and sanitation, abating pollution, balancing all water water-related activities and interests in a catchment, and overcoming today's water management complexity.

Dilemmas do exist. Human activities affect the natural cycling of water; modern economic and industrial models generate wealth for improved human livelihoods, but pollute water more and more; food production is heavily water-intensive, leading to large-scale streamflow depletion of rivers in parts of the world; competition between sectors over water resources in basins is high, and so on.

Nevertheless, Professor Falkenmark's inspirational summary says that hydrosolidarity – the all-encompassing, multi-dimensional guiding ethic for solving water-related problems – is achievable. Human ingenuity, applied in the right place, at the right time, is what is needed.

Photo: David Dahmén Design: Quadrata, Print: Arkpressen, Västerås

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