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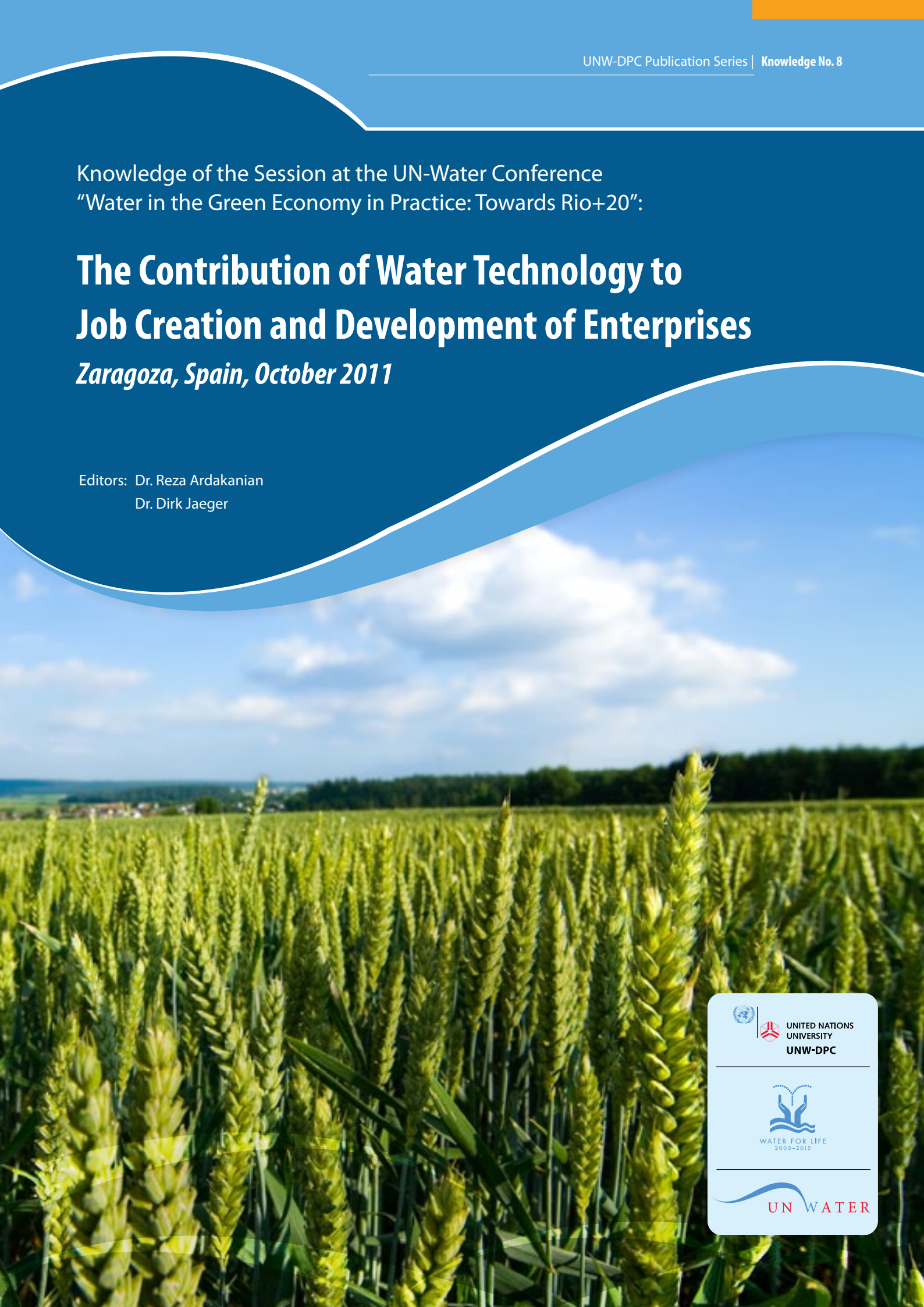
Knowledge of the Session at the UN-Water Conference
"Water in the Green Economy in Practice: Towards Rio+20":

The Contribution of Water Technology to Job Creation and Development of Enterprises

Zaragoza, Spain, October 2011

Editors: Dr. Reza Ardakanian
Dr. Dirk Jaeger



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FOREWORD

The International UN-Water Conference on "Water in the Green Economy in Practice: Towards Rio+20" was held in Zaragoza, Spain, from October 3 to 5, 2011, and organized by the UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC).

Around 60 participants from around the world were invited to discuss and outline the role of water as a key factor in the green economy. Participants included stakeholders, representatives of UN-Water, representatives of UN agencies and experts working in projects reflecting the importance of water in the green economy.

The main goal of the conference was to identify mechanisms and tools enabling the transition towards the green economy and to discuss lessons learnt from specific projects using different approaches to green the economy. The findings of the conference are intended to feed into the preparations for the UN Conference on Sustainable Development (Rio+20) being held from June 20 to 22, 2012, in Brazil.

UNW-DPC's contribution to the success of the conference in Zaragoza was manifold: as a conference committee member, UNW-DPC was involved in the conceptual design of the conference and its realization.

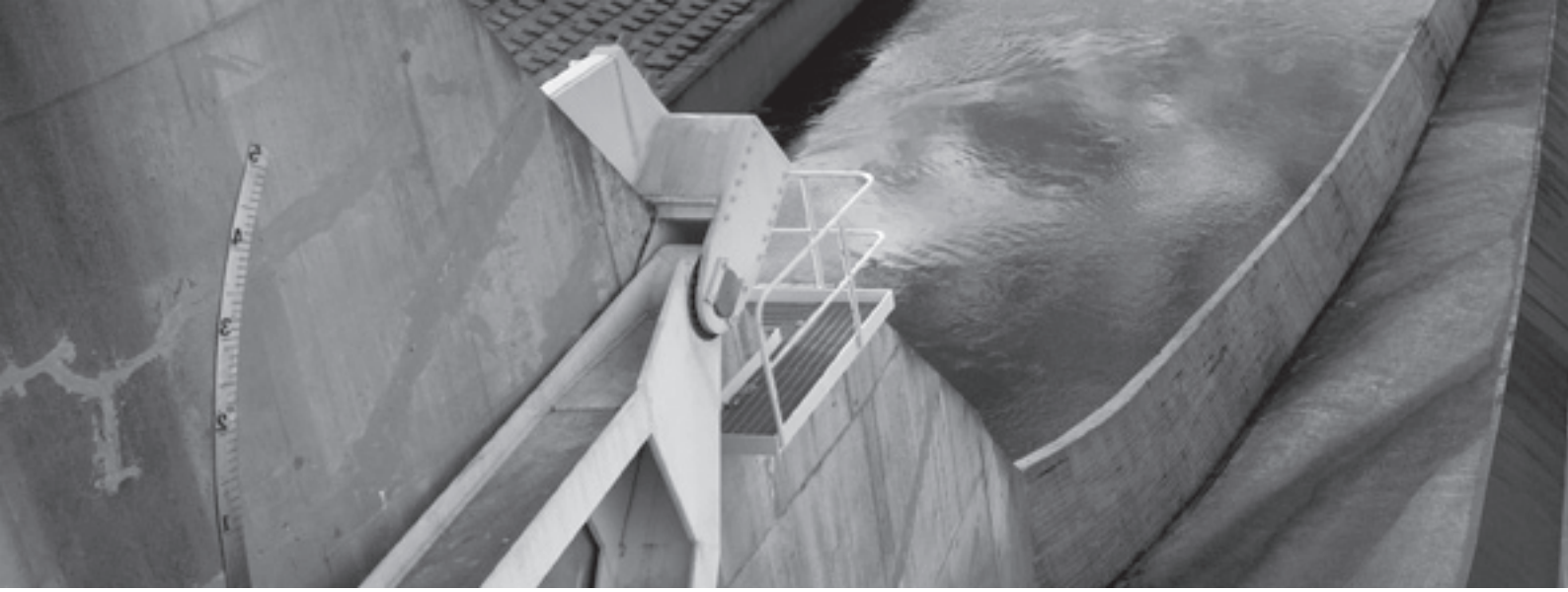
In addition, UNW-DPC organized one of the key sessions of the conference, session no 5: "The contribution of water technology to job creation and development of enterprises". This session was composed of an overview presentation and a plenary discussion by several water technology experts including the moderator, Professor Karl-Ulrich Rudolph, the Coordinator of the UNW-DPC working group on "Capacity Building in Water Efficiency", and three further panelists: Dr. Rajiv Gupta of the Government of Gujarat, India; Mr. Dieudonne Sawadogo, General Secretary of the National Water and Sanitation Company (ONEA), Burkina Faso; and Dr. Hani Sewilam, Programme Officer of UNW-DPC in his function as capacity developer in the MENA region.

Finally, UNW-DPC organized the presentation of six case studies related to water technology within the "Market Place" of the conference.

This report provides comprehensive summaries of all case studies presented during the conference and includes an introduction by Professor Karl-Ulrich Rudolph on "The Contribution of Water Technology to Job Creation and Development of Enterprises".

I wish you an enjoyable read.

Dr. Reza Ardakanian
Director, UNW-DPC
Bonn, Germany



WATER TECHNOLOGY SESSION: KEY FINDINGS AND LESSONS LEARNED

THE SESSION ON "THE CONTRIBUTION OF WATER TECHNOLOGY TO JOB CREATION AND DEVELOPMENT OF ENTERPRISES" PROVIDED A SIGNIFICANT CONTRIBUTION TO THE INTERNATIONAL UN-WATER CONFERENCE ON "WATER IN THE GREEN ECONOMY IN PRACTICE: TOWARDS RIO+20", HELD IN ZARAGOZA, SPAIN, FROM 3-5 OCTOBER 2011. IN ALL, THE SELECTION OF CASE STUDIES PRESENTED DURING THE KEY SESSION AND THE MARKET PLACE REPRESENTED A WIDE RANGE OF REGIONS AND PERSPECTIVES, TOUCHING ON THE FOLLOWING MAIN TOPICS, AMONG OTHERS:

1. THE ESTABLISHMENT OF A STATE-WIDE WATER GRID, MICRO HARVESTING FACILITIES, INTER-BASIN TRANSFER AND CONCURRENT POWER SECTOR REFORMS TO FOSTER PEOPLES' PARTICIPATION IN WATER GOVERNANCE IN GUJARAT, INDIA.

2. WATER LOSS REDUCTION THROUGH LEAK DETECTION DEVICES AND PRESSURE MANAGEMENT USING AN INTELLIGENT GIS-BASED COMPUTERIZED SYSTEM IN OUAGADOUGOU, BURKINA FASO.

3. E-LEARNING METHODS TO ENABLE INTERDISCIPLINARY CAPACITY BUILDING OF WATER EXPERTS IN EGYPT.

4. INDUSTRIAL WASTEWATER TREATMENT BY MODIFIED PROCESS TECHNOLOGY FOR IRRIGATION PURPOSES OF URBAN GREEN.

5. HYDROPOWER SUSTAINABILITY ASSESSMENT PROTOCOL AS A TOOL FOR ASSURING ENHANCED SUSTAINABILITY OF HYDROPOWER PROJECTS, AND

6. REGIONAL IMPACTS OF THE THREE GORGES PROJECT.

This introductory chapter serves to summarize the key findings and lessons learned from the case studies presented at this session.

Water Technology

The case studies presented at this session demonstrated that water technology is readily available to help address existing and future water stress and insecurity due to climate change. However, these forms of water technology cannot simply be transferred (e.g., from North to South) but need adaptation to local conditions and needs.

One main finding was that the early stage of industrialization in least developed countries (LDCs) offers not only challenges but also avenues and opportunities for leapfrogging and adopting technologies, which offer greater energy and resource efficiency. The case of the City of Windhoek, Namibia, is a good example of a cost efficient and simple solution for adopted and adapted water technology.

In general, the following conclusions relating to water technology could be drawn from the case studies and discussions presented at this session:

- Good and harmful impacts need to be accounted for before implementing technological innovations.
- Water technologies can contribute to more efficient use of water resources by positively impacting water resources assessment, reduction of water losses, waste water treatment, and efficiency of water utilities.
- Green water technologies mostly benefit public customers (municipalities, water associations, municipal companies).
- Water technology cannot solve water management problems, e.g., deep tube wells that had become necessary due to over-drafting of water, resulted in high energy consumption for pumping and also in decreased water quality due to excessive fluoride levels in Gujarat, India.
- Technological initiatives to improve drinking and irrigation water supply have to be duly complimented by grass-roots people's participation in the management of water distribution.
- Progress and development of new adapted technologies in the water sector are often "collateral gains" from technological advances in higher valued sectors outside the water sector.

Water Resources Management/Governance

It is clear that the on-going trend towards urbanization will contribute to the further degradation of water resources due to contamination and reduced natural groundwater recharge. In addition, the effects of climate change will probably accentuate the gap between sustainably available water resources and demand. Overall the message is clear, however: We are not short of water, we are short of water management. Interdisciplinary cooperation and governance can go a long ways towards better management of water resources. To tackle the problems of water scarcity, water management clearly needs to be carried out in an interdisciplinary environment. In conjunction, political

governance and donor finance have been able to open up opportunities to unlock green technology development potentials, such as for launching pilot projects for water loss reduction under a public-private partnership scheme, generating savings for the benefit of the utility which exceed the expenses. Water management can further serve to influence land use planning in order to locate water-demanding agriculture, industry and settlements in areas which have water resources available at low costs.

In all, the following specific suggestions and lessons learned emanated from the experts presenting these case studies in the session at the Zaragoza conference:

- It is necessary to balance the importance given to both micro-water harvesting and large water resources development projects.
- Ownership of water structures by local communities is generated through subsidies combined with loans while accounting for communities' in-kind contributions ("gospel of the dirty hands").
- Water engineers must cooperate with socio-economists and environmentalists to sustainably manage water resources.
- Main water technologies have been developed and are ready for use, however, it needs political will to actually implement them.
- Water supply and management improved through new water governance models in India where the state's role of governance shifted from provider to facilitator and empowered village-level institutions to establish community-managed rural water supply systems through extensive capacity building.

Water Reuse

In Windhoek, wastewater is now being considered a valuable resource, knowledge which brings with it significant changes in governance and institutional development in the local water sectors (i.e. treated with care and reused instead of simply discharged to a sensitive environment). Reuse of treated wastewater has a huge impact on the environment in all cases where the reduction of fresh water intake prevents negative environmental impacts and reduces or eliminates contaminated wastewater discharge. Additional information on the benefits and use of wastewater is being provided in a multi-year, multi-stakeholder UN-Water project on the "Safe Use of Wastewater in Agriculture," which will result in regional workshops and capacity needs assessments throughout 2012 and 2013.

Water Loss Reduction (WLR)

First of all, it is clear from these case studies and examples that activities to enhance water use efficiency lead to green growth. To improve water supply systems, a best practice approach has been to prioritize measures of water loss reduction, since these are relatively easy to implement and very effective ("low-hanging fruits"). Reliable water supply due to WLR raises public appreciation and care for water structures and supports utilities in introducing tariff systems for service compensation, thereby increasing willingness to pay for water services. It is clear that the higher the costs of water production are, the more water-saving/water loss reduction measures are undertaken and the more sophisticated water recycling technologies become profitable.

The following specific examples and best practices were furthermore provided in this session:

- In order to serve more consumers in Burkina Faso, especially those from low income areas, the necessary increase of capacity of water supply systems is easier to be achieved through water loss reduction than the utilization of additional water resources, i.e., through new river dams, desalination plants or underground well fields.
- The real value of water and water utilities is not reflected in the effort and status of WLR in many countries.

- Introduction of water loss reduction technologies and programmes need to be supported by capacity development activities.
- Economic development, public health and a comfortable environment are all based on the quality of water and sanitation onsite, which improve significantly with water efficiency increasing through WLR.

Tariffs

Regarding the introduction of water tariffs, a key message is that market prices and political will decide over green or not-green growth. Subsidised water tariffs, for example, suppress green growth. In order to ensure the sustainability of water utilities, tariff systems need to be developed to allow for full cost recovery while supporting the poor. Once the tariffs recover the full-costs of water supply measures, enhancing water loss reduction will be profitable in many countries. It is interesting to note that much more money is spent on energy, IT and cell phones in many countries than on water and sanitation.

Capacity Development

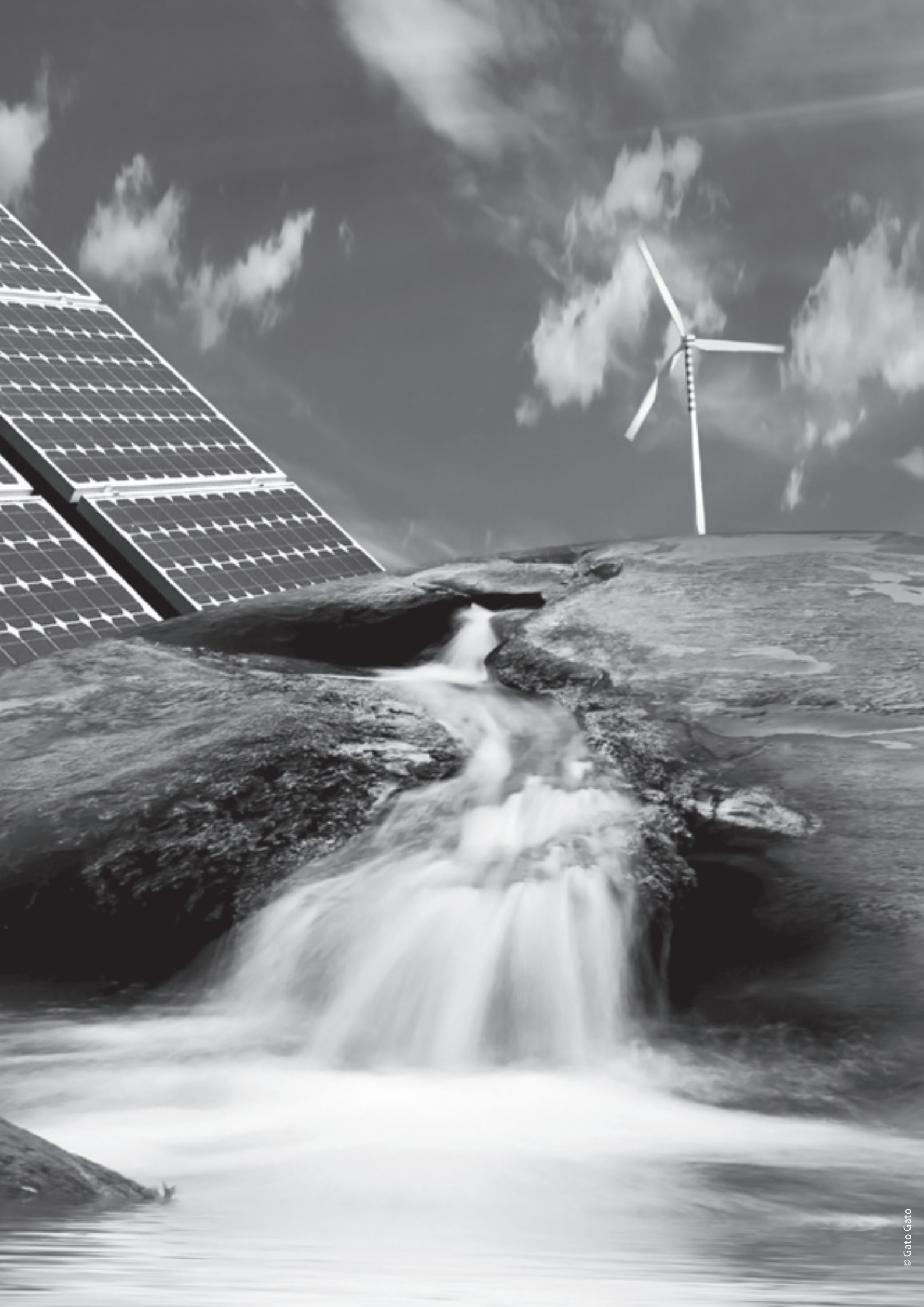
Water technology plays a key role for economies transitioning towards green economies; therefore, capacity building with respect to competencies in water technology is essential. Capacity building and knowledge transfer are critical tools without which developing countries and transitional economies will remain disadvantaged and unable to reap environmental, social and economic benefits. Capacity building is needed on several levels: institutional capacity building is important and needed to ensure to effectively integrate sustainability into design, construction and management of hydropower projects and to assess alternative options. At the same time, training of different stakeholders, networking of national experts, information exchange and dissemination of proven experiences are essential for the implementation of interdisciplinary water management techniques. Finally, international cooperation and local collaboration on research and development (e. g. through networks or clusters) contribute to developing, absorbing, adapting, nurturing and disseminating innovation and green technologies.

Some of the most successful methods to enhance capacity building in water management and sustainable water development to date have been blended learning techniques, which combine e-learning, face-to-face learning and self-study. Some of the key examples focused on in this session included the following:

- Knowledge transfer is one of the key issues to help the MENA region to cope with the scarcity of water resources and the serious impacts of climate change.
- Web-based Learning Management Systems support capacity development in water resources management by providing flexible access for the target groups from any location and at any time.

Hydropower

Although it has been acknowledged that hydropower is a sensitive issue, if it is developed and managed in a sustainable manner, it can provide national, regional and local benefits, and has the potential to play an important role in enabling communities to meet sustainable development objectives. In fact, hydropower as a clean, renewable energy source contributes directly to global low-carbon energy goals, and therefore to climate change mitigation. The benefits of hydropower are manifold: hydropower reservoirs help address climate change adaptation through enhanced water security and management; they provide flood mitigation, water storage for irrigation and other purposes, and contribute to stable downstream flow regimes.



2 | INTRODUCTION

THE CONTRIBUTION OF WATER TECHNOLOGY TO JOB CREATION AND DEVELOPMENT OF ENTERPRISES

KARL-ULRICH RUDOLPH [1]

> "GREEN TECHNOLOGIES CAN CONTRIBUTE TO GREEN GROWTH BECAUSE THEY HAVE THE POTENTIAL TO CREATE NEW BUSINESS OPPORTUNITIES, MARKETS AND JOBS. THEY CAN BOOST WATER AND ENERGY USE EFFICIENCY, CONTRIBUTE TO ACHIEVING THE MILLENNIUM DEVELOPMENT GOALS AND TO BUILDING THE GREEN ECONOMY. INNOVATIVE WATER TECHNOLOGIES CAN INCREASE THE AMOUNT OF WATER FOR DRINKING, AGRICULTURE, AND MANUFACTURING AND CAN ALLOW US TO USE WATER MORE EFFICIENTLY. THIS CAN BE DONE BY TECHNOLOGIES IN AREAS SUCH AS WATER RESOURCES ASSESSMENTS, REDUCTION OF WATER LOSSES, WASTE WATER TREATMENT, EFFICIENCY OF WATER UTILITIES, BIO TECHNOLOGIES, ETC.

Technology development – if combined with public awareness – can also contribute to decreasing the water footprint through increased conservation, reuse and recycling, and greater efficiency in most water-using sectors, particularly agriculture. This can enhance overall poverty reduction and socio-economic development. Research and development (R&D) and innovation are central to the green economy since they can reduce the costs of existing environmentally sustainable technologies and deliver the new technologies that are needed to advance efforts to cut emissions, reduce waste and increase resource efficiency. In both developed and developing economies, innovation plays a critical role in generating employment; enhancing productivity growth; increasing energy, carbon, water, and material efficiency; improving performance of goods and services and creating new markets and jobs through knowledge creation and diffusion".[2]

[1] Prof. Dr. Dr. Karl-Ulrich Rudolph, Coordinator of the UNW-DPC Working Group on Capacity Development in Water Efficiency, Institute of Environmental Engineering and Management at the University of Witten/Herdecke gGmbH, Alfred-Herrhausen-Str. 44, 58455 Witten, Germany, e-mail: mail@uni-wh-utm.de; www.uni-wh-utm.de

[2] Media Brief: Technology Tool UNW-DPAC

Technological Challenges for Green Growth in the Water Sector

The challenges to implement advanced and more efficient water technologies and management have been highlighted in the SICK WATER REPORT of UNEP and UN-HABITAT, 2010, especially for urban areas:

"Already, half of the world's population lives in cities, most of which have inadequate infrastructure and resources to address wastewater management in an efficient and sustainable way. 21 of the world's 33 megacities are on the coast where fragile ecosystems are at risk. Without urgent action to better manage wastewater, the situation is likely to get worse: By 2015, the coastal population is expected to reach approximately 1.6 billion people or over one fifth of the global total with close to five billion people becoming urban dwellers by 2030. By 2050, the global population will exceed nine billion".

The combination of (a) population increase, (b) the rise of specific water consumption, (c) improvements in public health and welfare, (d) the trend towards urbanization (causing problems like contamination of raw water resources, widely spread land sealing with prevention of natural groundwater recharge), and (e) global climate change will definitely lead to more pressure on politicians and industry to resolve water problems. See figure (1) "Population increase and water resources".

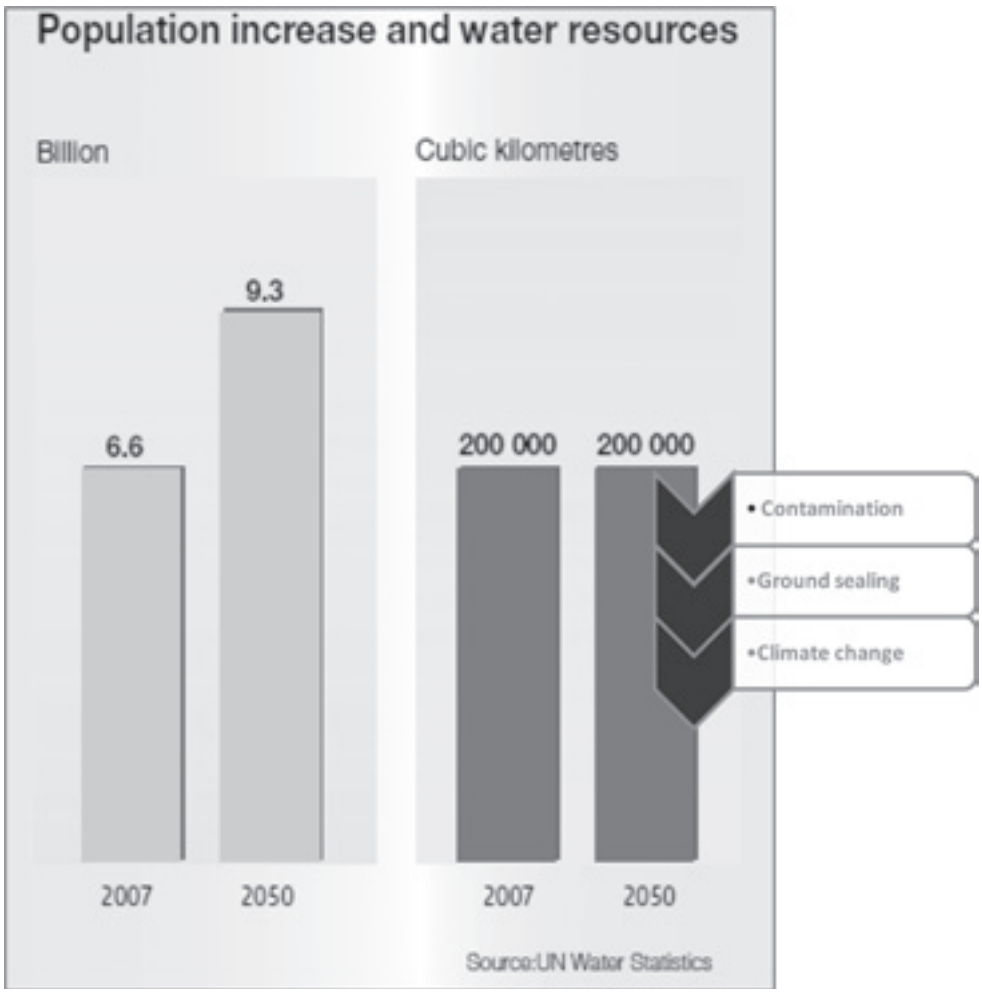


Figure (1): Population increase and water resources

Water supply is a regional issue, with shortcomings depending on location and time (season). This is a significant difference to energy supply, where problems are not related or limited to regions, like the greenhouse gas emissions.

From the point of view of water management, water-demanding agriculture, industry, and settlements should (preferably) be located wherever cheaper water resources are available. However, there are other motivations in spatial planning, obviously dominating, which means that nobody can prevent water-intensive activities in arid or in urban areas which are short of water.

The need for improved technologies to expand supply-water production and to enhance water efficiency (the latter can be understood as driver of green growth) is visualized in figure (2) "Hierarchy of water production costs".

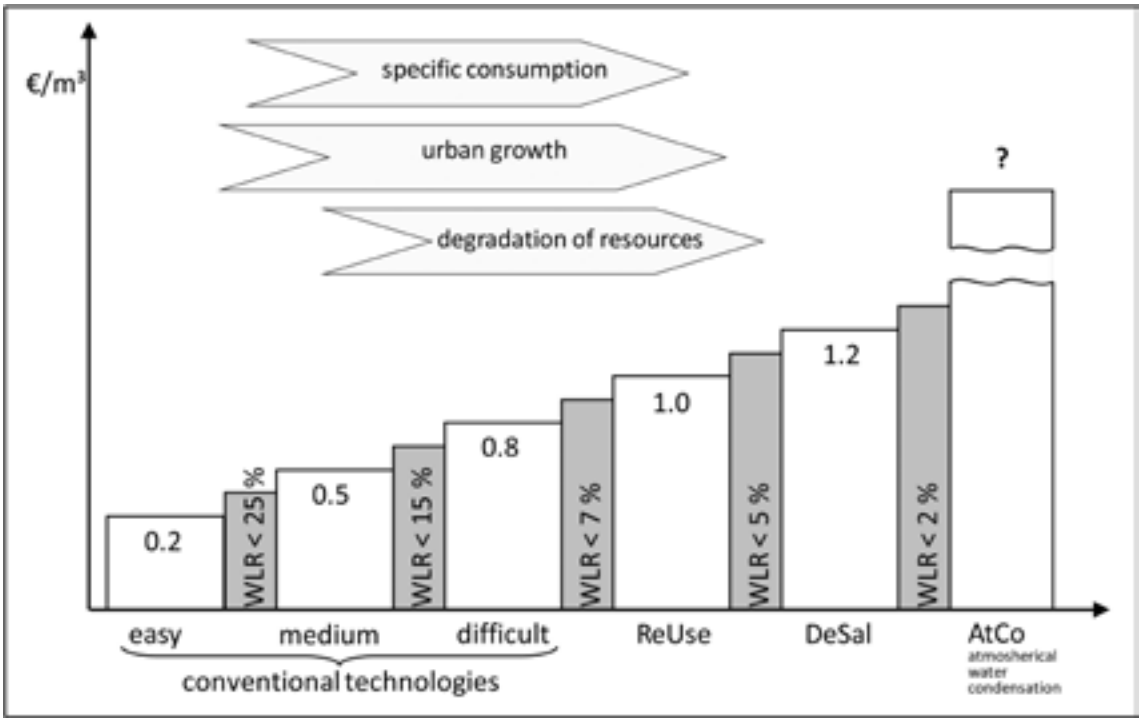


Figure (2): Hierarchy of Water Production Costs

The higher the costs of water production are, the more water-saving measures are undertaken. In turn, water loss reduction (WLR) improves and more sophisticated water recycling technologies become profitable. WLR, showcased in figure (2), is one important method within a broad toolkit to enhance water efficiency.

In locations where water production is easy and cheap (like in towns with clean mountain water that needs no pumping to reach the consumer's tap), it may well be acceptable to tolerate water losses of 25 %. But as soon as water production relies on pumping deep groundwater or even the purification of contaminated raw waters with significant technical efforts, water loss should be decreased. The economic optimum might range between 15 % and 7 %. In water-scarce locations, the conventional water production will need to be accomplished with more expensive technologies like water reuse (waste-water recycling or downcycling) and brackish water or seawater desalination. Under such circumstances, water loss rates above 5 % would not be feasible economically. In cases with very high water production costs (e.g. for supply water condensed from the air, atmospheric water supply), the water losses

should be as low as around 2 % (about the very best benchmark currently achieved in water distribution networks in Germany, where the national WLR 2010 is reported to be 6.8 %).

Looking at the effort and status of WLR in many countries world-wide, one could say that the real value of water and water utility is not reflected appropriately in day-to-day water operations, and there seems to be much room for profitable WLR measures in many places.

Besides solutions for more water efficiency (i.e. efficiency in water consumption like water-saving technologies and water demand management, water loss reduction, water reuse, utilization of unused water resources as with rainwater harvesting, etc), there are technological challenges which contribute to a non-greentech growth. Such technologies are seawater desalination, which requires considerable energy consumption, especially if it is oil-, coal- or gas-powered, and energy-consuming water reuse technologies (like multi-stage membrane technologies with reverse osmosis). However, even for those technologies, a trend towards greentech is happening (e.g. towards solar-powered desalination etc). Another issue is the improved comfort and welfare leading to water consumption in the "health and wellness sector", ranging from necessary medical applications to luxury applications, such as private pools and spas, in arid and water-scarce regions. This field of water consumption bears a "green image" but often implies extensive water use. It cannot be regarded as a "green growth" element, at least not in water-scarce locations and seasons.

Overall, the technical challenge in the water sector is pushing a multi-coloured growth, with strong elements of green growth. Depending on market prices and the political costs of raw water resources and environmental pollution through wastewater discharge (which is very much a matter of governance and law enforcement), the market powers (which, in the long run, are stronger than political talking) will focus either on GREEN or UN-GREEN growth.

The role of the water sector regarding green growth is ambiguous due to the fact that it is incorporating strong drivers as well as strong barriers for green growth business development.

Value-wise, the water sector is less important (in nearly all countries world-wide) than the energy sector, the IT/communication sector (industrialized, fully developed countries) or strong industrial branches like the automotive sector. Furthermore, within the water sector, water supply is definitely stronger, value-wise, than wastewater and sanitation. This may be a contradiction to the real importance water supply and sanitation certainly have for the survival of deep land economies. And, it may be a strong contradiction to official statements from scientists, NGOs and politicians. Nevertheless, it is a fact that much more money is spent on energy, IT and cell phones in many countries, as well as in many slum settlements, than on water and sanitation. Technology-wise, there has been huge progress and positive development of new, adapted technologies in the water sector. Anyhow, many of those are "collateral gains" from higher-valued sectors, like membrane technologies (first applied in industry and marine technology), IT/automation (most hardware and software was originally developed and applied in higher-valued fields of business asset management etc) and high-tech bio-technologies (many of those coming from the organic chemistry or pharmaceutical industry).

Barriers for Technology in the Green Economy

"Technological innovations may have unprecedented good or harmful impacts in the future and accountability for the harmful impacts is often lacking. Much depends on the framework in which it is developed and disseminated. More could be done to assess social, environmental or other impacts more thoroughly and holistically before innovations are embraced, disseminated and promoted on a large scale.

The technological development cycle does not exist in a vacuum. It is influenced by government priorities, market interests, social trends and risk thresholds, and power dynamics. As a result, policies and market mechanisms do not necessarily direct technological innovation to areas or people who need it the most nor to fields where they advance sustainability. If technological development is not regulated, the current uneven technological capabilities may aggravate existing inequalities between the developed and developing world and perpetuate polarities of haves and have nots.

Structural or policy obstacles to technology transfer and dissemination due to intellectual property barriers, lack of investment in research and extension or lack of funding, may lead to regional disparities in access, potentially aggravating the current income gaps. Such gaps in access already exist, with small pockets of private sector interests holding the majority of public-interest patents and intellectual property rights. Cultural obstacles to technological uptake, such as the resistance to the recycling of sewage water for drinking, can *delay the adoption of technology.*" (WWDR4)

"Technology is often seen as a proxy for progress and sometimes raises unrealistic expectations as a cure-all for what ails society. More consideration could be given to broader implications of its development and dissemination – or lack thereof in some sectors." (SG Panel)

TABLE (1): BARRIERS TO GREEN GROWTH WITHIN THE WATER SECTOR

	WATER SECTOR SPECIFICS	GREENTECH AS A "STATE-GUARANTEED MARKET"
1.	The water sector (in almost all countries) is state-guaranteed (especially wastewater and sanitation, which cannot survive without enforcement of environmental standards).	Based on environmental standards set and enforced by the state (e.g. wastewater treatment plants for natural water body protection), greentech can be profitable or not.
2.	The water sector (in almost all countries) is state-regulated (the state defines which standards, rules, organizational structures, and technologies are admitted to that market).	Wastewater treatment seldom serves the final beneficiary (this would be the water consumer, not the municipal utility or other, asking for private technology providers, operational services, etc).
3.	The water sector is dominated by public entities (only 5 to 10 % of water services are provided by private industry, nearly 98 % of water resources world-wide are owned and governed by the public sector).	Water greentech is beneficial mostly to public customers (municipalities, water associations, municipal companies).
4.	Due to the "natural monopoly" of network-bound infrastructural services (supply or disposal), there is no, little or limited competition.	Greentech providers have to obey public procurement procedures (in developing countries strongly influenced by donor banks).
5.	Water tariffs and wastewater charges are not "real" market prices due to the lack of competition under the economic balance of supply and demand.	Greentech providers are mostly contractors in a service market fed through state-fixed "prices" (water and wastewater fees, solid waste charges, carbon credits, subsidies for regenerative energies...).
6.	The need for better water services is not the same as the demand for better water services.	Wherever a public water utility does not fulfill demand, customers who can afford it will seek for other "nonofficial" services.

"Inadequate governance and decision-making systems may create market distortions towards inefficient technologies, for example through inappropriate subsidies or a lack of long-term vision." (WWDR4)

"The focus of investments is too often exclusively on those areas that will make returns at shorter term, i.e. specific renewable technologies that some governments favor more than others with specific subsidies." (UNECE)

"The current economic and financial crisis lowers the financial potential of many countries to implement innovative water technologies." (UNW-DPC)

"The lack of dissemination of knowledge may hinder the application of water technologies and the implementation of procedures and techniques." (UNW-DPC)

To understand the barriers against the desire for green growth in the water sector, it is necessary to highlight the specifics of the water sector, especially those in DDM (donor-driven markets) in contrary to CDM (customer-driven markets).

Furthermore, greentech rarely is a "stand-alone-business":

- Sometimes, environmental protection is the main purpose of a business (e. g. a sewage sludge incineration plant)
- More often, environmental protection is one of several purposes of an investment (e. g. for a solid-waste-fed combined power plant)
- Very often, environmental protection is just a side-effect of an investment (e. g. for recuperation of energy and valuable components).

The Approaches

The Importance of Success Stories

Looking at the needs in day-to-day operations of water utilities (which must take care of a reliable and safe continuous water service and must try to avoid risks and experiments) and taking into account the situation of political decision-makers governing the water sector and local utilities (who want to be re-elected and tend to avoid the introduction of promising technologies and solutions unless all related political risks are eliminated), it is obvious what the water sector needs. Green growth must be explained, yes, but much more valuable than general explanations and overwhelming arguments are success stories that include references to locations, situations, site conditions, and cultural aspects comparable or transferable to the case under discussion.

Considering Exceptions

There may be some important exceptions like (1) biological water process technologies, such as the activated sludge process, forest removal, algae production or no-dig-pipe rehabilitation with robot-driven underground machines, as well as (2) the anaerobic process technology for biogas generation from organic waste. These technologies have been developed pre-dominantly in and for the water and sanitation sector, with a spill-over of inventions and technical progress to other industry sectors.

Learnings from other Sectors

Envisaging this background, water technology researchers, project developers and pro-ject managers may be advised, in general, to have a closer look at other sectors of industry which are technologically advanced compared to the water sector, e.g., (1) network construction and management for precious chemical

gases, (2) the technological set-up of the supply chain in automotive industry or (3) monitoring and control systems in industry, etc.

Choosing Technologies

In the past, as long as water was not scarce and precious, it was reasonable to apply low-tech plus low-cost technologies in the water sector, even when this meant neglecting certain negative side effects like secondary contamination (e.g. emissions of volatile organic compounds from water plants) or energy consumption (such as for robust pumps or aerators with limited efficiency but easy maintenance and reliability, cost-efficient in times when power was cheap). Nowadays, as the transition to greentech is needed and turns to become economically viable, there is a lot to do in the water sector.

Figure (3) highlights water losses in different countries. The UN Water Working Group on Water Efficiency has raised the issue of SURPLUS COSTS through poor water efficiency exceeding direct productivity losses considerably.

Huge deficits, especially in the developing and emerging countries, are one side of the medal. The other side includes huge chances to develop green business when moving from low to high water efficiency.

International cooperation and local collaboration on research and development (e.g. through networks or clusters) contribute to developing, absorbing, adapting, nurturing, and diffusing innovation and green technologies.

One example, well known in the water and sanitation sector, is the progress with small scale biogas plant technologies for rural farm estates, delivering gas for cooking and heating. This could not have happened without research collaboration in process and tank construction technologies, including international as well as local players, and strong support from multilateral donors for implementation.

The least developed countries' (LDCs) early stage of industrialization offers avenues for leapfrogging and adopting technologies for greater energy and resource efficiency. They can adopt new and state-of-the-art technologies. One very important example is the advancement of analysis technology for metering water toxicity online to locate harmful substances like pesticides, hormones, heavy metals, and all kinds of non-degradable xenobiotics, etc. Even though clearly high-tech and expensive, the analysis can bring enormous

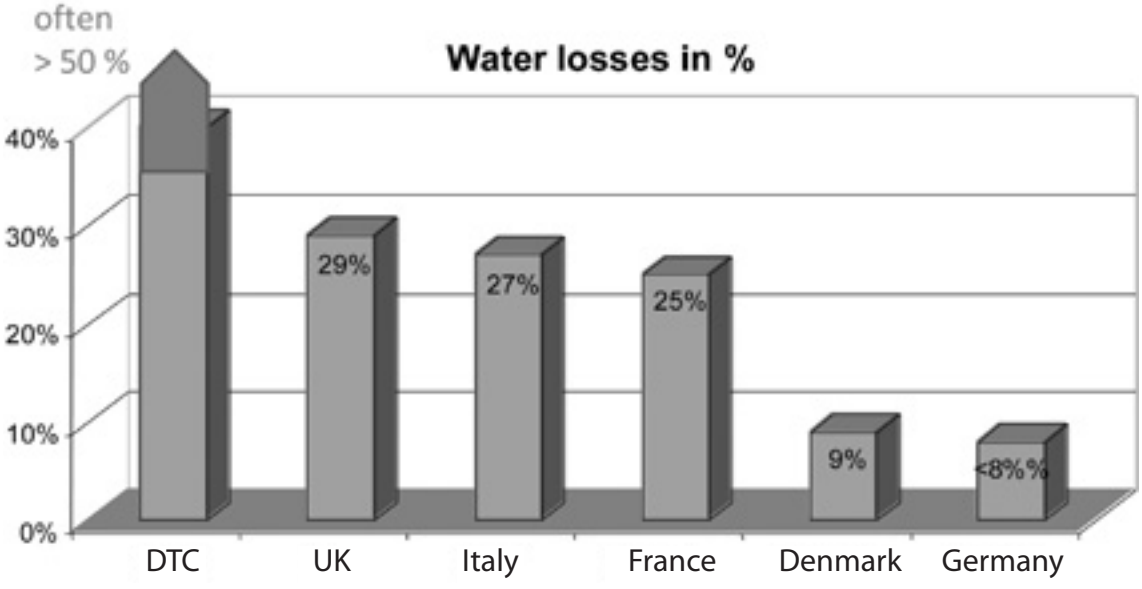


Figure (3): Shortage of water management as revealed by water losses

savings (a) for factory owners to detect and eliminate spill-overs of precious chemicals (like in factories that produce or mix chemicals for agriculture) and (b) for environmental monitoring to eradicate hazardous pollution near the source.

The experience with information and communication technologies is revealing the capacity of poor countries and poor communities to leapfrog the technological development process. One good example, although under political controversy, is the development and implementation of computer-based remote-control pre-paid systems technologies. They allow water utilities to serve poor income zones without having to provide water without revenues from tariff payment, and without powers to prevent excessive waste of water. Pre-payment systems allow to limit free water service to, e.g., 6 m^3 per connection and month.

Lessons learned from the Case Studies

Two general mechanisms can be observed which might be valuable as elements for building a strategy towards green business development:

- Political governance and donor finance have been able to open up opportunities to unlock greentech development potentials for launching pilot projects for water loss reduction under a public-private partnership scheme, generating savings for the benefit of the utility which exceed the expenses (even though, due to low water tariffs, the utility has not yet reached the level of financial sustainability).
- Greentech developments have generated technologies that have proven to be strong enough and tear down barriers and deficits in governance well-known in the water sector. One deficit is the huge gap between environmental law and the environmental situation in many developing and emerging countries due to poor law enforcement. Online monitoring of wastewater effluents, with real-time data transmission preventing manipulation in sampling and analysis data, can be a contribution to introduce transparency in an emerging country with poor law enforcement. Alternatives are decentralized technologies for water treatment and wastewater reuse that allow for small-scale investment and development outside of fixed network structures. They set a strong benchmark in water and economic efficiency and lead to "virtual competition" for non-efficient utilities. The author has seen hotels operating their own small water supply with a membrane plant, greywater reuse and stormwater harvesting after the public utility had failed to serve, at a level of managerial and technical efficiency the politicians managing the utility could never achieve.

As a general, overall conclusion, it seems justified to say:

1) Lack of water management steers water scarcity. In this world, there is no lack of water as a resource, there is a lack of water management. Once the implemented level in water efficiency is equal to good technical practice, the utmost of regions suffering water scarcity will find themselves served sufficiently.

2) Subsidized water tariffs suppress green growth. From the author's point of view, it would be wise to subsidize the poor, not the water tariffs.

3) Green business needs business structures. Develop from charity to investment and include PSP options to unlock the potential and serve the need for greentech-based water sector development.

Above statements may have to be differentiated and modified for implementation depending on political, cultural or regional priorities and conditions. This shall be a matter of the discussion to follow.

3 | CASE 1

IMPROVEMENT OF WATER SUPPLY THROUGH A GIS-BASED MONITORING AND CONTROL SYSTEM FOR WATER LOSS REDUCTION

M. YAMBA HAROUMA OUIBA[1]

THE CASE STUDY PRESENTS THE APPLICATION OF TECHNOLOGY TO ENHANCE THE EFFICIENCY OF WATER USE, SPECIFICALLY THE USE OF A GIS-BASED MONITORING AND CONTROL SYSTEM WITH GIS-SUPPORTED DYNAMIC PRESSURE CONTROL, AUTOMATED VALVES AND LEAK DETECTION SYSTEMS. IT WAS CARRIED OUT BY THE MUNICIPAL WATER UTILITY OF OUAGADOUGOU IN BURKINA FASO OPERATED BY ONEA (OFFICE NATIONAL DE L'EAU ET DE L'ASSAINISSEMENT).

Relevance of the Challenge and Objectives

In many countries of the developing world, including regions with water scarcity, water losses (technical leakage, water theft) are very high, mostly above 40 %, and often even higher than 60 %. To improve water supply and serve more consumers (preferably from low income areas, which often remain unserved), the capacities of the water supply systems must be increased. Very often, the necessary increase can be achieved through water loss reduction (WLR). WLR may be much more feasible (in economic and ecological terms) than the expansion of water production, i.e. through new river dams, desalination plants, underground well fields or else.

A pilot project has been implemented to reduce water losses within the distribution system of the municipal utility in Ouagadougou. The technical components of the process are leak detection devices, pressure and

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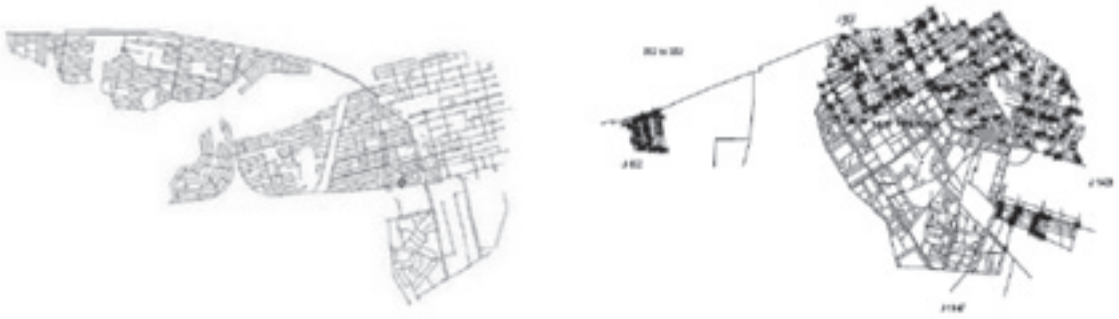

Figure (1): GIS file of the distribution zone (left), with the most critical point of pressure and water losses (right).

flow control sensors with real-time and online data transmission, automated pressure valves, and an intelligent, GIS-based (Geographical Information System) computerized system to steer the whole process. Figure (1) shows the GIS map of the distribution zone (left), with the most critical point of pressure and water losses to be controlled through pressure reduction (right part of figure (1)), as simulated with the hydraulic modelling tool EPANET.

The Drivers of Technological Change

There has been a tremendous progress in computer-based control, on the one hand for pump efficiency (accompanied by energy-efficient pumps) and on the other hand for network management, especially dynamic pressure control. This presented an opportunity to go forward with the water loss reduction programme. The driver of technological change to develop these above-mentioned technologies were, of course, water scarcity and the fact that the water losses were being too high in the utility. The basic technological development took place in other sectors of industry dealing with higher financial volumes than the public water sector. Pump efficiency, for example, was established at a very high technological level in the chemical industry for pressure control of gas pipeline networks or for oil pipeline networks in industrialized countries.

Barriers to technological Development, Adaptation and Adoption

The strongest barrier slowing down technological development, adaption, and adoption is the fact that water tariffs are subsidized and cannot be implemented in the range of full cost recovery in many developing countries because of political restraints and the need to support the poor. The greatest barrier is the lack of willingness to charge, respectively the lack of willingness to pay, for water. Therefore, the implementation of technology to reduce water loss was supported by an extensive capacity development programme to secure the necessary change process.

Lessons learned from Implementation

Implementation was successful for a limited zone within the city and service area of the utility. Due to the instable political situation in the country and on account of priorities exceeding those of water loss reduction (politically as well as financially), implementation has not been completed within the whole service.

Scaling up

Regretfully, the Water Loss Reduction Programme has not been extended throughout the region, yet, even though the perspectives of a profitable water loss reduction programme (in a priority of actions taking the "low-hanging fruits" first) has been verified successfully. With support of UNW-DPC, the scaling up of such water loss reduction technologies and programmes in other developing and transition countries could be done. One very helpful activity was a workshop with the African Water Association in Ouagadougou, where the success of the project was presented to other utilities, the lessons learned were shared and training activities for participants from all over Africa were undertaken. Furthermore, UNW-DPC has disseminated the technologies and overall management concepts, including economic and financing aspects, in other regions like Latin America and Asia.

Evaluation: Triple Bottom Benefits/Impacts

The impacts on the local economy have included the following: The local jobs created alongside the investment and continuous operations of the water loss reduction programme are visible. Yet they are still less important than the jobs created by the fact that economic development, public health, and an intact environment are based on the quality of water and sanitation onsite. All improved significantly after water efficiency had been increased through WLR. In figure (2) shows the direct monetary profit of the water loss reduction programme, accompanied by improvements of general maintenance and operations. Once the water losses are reduced from approx. 45 % to 6 % and the technical failure from 30 % to 6 %, the water service costs could be reduced from 4 EUR/m³ to 1.33 EUR/m³.

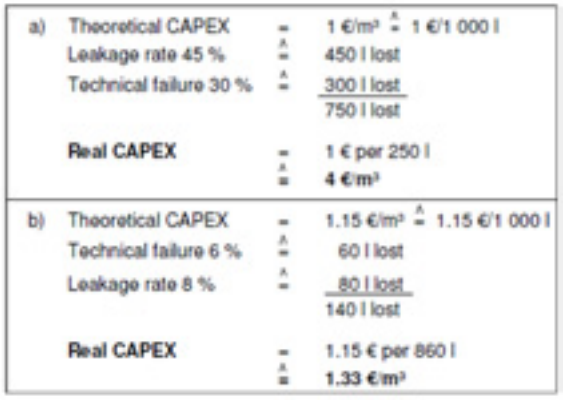

Figure (2): Water losses and technical failure cause high production costs

Additional economic gains are expected from the reduction of damages going along with water loss, so-called "surplus damages". In technical terms this especially refers reduced lifetime of the pipe network caused by mechanical stress with non-continuous supply generating hydraulic shocks. Examples of administrative terms include reduced willingness of customers to pay when they are faced with high water losses and see that other consumers are not charged or do not need to pay.

For the case of Ouagadougou, the direct savings of the water loss programme have been estimated to be around 0.8 EUR/m³. When adding the surplus costs, the total economic profit might well exceed 2.0 EUR/m³ with the external profits for public health and the gross national economic product not yet taken into account.

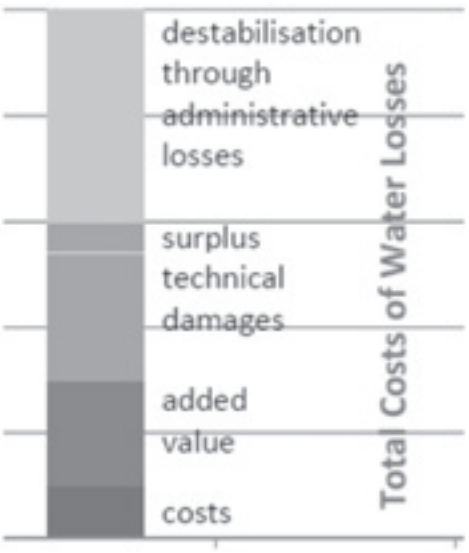

Figure (3): The sustainability benchmark for cost-benefit analysis of WLR programmes

Figure (3) indicates what should be considered when defining a "sustainability benchmark" for cost: benefit-analysis of water loss reduction programmes and target values as well as site-specific standards of water losses (set as percentage of raw water abstraction, as m^3 per day or as m^3 per pipe km).

Along with the improvements of water efficiency, the environmental situation will improve step by step, provided that the development in sanitation will follow the development in water supply efficiency.

Social impacts, poverty reduction and changes in governance are related to the performance of water supply and utility. The situation before was characterized by poor or no water supply in specific town areas and at certain times, by water theft and an attitude that it does not make sense to care about resources and public water properties. After improving water efficiency, the water utility is now empowered to introduce transparent structures and cut water theft. It has also raised the awareness among the population and customers to take care of water properties and transparency.

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4 | CASE 2

THE ROLE OF WATER TECHNOLOGY IN DEVELOPMENT: A CASE STUDY IN GUJARAT, INDIA

RAJIV K GUPTA[1]

THIS ARTICLE TRACES THE HISTORICAL WATER PROBLEM IN GUJARAT BOTH FOR DRINKING AND IRRIGATION WATER THAT AFFECTED THE DEVELOPMENT OF THE STATE, CAUSED REGIONAL IMBALANCES, AND INCREASED INCIDENCES OF RURAL POVERTY. TECHNOLOGICAL INITIATIVES LIKE STATE-WIDE WATER GRID, MICRO WATER HARVESTING, INTER-BASIN TRANSFER OF WATER, AND POWER SECTOR REFORMS HAVE CHANGED THE ENTIRE WATER SCENARIO IN THE STATE. THERE HAS BEEN A GREAT DEAL OF EMPHASIS ON PEOPLE'S PARTICIPATION IN WATER GOVERNANCE AS WELL.

Background of the Water Problem in Gujarat

Gujarat has just 2.3 % of India's water resources and covers 6.4 % of the country's geographical area. This is further constrained by imbalances in intra-state distribution. The state has an average annual rainfall of 80 cm with a high coefficient of variance over time and space and as a result droughts have been frequent. Out of 185 rivers, the state has only eight perennial rivers and all of them are located in the southern part. Around 80 % of the state's surface water resources are concentrated in central and southern Gujarat, whereas the remaining three-quarters of the state have only 20 %. On average, three years in a cycle of 10 years have been drought years. Since Indian independence in 1947, the draught years of Gujarat have been as follows: 1951, 1952, 1955, 1956, 1957, 1962, 1963, 1965, 1968, 1969, 1972, 1974, 1980, 1985, 1986, 1987, 1991, 1999, 2000, and 2003.[2]

1 Rajiv K gupta, Government of Gujarat, India [2] (Gupta, 2004)

Until 2001, drinking water scarcity posed a serious threat to human and cattle population in Gujarat. Successively, governments had to spend billions of Rupees (Rs) on temporary measures to supply drinking water by road tankers and sometimes even through special water trains. The state, which generally had a track record of peace and harmonious social ethos, even witnessed "water riots" due to severe water scarcity caused by poor water resource management.

Overdrafting of ground water (as compared to annual recharge) caused serious water quality problems due to excessive fluoride, nitrate and salinity levels. The number of fluoride-affected settlements increased from 2,826 in the year 1992 to 4,187 by 2003. The fluoride concentration in these villages ranged from 1.5 mg/liter to as high as 18.90 mg/liter. Fluoride has been the cause of extensive health damages in many parts of Gujarat. Dental fluorosis causes permanent pigmentation of teeth in children and bone deformities result from skeletal fluorosis even in adults. Other serious problems experienced due to high concentration of fluoride have been anemia, loss of appetite, nausea, and thyroid malfunction. This sometimes results in brain impairment in children, may have adverse impacts on fetuses and cause abortion or stillbirth in expectant mothers. The water problem also led to intra-state migration from drought-prone regions like Saurashtra and Kutch (western & southwestern Gujarat) to the central & southern regions of the state. Many times, this migration included a relocation of livestock and caused a shift of the prime workforce of hundreds of thousands of people, dislocating them economically, socially and culturally. Therefore, regional imbalances in Gujarat got accentuated because of increasing water scarcity.[1]

In the past, most of the drinking water supply was based on ground water. Deep tubewells with high-capacity pumping machinery were being utilized in the state, leading to tremendous electricity consumption and high carbon footprints of water supply.

Technological Initiative for Drought Proofing

During the last decade the state drew up an ambitious strategy for creating a "State-Wide Drinking Water Grid" for bulk water transmission from sustainable surface water resources to water-scarce and poor water quality settlements. Large-scale infrastructure has been created, which includes 1,987 km of bulk pipelines and more than 115,058 km of distribution pipelines. 10,781 hydraulic structures like elevated storage reservoirs with a total capacity of 1,164 million liters and 10,683 storage sumps and high ground level reservoirs with a capacity of 2,504.80 million liters have also been constructed in the state. Along with this 151 water filtration and treatment plants with a total capacity of 2,750 million liters per day (MLD) have been constructed. Thanks to the water supply grid, about 2,250 MLD of treated water are delivered to more than 10,501 villages and 127 towns in the state, ensuring safe and secure water supply to about 65 % of the state's population in draught-prone and water-quality-affected areas.

Impacts

This major technological initiative has not only largely solved the drinking water problem but has also made a significant impact on water quality issues faced in the past.

Reduction in Fluoride

All these efforts have resulted in considerable relief from the problem of excessive fluoride contamination. According to a recent survey, only 987 settlements have been found to still be affected and the range of fluoride content has also shrunk considerably.

1 Gupta, 2003

TABLE (1): STATUS OF FLUORIDE-AFFECTED SETTLEMENTS

DISTRICT	NO. OF TOTAL SETTLEMENTS	AS PER 2003 SURVEY	AS PER RECENT SURVEY	MAXIMUM FLUORIDE LEVEL (PPM)
Ahmedabad	727	120	20	7.20
Gandhinagar	424	132	2	6.27
Patan	651	246	43	13.25
Mehsana	851	176	2	4.40
Sabarkantha	2,438	531	9	6.93
Banaskantha	1,736	521	20	5.75
Surendranagar	696	205	72	8.72
Rajkot	871	126	120	5.40
Jamnagar	756	52	5	2.00
Junagadh	925	76	48	2.80
Porbandar	184	46	0	3.70
Bhavnagar	804	108	66	6.40
Amreli	650	49	146	3.20
Kutch	1,126	34	6	3.20
Vadodara	2,187	438	189	5.81
Narmada	722	49	0	2.60
Kheda	2,101	406	52	10.03
Anand	920	96	17	5.89
Panchmahals	2,531	401	86	6.40
Dahod	3,168	286	0	12.50
Surat	3,258	44	29	2.20
Bharuch	790	21	30	4.00
Valsad	3,923	2	25	1.79
Navsari	2,080	22	0	--
Dangs	326	0	0	--
Total	34,845	4,187	987	

Source: Gujarat Water Supply and Sewerage Board, 2009

TABLE (2): ANNUAL EXPENDITURE ON TANKER SUPPLY FROM 1990 TO 2009

YEAR	VILLAGE	COST (RS. IN MILLION)*
1990-91	896	23.40
1991-92	1,943	92.90
1992-93	700	14.00
1993-94	1,803	83.00
1994-95	724	24.96
1995-96	1,619	96.30
1996-97	1,642	123.95
1997-98	1,447	62.19
1998-99	1,215	41.02
1999-2000	2,987	346.20
2000-2001	4,054	436.94
2001-2002	2,959	348.11
2002-2003	3,961	475.36
Sub-total		2,168.06
2003-2004	600	47.38
2004-2005	869	92.32
2005-2006	398	77.06
2006-2007	207	17.08
2007-2008	188	14.17
2008-2009	326	13.94
Sub-total		261.95
Total		2,430.01

Source: Gujarat Water Supply and Sewerage Board, 2009 * 1 US$ ≈ Rs.46

Less Expenditure

The improved water infrastructure has also resulted in a sharp decline in expenditure on tanker water supply in the state from 2003-04 onwards. This is another indicator of the creation of water security in the state.

Reduction of Carbon Footprints

In several villages, bore wells are now utilized as a secondary source and operational hours have been reduced. Based on a random survey, significant savings have been achieved in electricity consumption. These are now available for alternative uses, which is an eco-friendly achievement. Solar pumps have also been commissioned in 260 villages in the state and about 200 more solar-based pumping systems will be installed in the near future. In various parts of the state, including coastal and also tribal areas, roof top rain water harvesting structures have also been constructed for public buildings, schools and individual households. These measures, as well as energy audits for various group water supply schemes, have resulted in substantial electricity savings.

Paradigm Shift

Many fluoride-affected settlements have been connected to piped water supply. This is a paradigm shift from dependence on drinking water supply by tankers, trains, and deep bore wells to the availability of safe surface water. Technological interventions like defluoridation through reverse osmosis have also been taken up in some villages. In the remaining villages safe water sources have been identified or created and are being used for drinking water purpose. Thus, a "vicious circle" has been transformed into a "virtuous cycle" with a win-win situation for water, energy, environment, and health sectors and considerable economic benefits. In short, this is Gujarat's technology-oriented response to the existing and future water stress and insecurity due to Climate Change.

TABLE (3): EMISSION SAVINGS IN DRINKING WATER SUPPLY

SR. NO.	PARTICULARS	ENERGY SAVINGS MWH PER ANNUM	EQUIVALENT CARBON DIOXIDE EMISSION PER ANNUM IN TONS
1.	Piped water supply to villages and towns	65,905.00	14,696.82
2.	Savings due to energy audit	5,184.78	1,156.21
3	Solar based pumping systems	611.16	136.29
4	Rooftop rain water harvesting	386.74	86.24
	TOTAL	**72,087.68**	**16,076.14**

Source: Gujarat Water Supply and Sewerage Board, 2009

New Water Governance Model

The creation of Water and Sanitation Management Organization (WASMO) was a significant shift in the role of governance from provider to facilitator, empowering village-level institutions through extensive capacity building and pro-active facilitation. Since its inception, WASMO has been able to bring in effective citizen engagement through its innovative governance model for facilitating successful community-led water supply programme throughout the state of Gujarat. Now more than 16,740 Village Water and Sanitation Committees have been established in the state that are ready to take on the responsibility of management of service delivery and water resource management at the decentralized level. More than 6,500 villages have already commissioned infrastructure and water conservation projects in a demand-driven mode. Another 4,547 villages are presently implementing the decentralized community-managed rural water supply programme in their villages with a strong feeling of ownership.

WASMO's strength lies in its organizational professionalism, innovations in governance, and strong partnerships with about 48 civil society organizations. The rural community is the central focus of WASMO's decentralized approach. Its innovation has led to the scaling up of reform processes to cover the entire state. Its professionals have created an enabling environment which has resulted in communities being fully empowered to take ownership of their water service delivery wherein operation and maintenance are secured through tariff mechanisms devised by consensus in the village assembly. WASMO has also been able to institutionalize the rural water quality monitoring and surveillance programme. The majority of villages are now able to monitor their duly-trained water quality teams. WASMO's innovative approach in Gujarat has emerged as a model for learning and exchange, influencing policy initiatives in the water sector at the national level. WASMO received the United Nations Public Service Award in the category of fostering participation in policy-making decisions through innovative mechanisms.[1]

Inter-basin Water Transfer through Sardar Sarovar Project

The Sardar Sarovar Project on river Narmada is a multi-state, multi-purpose river valley project born out of deliberations of a constitutional body and following the principles of "Equality of Right" and "Equitable Utilization" of the whole course of an inter-state river. This unique project is planned to irrigate 1.905 million ha of land, increase the agricultural production by 8.7 million tons per annum (worth US$ 430 million), generate environmentally friendly hydropower with installed capacity of 1,450 MW, and supply drinking water to 8,215 villages and 135 urban centers of Gujarat (with a population of around 20 million). In addition, it is supposed to generate 1 million jobs, mostly in rural areas, prevent rapid processes of desertification, salinity ingress, and

[1] (Modi, 2010), [2](Gupta, 2003)

TABLE (4): SARDAR SAROVAR DAM HEIGHT AND STORAGE INCREASE IN SARDAR SAROVAR PROJECT

STAGE	2003	2004	2006	ULTIMATE
Height	100 m	110.64 m	121.92 m	183.68 m
Gross storage	2,602.6 MCM (3.00MAF)	3,700 MCM (3.00 MAF)	5,265.8 MCM (4.27 MAF)	9,460 MCM (7.7 MAF)
Live (usable) storage	– –	– –	1,565.8 MCM (1.27 MAF)	5,800 MCM (4.77 MAF)

Source: Sardar Sarovar Narmada Nigam Limited, 2009

rural to urban migration being experienced in many parts of Gujarat. The catchment and drinking water supply areas of the project are precisely the zones with the highest water scarcity rates in the whole state.[2]

Increased Dam Height & Storage

With a concerted strategy and satisfactory compliance of the project obligations in terms of rehabilitation of project-affected persons and environmental measures, the dam height was raised to 100 m in 2003, 110.64 m in 2004 and 121.92 m in 2006. This facilitated a much higher increase in storage of Narmada waters. Raising the dam height and the corresponding increase in the storage capacity have significantly improved the water supply. The real benefits of the project, awaited for almost 15 years, have now started to show. The diversion of Narmada water to the main canal of the project, the world's largest lined irrigation canal, was just 705 million cubic meters (MCM) in the year 2001 but spectacularly increased to 5,195 MCM in 2003 and to 6,194 MCM in 2004. Although the water flow was decreased in subsequent years due to consecutively rain-laden monsoons, it remained to the extent of 4,201 MCM in 2005, 4,292 MCM in 2008, 5,870 MCM in 2008 and 5,870 MCM in 2009. The construction of the main canal was also completed in the year 2008 and water supplies started to be provided to the neighboring state Rajasthan in March 2008, fulfilling the real objective of this project as inter-state river project.

What's more, with the command area being covered to the extent of around 500,000 ha, significant interlinking has been achieved for many rivers through the interbasin transfer of Narmada waters using the Sardar Sarovar Canal Network.

Hydro Power

Another long-pending issue was that of operationalizing the 250 megawatt (MW) Canal Head Power House, which was built to fulfill the required water head in the reservoir. We started running this power house in August 2004. Thereafter, a river bed power house with 1,200 MW capacity was also put into operation in several phases between February 2005 and June 2006. Between August 2004 and March 2010 hydropower generated from the Sardar Saroval Project was 15,070 million kWh of electricity.

Micro Water Harvesting

The miseries of millions of small and marginal farmers due to vagaries of nature and difficult terrain conditions have been reduced through rainwater harvesting with micro irrigation structures. The local population participated in the implementation.

Sardar Patel Participatory Conservation Project (SPPWCP)

This scheme stipulated that check dams and village tanks/ponds could be taken up for construction by a beneficiary group or any non-governmental organization (NGO) with technical and financial assistance from the local representative body of the District Panchayat. Initially, a contribution of 40 % of the estimated costs was required; this was later reduced to 10 %. The rest was to be funded by the government depending upon the progress of the work. Since 2007, groups benefitting from the project have been given the option of contributing their 10 % by way of physical labor which increased their identification with the project by "the gospel of dirty hands". Six prototype designs were circulated with a maximum cost of Rs 1,000,000.

However, the beneficiary groups were also given the latitude to take up the work as per their own design if necessary and feasible. The technical scrutiny and work supervision was to be conducted by the engineers of the local body. The entire responsibility of the quality of construction of work, however, was to rest with the beneficiary group/NGO under continuous guidance and technical inputs from the government technical staff. Maintenance works for these micro water harvesting structures were to be carried out by the beneficiary group at their own expense. The result: A total of 353,937 check dams and village ponds/tanks have been created in the last eight years, providing direct benefit to over 13 million people in rural Gujarat.

Drip Irrigation: Gujarat Green Revolution Company Ltd.

Gujarat has created the Gujarat Green Revolution Company Ltd. (GGRC), a special-purpose vehicle to popularize the adoption of drip irrigation among farmers. GGRC offers attractive subsidy loans to adopters, but more importantly, it has fast-tracked and simplified the administrative procedures for accessing these. Farmers contribute only 5 % of the cost initially; GGRC provides a 50 % subsidy and helps arrange a loan for the remaining 45 %. Around 100,000 ha are covered by drip irrigation and most of these have been moved to high-value crops (Gulati, 2009). It has been estimated that around 74.1 million kWh of energy are saved in just one year due to the adoption of drip irrigation by GGRC, a body specially created for this purpose.

Jyotigram Scheme (Technological Initiative in Power Sector for Irrigation Needs)

Like elsewhere in India, unreliable farm power supply in Gujarat had been anathema to farmers as well as to rural society as a whole. Uncontrolled farm power subsidies had led to an unsustainable increase in ground water withdrawals and left the Gujarat Electricity Board nearly bankrupt. To control farm power subsidies, the government began to reduce the hours of three phase power supply used by tubewell owners while providing 24 hours single/two phase supply sufficient for domestic users. In response, farmers in many parts began using capacitors to run heavy motor pumps on two-phase or even single-phase power. This resulted in a poor power supply environment in rural areas.

International donors and power sector professionals advocated the metering of tubewells and consumption-linked charging for farm power. However, for a variety of reasons, farmers strongly resisted metering. Researchers had advocated a second-best policy of intelligent rationing of farm power supply by separating feeders supplying power to tubewells. In 2003, the Gujarat government implemented the Jyotigram Scheme (JGS, the "lighted village scheme"), which incorporated the core ideas of the second-best strategy of intelligent rationing. JGS's aim was to provide three-phase power supply

to Gujarat's 18,000 odd villages; but this could be done only if effective rationing was imposed on farmers. During 2002-06, around US$ 260 million were spent on the project to ensure 24 hour, three-phase power supply for domestic and commercial uses in schools, hospitals, etc, and eight hours a day, three-phase full voltage power supply for agriculture, i.e., continuous and full voltage power especially for agriculture at predictable timings for villages across Gujarat. By 2007-08 all 18,066 villages were covered by JGS. With this, Gujarat has become the first state in the country where villages get three-phase power with 24 hour supply per day and farmers get three-phase, uninterrupted power supply at 430-440 voltage for eight hours according to a strict, pre-announced schedule.

Jyotigram pioneered a real-time co-management of electricity and groundwater for agriculture found nowhere else in the world. Farmers were satisfied because they were spared the very high repair and maintenance cost that poor power supply imposed on them. Moreover, most farmers welcomed Jyotigram for limiting competitive pumping of water and addressing the common property externality inherent in groundwater irrigation. Ground water and power rationing through the Jyotigram scheme not only increased efficiency of water and power utilization for agriculture, but also freed these resources for the rural non-farm economy to grow. Higher access to water not only had a land-augmenting effect, but also allowed for multi-cropping and cultivation of high-value fruits and vegetables like mango and banana that require much water. More water has also been available for livestock, animal husbandry and fisheries, which are significant sectors of Gujarat's economy.

Impacts

There have been wide-ranging impacts of both large-scale water management and micro water harvesting in improving ecology of other rivers, reversing the trend of depleting water tables and tremendous growth in agricultural production.

Greening of other Rivers

Narmada water has been released into the dry beds of Heran, Orsang, Karad, Dhadhar, Mahi, Saidak, Mohar, Shedhi, Watrak, Meshwo, Khari, Sabarmati and Saraswati rivers. The ecology and water quality of these rivers have drastically improved over the last couple of years.

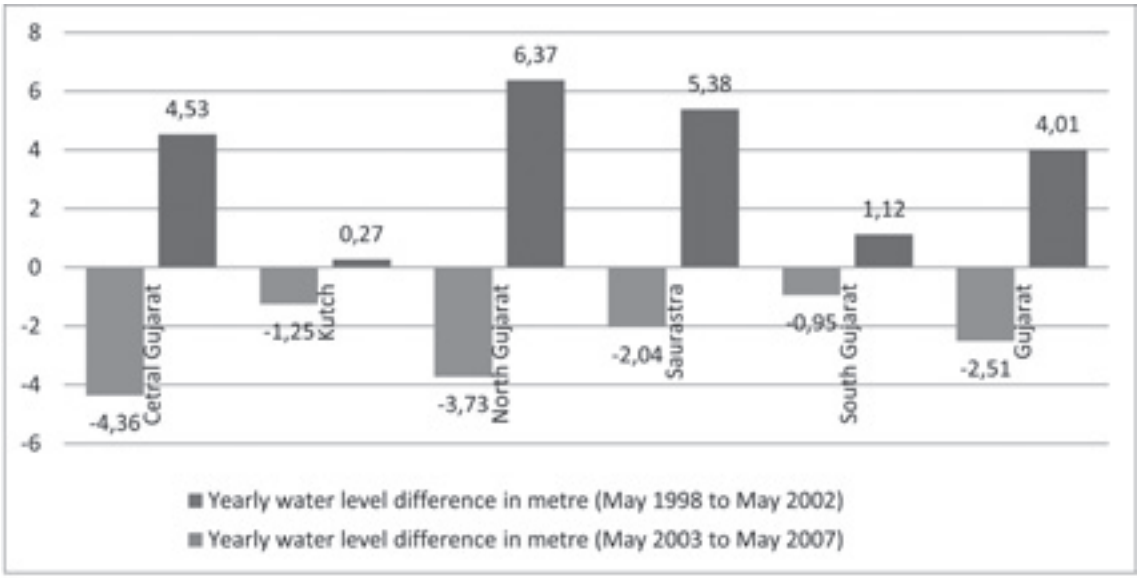

Figure (1): Ground water level fall/rise (in meters) Source: Narmada, Water Resources, Water Supply and Kalpsar Department, 2009

In addition to minor rivers, around 700 village tanks have also been filled with Narmada water as part of drought management measures. This has substantially improved water availability for irrigation purposes in these villages.

Increasing Water Tables

The average depletion of water levels in northern Gujarat before the launch of this massive programme was around 3 m per year, which by now would have cumulatively declined almost 20-26 m, leading to a sharp rise in electric consumption for withdrawal of ground water. But there has been a reported average water level rise of about 4 m during recent years as shown in figure (1).

Boost for Rural Economy

Myriads of micro water harvesting structures dotting the landscape of Gujarat have led to the reduction of soil moisture evaporation in the surrounding agricultural fields and have facilitated the creation of orchards in places that barely used to produce single rain-fed crops. Employment opportunities have been created for local residents and agricultural production has been enhanced, leading to a rise in household incomes. The living standard and the average productivity of milk cattle has also gone up due to the now year-around availability of fodder. The average annual growth rate of milk production in the state during the last decade has been recorded at 6.8 % whereas the same for the entire country has been at 4.4 %. See also figure (2).

This in turn has bolstered the rural economy of Gujarat and has particularly supported the 4.2 million families of the state who rear animals for their livelihood.

Outstanding Performance in Agriculture

The cumulative effect of all these innovative technological and participative water management initiatives has been an increase in productivity of the major crops of the state, despite 0.1 C to 0.9 C average increase in

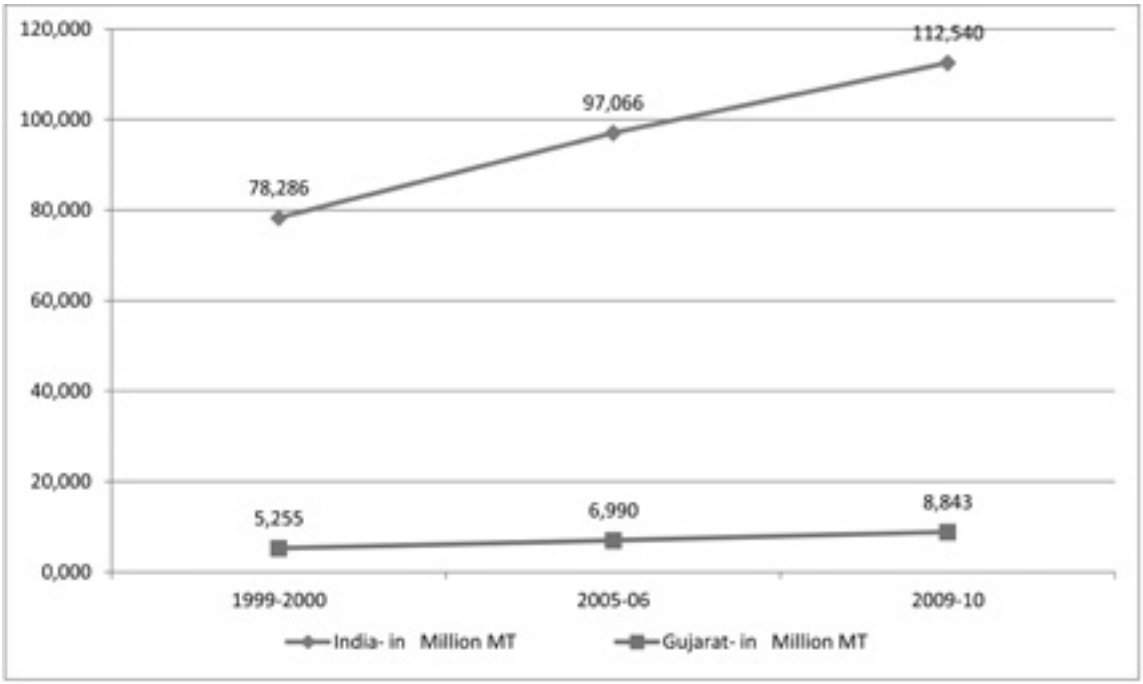

Figure (2): Comparative Growth of Milk Production in Last Ten Years, Source: Directorate of Animal Husbandry, 2010

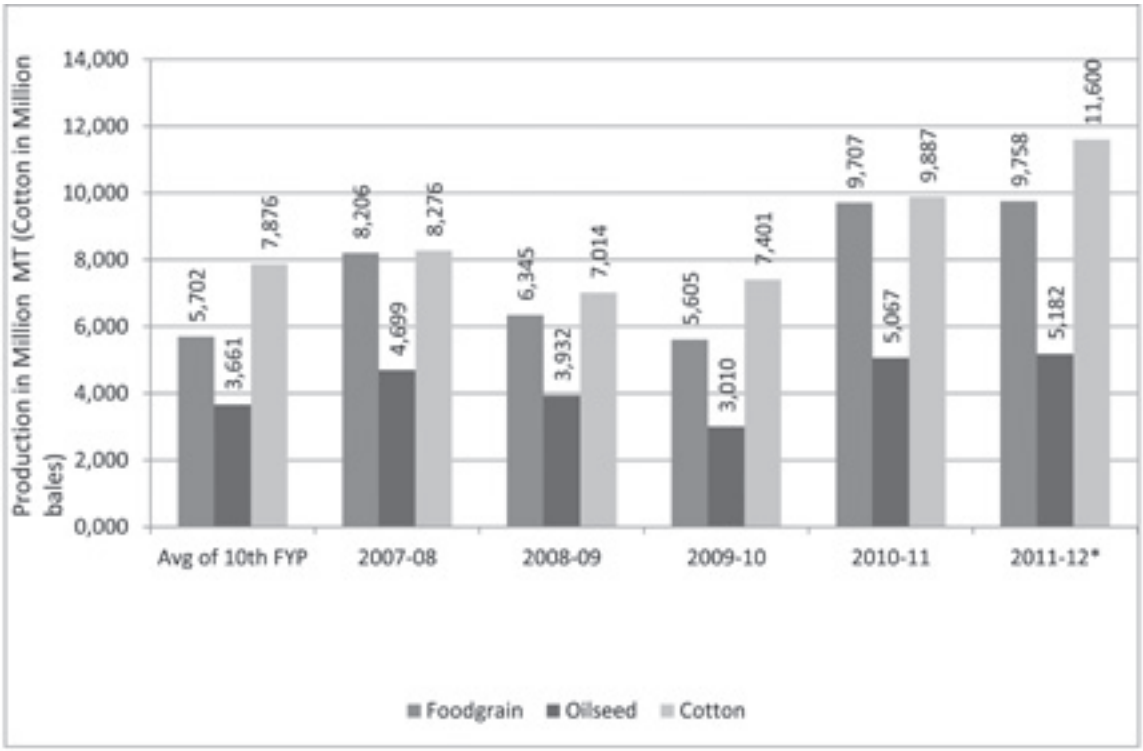

Figure (3): Agriculture Production Scenario Data for 2011-12 provisional, Source: Agriculture and Cooperation Department, 2011

temperatures recorded at various locations during the last couple of years as. Please see figures (3) to (5). As compared to other states in India, Gujarat is an outstanding performer in agriculture, growing at the rate of 9.6 % per annum. Though there is high volatility in the agricultural growth rate for almost all states in India, the performance of Gujarat's agriculture is more than thrice that of India as a whole. The International Food Policy Research Institute, in a document from 2009, specifically commended Gujarat's recent growth in cotton, fruit, vegetable and wheat production.

Conclusion

The most important lesson that emerges from the foregoing discussion is that technological initiatives to improve drinking and irrigation water supply have to be duly complimented by grassroot people's participation in the management of water distribution. The decentralized community-managed water supply programme in Gujarat has proven to be a suitable model for the entire country. Another very significant aspect is the necessity to balance the importance given to both micro-water harvesting and large water resources development projects. This has led to unprecedented agricultural growth in the state. The increased availability of water and the reduction in consumption of conventional power have also led to a reduction of carbon footprints in water supply and have promoted further development of a low-carbon economy in the state.

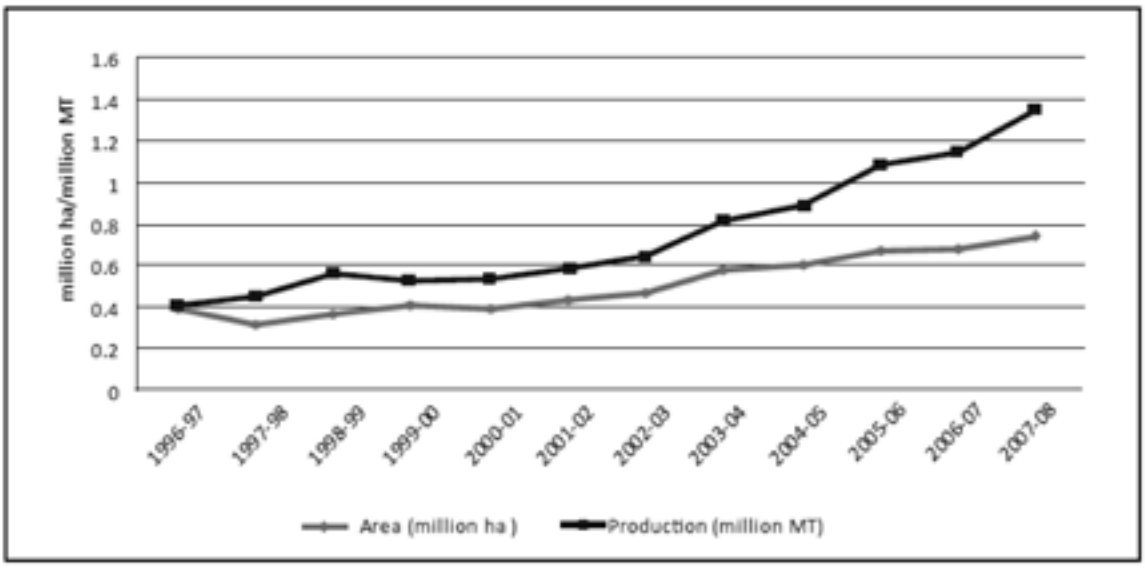

Figure (4): Area and Production under Total Fruits and Vegetables in Gujarat (area in million ha, production in million MT)

Source: Directorate of Horticulture, 2011

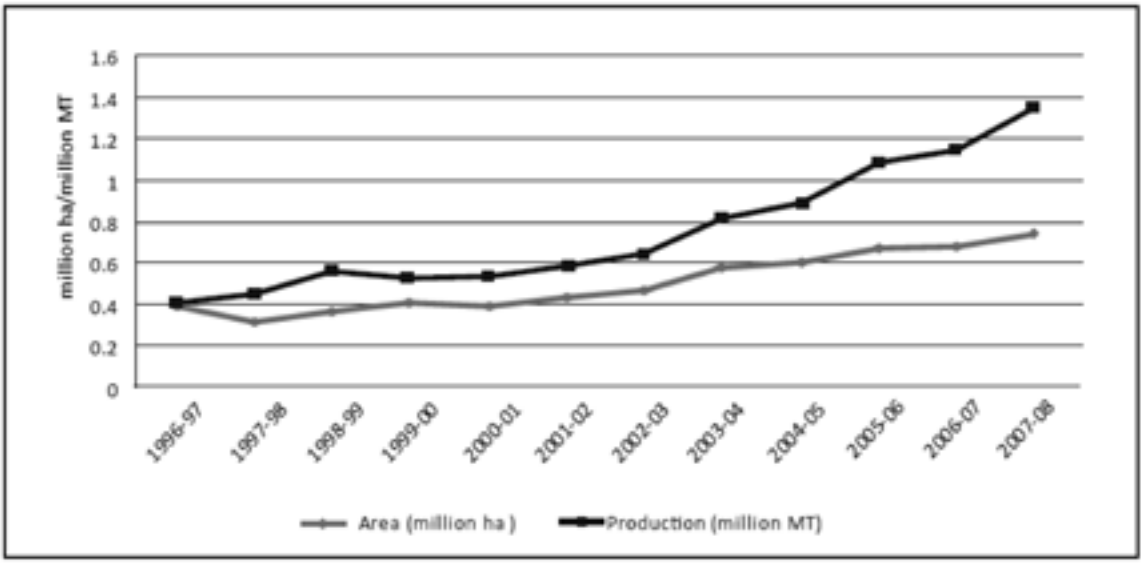

Figure (5): Growth in Agriculture Income (Rs in million), Source: Agriculture and Cooperation Department

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5 | CASE 3

WEB-BASED SYSTEM FOR WATER AND ENVIRONMENTAL STUDIES IN THE MENA REGION WITH FOCUS ON EGYPT

DR. HANI SEWILAM[1]

THE STUDY EMPHASIZES METHODOLOGIES FOR CAPACITY DEVELOPMENT TO PROVIDE A "GREEN" MARKET WITH QUALIFIED PERSONNEL. EGYPTIANS HAVE BEEN MANAGING THE NILE WATER FOR IRRIGATION FOR MORE THAN 5.000 YEARS. HOWEVER, WATER SCARCITY AND THE DRAMATIC INCREASE OF POPULATION MAKE THE MANAGEMENT TASK MORE COMPLEX BECAUSE OF THE CONFLICTIVE INTERACTION BETWEEN ECONOMIC, SOCIAL AND ENVIRONMENTAL ASPECTS. WATER MANAGEMENT HAS NEVER BEEN ONLY A TECHNICAL OR ENGINEERING PROBLEM AS COMMONLY RECOGNIZED.

Water management must be carried out in an interdisciplinary environment. Water engineers must cooperate with socio-economists and environmentalists to sustainably manage water resources. In Egypt, there is a significant lack of cooperation between farmers and water officials on one hand and even among water officials (irrigation engineers, environmentalists, socio-economists) on the other hand. The practice of considering only technical aspects in water management is causing many conflicts and problems for the Egyptian water system. Without interdisciplinary and integrated water management procedures, maximizing the economic outcomes of agricultural lands leads to minimizing the environmental performance. Water logging and soil salinity are becoming serious problems in Egypt. Saline areas in the Nile Valley and Delta were estimated at 1.2 million ha. Deterioration of water quality is a significant issue caused by the use of chemical fertilizers, which has increased fourfold in the last two decades. There are also many social problems, e.g., the involve-

[1] Dr. Hani Sewilam, UN-Water Decade Programme on Capacity Development (UNW-DPC)

ment of women in irrigation activities does not exceed 4 % of those economically active in agriculture. Even if unpaid family labor is included in the calculation, this ratio still only rises to about 10 %. There is an urgent need not only in Egypt but also in the other MENA countries to improve water resources management and water services and to accelerate sustainable development in the water sector. Training of different stakeholders, networking of national experts, information exchange and dissemination of proven experiences are essential for the implementation of interdisciplinary water management techniques. Combining electronic learning and information exchange can contribute to capacity building in water management and sustainable water development. These activities can also provide a framework for North-South and South-South cooperation.

TOTWAT

Think Interdisciplinary: A Training of Trainers Program in Interdisciplinary Water Management (TOTWAT) is an EU funded project under the umbrella of the TEMPUS programme. The consortium of this project is composed of five partners, which are Cairo University (Egypt), Alfayounm University (Egypt), the National Water Research Center (Egypt), RWTH Aachen University (Germany) and the Institute of Advanced Studies (Austria). The project's main objective is the development of a Training of Trainers (TOT) programme. The training programme should be developed during the project lifetime (3 years) and made available to water officials in Egypt and other MENA countries. The specific objectives of the project can be summarized as follows:

- To design the course structures and develop course contents.
- To improve the training skills of the trainers of the three Egyptian partners to successfully deliver the training programme.
- To procure the necessary tools and equipment to successfully carry out the courses at both Egyptian universities.
- To develop multimedia, web-based and eLearning tools to support the training programme.
- To improve the skills of the IT administration team of both Egyptian universities to enable them to cope with the new multimedia-based training programme.

The Drivers of Technological Change: Development Adoption and Adaptation

The main eLearning platform used in this project was Moodle, a Learning Management System (LMS) which supports the Arabic language. However, to have a complete LMS, some adaptations were necessary to develop materials in Arabic for certain courses. For example, the development of Arabic language quizzes for self-assessment was a challenging issue and Arabic video integration with PowerPoint was necessary to develop online lectures.

Training Needs Analysis (TNA)

It was necessary to conduct an up-to-date and comprehensive training needs analysis (TNA) prior to the implementation of most of the TOT activities. This activity was devoted to assessing the qualifications of the ministry staff responsible for the management of the Egyptian water system. The qualifications determined through questionnaires (first source of information) were scientific background, IT skills, the knowledge of using computer models, and the level of communication between different disciplines (engineers, socio-economists and environmentalists). The second source of information for this activity was direct interviews with the ministry staff. Almost 90 questionnaires were filled out by ministry staff members from all over the country and 20 interviews were carried out. As an example of the results of the TNA, figure (1) shows that

the majority of the staff members asked did not use computer models in their daily water management. The TNA also showed that there is a lack of interdisciplinary water management and there is a need to bring engineers together with ecologists and socio-economists in the day-to-day water management (see figure (2)).

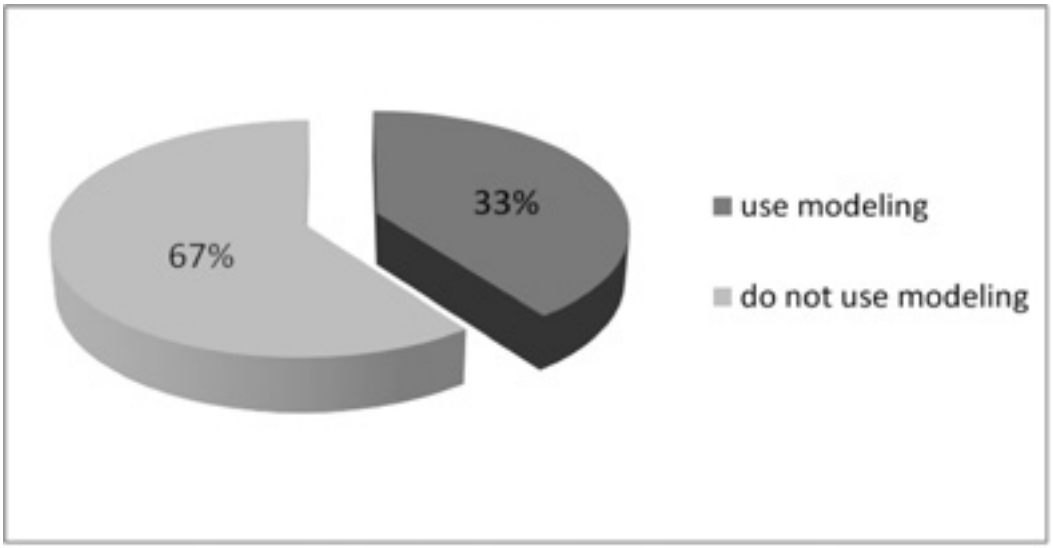

Figure (1): TNA results (% of using computer modeling)

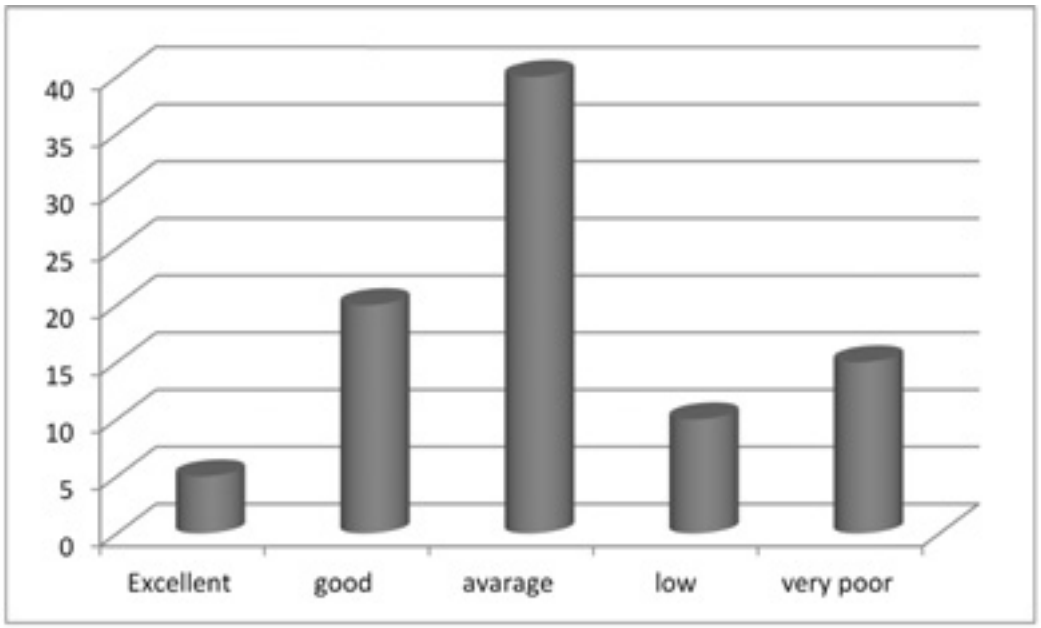

Figure (2): The level of interdisciplinarity in managing water resources

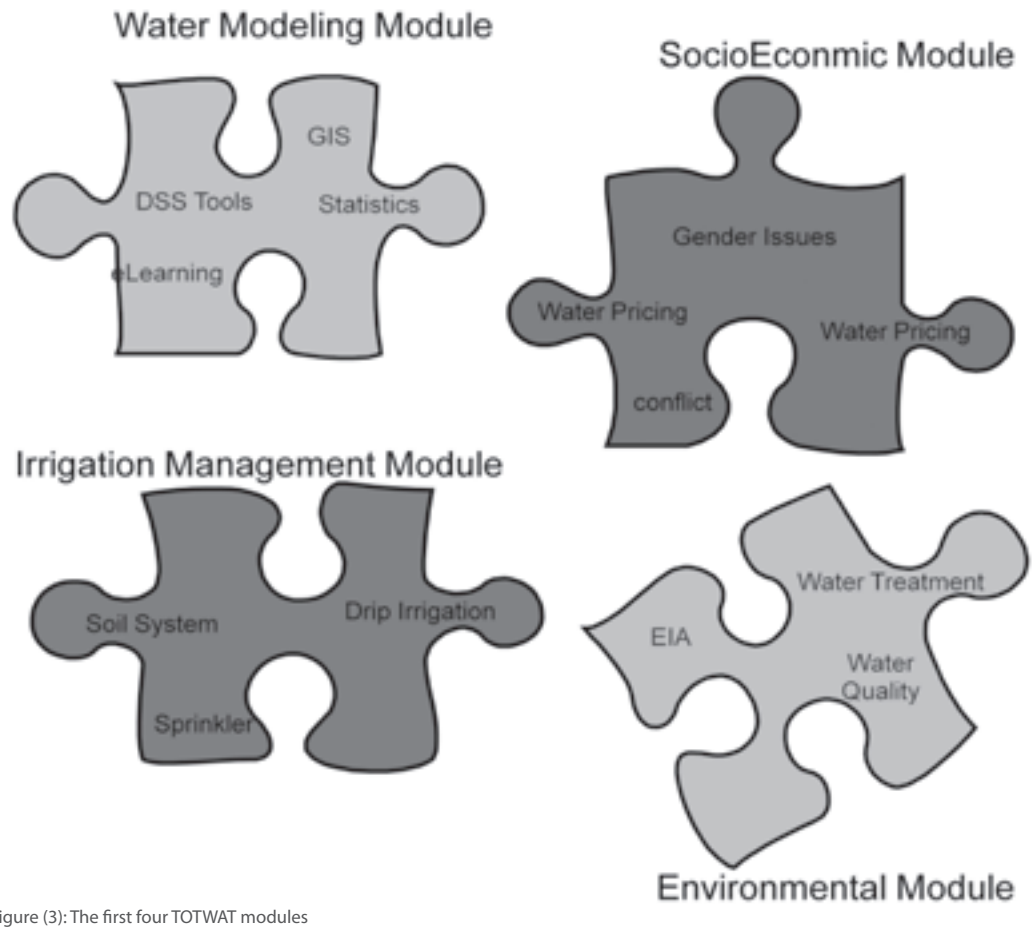

Figure (3): The first four TOTWAT modules

TOTWAT Training Programme

The TOTWAT training programme has four target groups: water engineers, socio-economists, ecologists and modelers. Therefore, four TOT modules have been designed, one for each target group: Water Management Module, Socio-Economic Module, Environmental Module and Water Modeling and eLearning Module. Each target group has to attend two training courses (2 weeks each in Egypt and Europe). All four groups have to complete the same interdisciplinary training module (module 5). This training module is composed of practical sessions. The trainees are exposed to a real-world water management problem, and their main task is to solve it in an interdisciplinary work environment. More than 60 trainees have benefited from TOTWAT so far.

Project Challenges and Solutions

The main technical challenge of TOTWAT was the use of eLearning technologies given the unreliability of available home internet connections and their bandwidth. To offer the users of the system the opportunity to overcome the bandwidth problem, computer labs with an adequate internet connection were established at each of the universities involved. What's more, the system was adopted to offer audio online lectures in addition to video recordings. The developed LMS enables flexible access for the mentioned target groups from any location and at any time. The system provides online courses to cover topics such as IWRM, EIA, water quality assessment, sustainable management of resources, gender issues, socio-economic issues, desalination, water treatment, etc. The courses were designed to

promote an understanding of the interrelationships between technical, social, economic and environmental aspects related to water management. The LMS also includes a self-assessment tool that enables the learner/trainees to assess their knowledge before and after participating in any online course. Additionally, the platform (LMS) offers communication tools that ensure continuous communication and social learning among learners from different levels and target groups.

Lessons learned from North-South Knowledge Transfer

This project provides several lessons learned that can be very important for further North-South cooperation in the MENA region. Two main lessons will be highlighted in the next sections.

Knowledge Transfer through Capacity Building

Capacity building through knowledge transfer is critical without to help developing countries and transitional economies to overcome disadvantaged and reap environmental, social and economic benefits. The capacity building programme strategy of TOTWAT aims at transferring European knowledge of interdisciplinary water management to enhance the skills of Egyptian staff members. The five training modules developed until today have provided a great opportunity for transferring European know-how of interdisciplinary water management to the Egyptian trainees. Different lessons have been learned from these five training modules and can be summarized as follows:

- All training modules provided by trainers from European countries should be based on local problems in the South. The main task of the trainers should be to try to introduce European solutions for similar Egyptian situations. The solutions are normally discussed intensively till trainers and trainees reach an agreement on the knowledge adopted.
- European trainers with different backgrounds should be involved in the training modules (engineers, ecologists, sociologists, economists, etc.).
- Only trainers who understand and accept other cultures should be involved in such training courses.
- Materials have to be as simple as possible given the various backgrounds of the trainees.
- The training should consider the educational level of the trainees and their English language level.
- Social, religious and cultural habits have to be taken into consideration while developing the training programme (praying time, feasts, etc.).

Knowledge Transfer through Blended Learning

When developing TOTWAT, a strong focus was laid on blended learning activities for different reasons:

- To enable virtual knowledge transfer without requiring trainers and trainees to be in the same location.
- Digital materials can easily be transferred and used online.
- The dissemination of knowledge to other groups who are not directly involved in the project is quite simple.
- The TOTWAT activities are based on the Selection-Organization-Integration theory (also called SOI theory). The fundamentals of the theoretical SOI model are:
  - » Human knowledge processing strictly distinguishes between aural and visual inputs (two separate channels for information intake).
  - » The processing capacity of those two input channels and short-term memory are limited (the magic seven).
  - » Learning is always an active process; we have to develop a coherent mental model (or reproduction) of the learning objectives.

Based on the assumptions of the SOI theory, Clark & Mayer (2002) developed six principles that should be obeyed during the conception and creation phase of

multimedia contents. The TOTWAT project has made the best out of combining both theories. The characteristics/principles of the developed eLearning materials for the knowledge transfer can be summarized as follows:

- Multimedia Principle: the materials always consist of a combination of text and diagrams/illustrations to achieve a more effective knowledge transfer than text-only versions.
- **Modality Principle:** explanations and descriptions of illustrations and diagrams are better understood when presented in spoken form (aurally) compared to written presentations.
- **Continuity Principle:** text information and diagrams that refer to each other are presented in an interrelated manner.
- **Redundancy Principle:** never present the contents in written and spoken form simultaneously (q.v. Dual Code Theory by Paivio).
- **Coherence Principle:** media elements are used in a targeted and economic (thrifty) way; an overkill will have negative consequences for the learning process.
- **Personalization principle:** expert sociolects should be avoided; in general, comprehensible explanations enhance and enrich the learning effect.

Based on the SOI theory and these principles of multimedia-based learning, in TOTWAT the materials have been designed in such a manner that more or less 80 % of the information is presented aurally (independent of whether it is a classic face-to-face or eLearning module). The remaining 20 % consist of animated graphs, flash files or video sequences.

Blended Learning Modules for the MENA Region

Two out of three years of the project lifetime were spent to develop the blended learning materials. The final product is a combination of training technologies that answer the needs of many water institutions in the MENA region. The most important characteristics of the web-based systems developed:

- Materials are available online and in Arabic language.
- The training covers water-related issues that fit the MENA region's problems.
- The LMS chosen (Moodle) supports the Arabic language.

Simple navigation in terms of "learning how to learn online". 10 to 15 minutes are required to learn the navigation basics; some more time is needed to master learning in this type of environment.

The eLectures are an essential tool for online learning. For each of the five modules a series of eLectures has been developed. It includes a video of the lecturer synchronized with the respective PowerPoint presentations. This makes online learning very easy for the trainees. The techniques used allow any user to access the LMS and simply watch the lecture without any additional installations. Figure (4) shows an example of one of the lectures in the socioeconomic module on gender issues.

In addition to the eLecture, the LMS includes a handout in the form of a pdf file for each lecture. The handout describes the details of the lecture and provides references and case studies for the subject investigated. To assess the knowledge gained, the LMS also offers the trainees a self-assessment system. This self-assessment system allows each trainee to go through an assessment process that is composed of 10 different types of quizzes (multiple choice, matching, short answer, essay, etc). Each trainee can try the assessment and get a final grade based on his/her answers. The trainees can also see the correct answers to enhance their knowledge.

Figure (4): An example for the Gender Issues Lecture in module 4 (socioeconomics in water resources)

Scaling Up and Relevance of Least Developed, Developing, and Transition Countries

The LMS and training materials developed in this project have been used by different Egyptian universities. At a later stage and following their successful use, the Ministry of Higher Education officially accepted this type of technologies for education and capacity development. The government has started promoting the use of such technologies for undergraduate students, motivating professors to develop their undergraduate courses using web-based techniques.

Evaluation: Triple Bottom Benefits/Impacts

Economic

Today the LMS developed is officially used by Zagazig University for civil engineering undergraduate students. More than 1,200 students have used this system for their courses. The impact assessment of the project on this group has shown a substantial improvement of the quality of graduate education, especially in regard to their knowledge of sustainable water management. In some cases students started their own business mainly in areas related to decentralized small water treatment units for rural areas.

Two universities in Egypt (Helwan University and Ain Shams University) are using this system now to enroll and teach a postgraduate diploma on "water and environmental management". The universities have already signed different agreements with local water and environment companies/consultancies to provide them with engineers with specific qualifications.

The LMS now enables Cairo University together with the National Water Research Center (NWRC) to offer training service for the professionals of the Ministry of Water Resources. According to the assessment of the impact of such training activities, the training has enhanced the skills of a large number of those water professionals responsible for managing water resources, as well as researchers from the NWRC.

Environmental

The developed online modules include many environment-related courses that have helped thousands of people to enhance their environmental capacities and knowledge.

Social

Although eLearning is often seen as a tool that has enormous negative impacts on social communication, such systems include social networking tools that do not only bring people from the same country together but also encourage people from all over the world who share common interests to communicate and work with each other.

Conclusion

Knowledge transfer is one of the key issues to help the MENA region cope with the scarcity of water resources and the serious impacts of climate change. One of the main mechanisms of knowledge transfer is capacity building. North-South cooperation to develop and organize training programmes is key. Using blended learning techniques facilitates the knowledge transfer and allows more countries and stakeholders to benefit from such programmes.

TOTWAT is an example for a North-South cooperation where European knowledge in the field of interdisciplinary water management is transferred to Egypt. More than 10 training courses have been organized in the fields of modeling, water management, socioeconomics, environmental engineering, and interdisciplinary water management. The project has also produced blended learning contents that could be disseminated and used by other water institutions in the MENA region. Through a network of national institutions and on-going projects of technical cooperation in the water sector, RWTH Aachen, along with other international partners, can organize and facilitate exchange of capacities, experiences and relevant information with potential multiplier effects.

Main references

http://blip.tv/eswes

http://blip.tv/totwat

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6 | CASE 4

INDUSTRIAL WASTEWATER RECLAMATION TECHNOLOGY FOR URBAN IRRIGATION

PIET DUPISANI[1]

THIS CASE PRESENTS TECHNOLOGIES FOR EFFICIENT WATER USE. SPECIFICALLY, IT DEALS WITH INDUSTRIAL WASTEWATER TREATMENT FOR REUSE FOR IRRIGATION PURPOSES USING A MODIFIED PROCESS TECHNOLOGY FOR LOCAL OPERATIONS, INCLUDING MBR (MEMBRANE BIO-REACTOR) AND UV-DESINFECTION IN THE CITY OF WINDHOEK, NAMIBIA, AFRICA.

Challenge and Objectives

Many cities in Africa (and elsewhere worldwide) suffer from water scarcity. Fresh and clean water resources may be too valuable to be utilized for irrigation of urban green, parks or small-scale agriculture. But in most cities industrial compounds generate wastewaters of such a quantity and quality that it is worthwhile purifying them up to a standard for irrigational reuse. Figure (1 shows basic data of the region and its very scarce water resources. The City of Windhoek is well-known as the first city worldwide to have successfully operated a direct wastewater recycling plant for potable water reuse for decades. Additionally, the city is already operating a number of reclamation facilities, including ones for irrigation based on domestic wastewaters. What is new is the effort to also utilize industrial wastewaters, which need more ambitious treatment technologies.

The objective of the project was to build a wastewater reclamation plant that would be based on high and cost-effective or, respectively, energy-effective technologies and still be viable for local operations. The specific focus was on industrial wastewaters, which may not be suitable for drinking water reclamation, but suitable for irrigational purposes. The technical components of the process installed were conventional mechanical treatment (buffer tank, robust type screening, and sand trap), advanced biological treatment (membrane bioreactor equipped with instruments for remote con-

[1] Piet DuPisani, Head of the Water and Wastewater Department of the City of Windhoek, Namibia

Namibia

- **Area** 825,000m^2
- **Population** 2,000,000
- **Average rainfall** 250 mm
- **Average evaporation** 3,700 mm

Windhoek Capital City
340,000 Inhabitants

Figure (1): Basic data on Namibia and the city of Windhoek

trol, automation and easy operations onsite), compact final settlement tank, and post-desinfection through UV (with additional chlorination upon request).
The standards for wastewater desinfection are quite stringent not only for crop irrigation but also for greenland irrigation (especially for golf courses). To avoid odours during irrigation, a UV radiation unit for post desinfection of reclaimed wastewater was installed.

The Drivers of Technological Change: Development Adoption and Adaptation

The membrane biological process was adapted to local conditions, especially in the construction concept and through a certain simplification of the process technology. This made it possible to build a plant of the size and with the standards of the one described here. Other well-known technologies, like activated sludge plants with post treatment (of advanced purification) in a sand filter plus activated carbon, etc., would have been too complicated and expensive.

Barriers to Technological Development, Adaptation, and Adoption

Until today, the greatest barrier has been the specific cost for wastewater that has been purified to a standard sufficient for safe reuse in irrigation. In the case described here this barrier was overcome by using all means of cost reduction on the one hand, and efficient financing and organization on the other hand. Thus it was possible to make ends meet and charge local industries with fees affordable and compatible to existing ones.

How the Barriers were Overcome

The process of implementation was realized through a BOOT-type contract (build, own, operate, and transfer) with a contractor consortium consisting of companies located in Africa and Europe. A similar technology (operated onsite by the same contractors) had already proven to be viable for wastewater reuse of non-industrial wastewater sources (easier treatment) and for direct reuse for potable purposes.[1]

1 Note: Windhoek was one of the first cities worldwide to realize direct wastewater recycling in its water supply scheme.

Lessons learned from Implementation

The scheme could not have been realized without the cooperation of professional technology providers from the private sector and a very active public utility as employer, who both focus on greentech business development in their local water sector. Technological progress, as well as BOOT, good municipal governance, and national finance, were essential to move this greentech project forward.

Wherever wastewater is regarded as valuable resource, treated with care, and reused instead of simply discharged to a sensitive environment, significant changes in governance and institutional development in the local water sector have been induced.

Scaling Up and Relevance of Least Developed, Developing, and Transition Countries

Scaling up and relevance for developing and transition countries is expected once the project's success can be demonstrated and once water tariffs and wastewater charges reflect a reasonable portion of real costs. However, a scale-up would be difficult in cases where water and wastewater are free of charge and represent no or little value to consumers and decision makers.

Evaluation: Triple Bottom Benefits/Impacts

The impact on the economy can be linked to the increased land value. Dry land with no water resources available for irrigation is not worth much in the area where this project was conducted. However, irrigated land has quite a high value. This is reflected by the economic potential related to specific land uses ranging from luxury purposes like golf courses down to simple and small agriculture, green land zones or parks. Related to these land use activities, there will be new jobs, new business opportunities, etc.

Once water for irrigation is available and bare land has been converted into a golf course or high-yield crop land, firstly, a rise in land value from 2,500 to 20,000 EUR per ha can be calculated. Secondly, expecting that 3,000 m^3 of irrigational water are required for each ha per year (with the UJAMS plant producing an estimated 1.5 million m^3/a, sufficient for 500 ha), the direct economic value generated through the water reclamation plant is about 17,500 EUR per ha and 8.75 million EUR total.

The macro-economic multiplier, which reflects jobs and incomes generated by local business developed on the irrigated land, may be estimated to be 2.3. This figure takes into account the economic cycle of salaries spent, generating income and salaries for third parties, fourth parties and so on, and includes results of extensive cost: benefit-analyses for similar infrastructural investments and operational outcomes. Summing up, the macro-economic capital value generated would be 2.3 times higher than 8.75 million EUR and as much as 20 million EUR. This economic perspective justifies the expenses for the wastewater reclamation plant, which will need an investment of about 8 million EUR, and total costs of around 3 EUR per m^3 (OPEX plus CAPEX under the BOOT contract).

Environmental Benefits

In general, water reuse has a huge impact on the environment in all cases where the reduction of fresh water intake (a) prevents negative environmental impact and (b) reduces or eliminates contaminated wastewater discharge.

Social Benefits

The project does not directly focus on low-income settlements nor aims at poverty alleviation, but it will generate considerable social benefits: if reuse water is available for irrigation, additional land will be made arable. And this land will generate business activities and contribute to the economic development of the City of Windhoek. These, in turn, will generate economic powers which will serve the public budgets, including those for social welfare.

Furthermore, the operation of the reuse plant will eliminate the contamination of the receiving river. This will decrease the pollution of the drinking water (raw water) which the poor population living downstream is forced to use up to now. They seem to have no other source or do not want to pay for water supply from public stand pipes or else.

Main references:

As the project is still fairly new and intermediate results are not final and not yet certified by the project-implementing agency, the only links available are the public call for pre-qualification and the tender documents for the BOOT-contract regarding the investment, design, and construction and operations of the wastewater reclamation plant

7 | CASE 5

HYDROPOWER FOR THE GREEN ECONOMY: A NEW APPROACH TO CAPACITY BUILDING AND SUSTAINABLE RESOURCE DEVELOPMENT

KRISTIN SCHUMANN[1]

THIS CASE PRESENTS THE INTRODUCTION OF AN HYDROPOWER SUSTAINABILITY ASSESSMENT PROTOCOL, WHICH HAS BEEN APPLIED IN AFRICA, ASIA, EUROPE, OCEANIA, MIDDLE EAST, NORTH AMERICA AND SOUTH AMERICA.

Challenges

In many countries there is considerable potential for hydropower to contribute to the emergence of a green economy because it offers much-needed low-carbon electricity for development. However, there remain significant challenges to ensure that hydropower can deliver sustainable developmental benefits locally, regionally, and globally, and meets the expectations of all stakeholders. A key challenge is the institutional capacity to effectively integrate sustainability into the design, construction, and management of hydropower projects, and, prior to the design of a project, to assess alternative options. Sustainability in hydropower is complex, involving a broad range of economic, social, and environmental aspects, and often requiring trade-offs between these aspects. Reaching consensus continues to be a challenge – between government and non-governmental stakeholders, nationally and internationally – at all stages of the development of a project. In turn,

1 Kristin Schumann, International Hydropower Association

this lessens the willingness of financial institutions to provide essential funding and expertise, thereby reducing prospects for moving towards the green economy. The Hydropower Sustainability Assessment Protocol is a response to these challenges.

Objectives

This case study presents the Hydropower Sustainability Assessment Protocol 2010 ("The Protocol")[1], a globally applicable framework for assessing the sustainability of hydropower projects. The Protocol enables project operators to assess the sustainability of projects according to a range of sustainability topics. It also gives an overview of where current operations meet basic good practice and proven best practice and indicates the scope for improvement. This case study will show that sustainable hydropower plays a significant and growing role in the green economy and that the last decade has provided the sector with insight on lessons learned from the previous adoption of tools and applications. Moreover, the Protocol benefitted from significant multi-stakeholder engagement during its development phase, and these stakeholders continue as members of the committee governing the Protocol.

In the green economy, hydropower plays a key role in both climate change mitigation (in its function as a low-carbon electricity source, as well as an enabler for other renewable energy sources) and climate adaptation (for example, reservoirs play a key role in water resources management infrastructure and often include hydropower, frequently the primary or only source of funding for the development of this infrastructure).

The Drivers of Change

The Protocol was developed by the Hydropower Sustainability Assessment Forum (HSAF), a wide-ranging multi-stakeholder forum convened by the International Hydropower Association (IHA), over a period of three years from 2008 to 2010. The range of stakeholders involved was extensive and included government and non-governmental stakeholders, developed and developing country representatives, and industry and financial organizations. Each played an active role and convened their own reference groups to discuss and agree on key issues.

The Approach: The Hydropower Sustainability Assessment Protocol

Protocol Principles and Structure

The Protocol assesses the four main stages of hydropower development: Early Stage, Preparation, Implementation, and Operation. The assessments rely on objective evidence to create a sustainability profile against some 20 topics, covering all aspects of sustainability (see table (1)), taking into account the relevant stage of the project.

It is important to emphasize that a Protocol assessment will provide a sustainability profile of a particular hydropower project/facility at a specific stage of its development, but not a pass or fail result. There is a common view across a diversity of sectors (e.g. governments, non-governmental organizations (NGO), civil society, industry, banks) on the important sustainability considerations that need to be taken into account to assess hydropower project sustainability. The Protocol itself however makes no specification on requirements for acceptable performance. Instead, it aims to provide an

TABLE (1): PROTOCOL TOPICS THAT ARE TYPICALLY ADDRESSED DURING AN ASSESSMENT

CROSS-CUTTING	ENVIRONMENTAL	SOCIAL	TECHNICAL	ECONOMIC / FINANCIAL
Climate Change	Downstream Flow Regimes	Resettlement	Siting and Design	Financial Viability
Human Rights	Erosion and Sedimentation	Indigenous Peoples	Hydrological Resource	Economic Viability
Gender	Water Quality	Public Health	Infrastructure Safety	Project Benefits
Livelihoods	Biodiversity and Invasive Species	Cultural Heritage	Asset Reliability and Efficiency	Procurement

Sustainable development requires people to look for synergies and trade-offs amongst economic, social, and environmental values. This balance should be achieved and ensured in a transparent and accountable manner, taking advantage of expanding knowledge, multiple perspectives, and new ideas and technologies.

analysis of the various sustainability topics being assessed. As presented in figure (1), scores are allocated in a range from 1-5, with 3 being basic good practice and 5 proven best practice. Thus, the scoring system highlights areas for improvement and provides an incentive for continuous improvement of the operations.

Protocol Development

The Protocol is the result of intensive work from 2008 to 2010 by the Hydropower Sustainability Assessment Forum (HSAF), a multi-stakeholder body with representatives from social and environmental NGOs (Oxfam, The Nature Conservancy, Transparency International, WWF), governments (China, Germany, Iceland, Norway, Zambia), commercial and development banks (Equator Principles Financial Institutions, The World Bank), and the hydropower sector, represented by IHA.[2] Further to the variety of stakeholders within HSAF, the development and review process of the Protocol was substantial. Four drafts were developed over a period of two and a half years, 20 field trials were undertaken in 16 countries across 6 continents, and overall stakeholder engagement was substantial involving 1,933 individuals in 28 countries (see figure (2)). Several of these trial reports are available on the internet.[3]

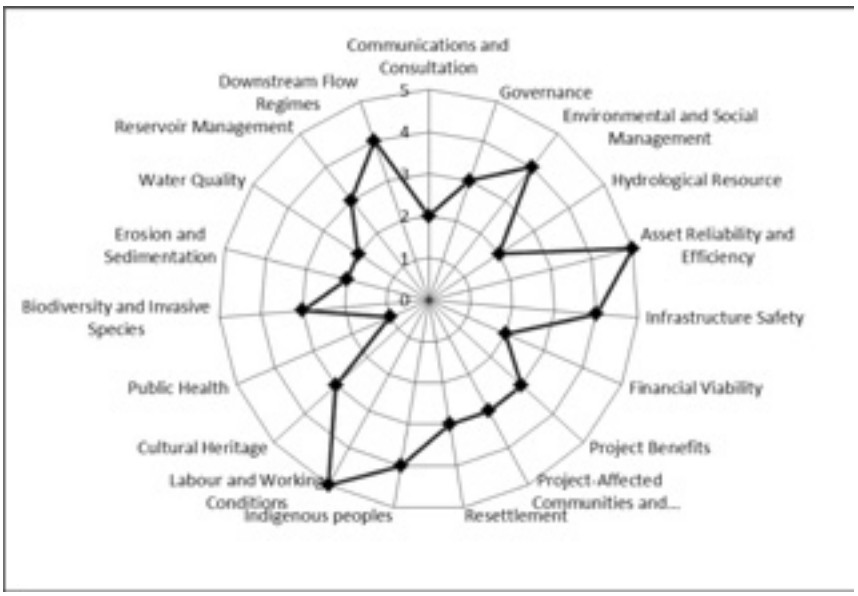


Figure (1): Sustainability Profile: For each sustainability topic, performance is scored from 1 to 5, with 5 being 'proven best practice'. The results are presented in an easy-to-read profile as shown in this figure.

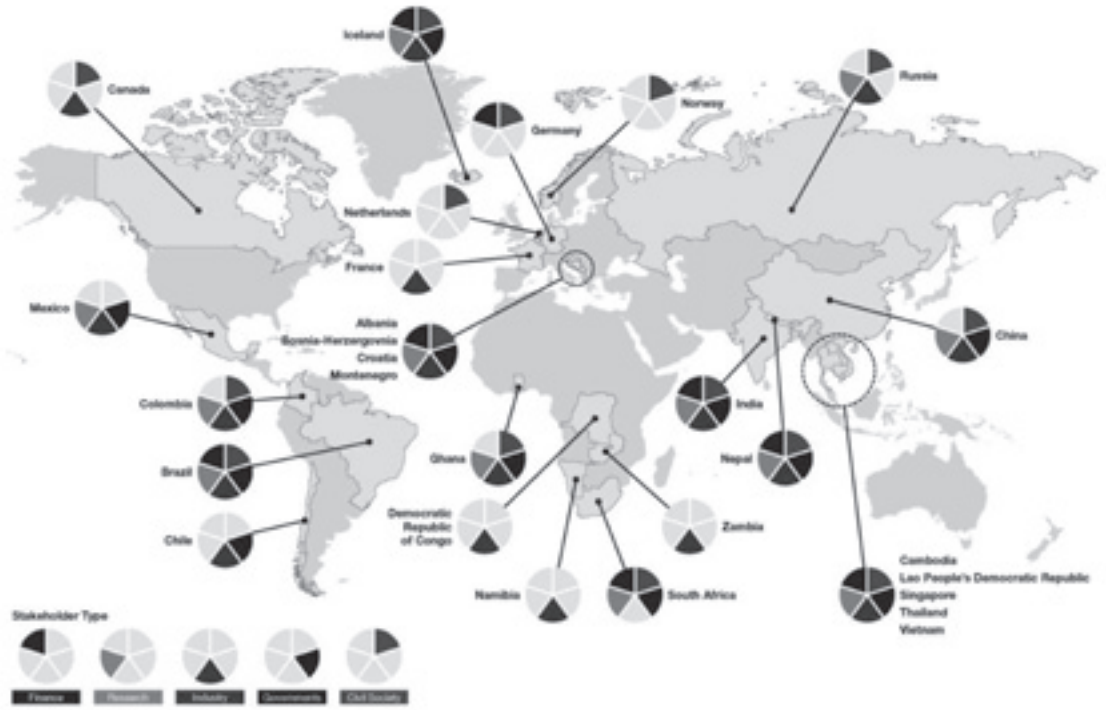


Figure (2): Extent of HSAF engagement activities during consultation phases.

The HSAF completed its work in November 2010. Between November 2010 and June 2011, an interim governance committee developed both the terms and conditions for use of the Protocol[4] and a charter for the Hydropower Sustainability Assessment Council[5]. The latter document outlines the permanent multi-stakeholder governance framework for the Protocol. This council comprises several chambers representing environment or conservation organizations, social impacts and indigenous peoples' organizations, project-affected communities, development, public or commercial banks, financial organizations, and private investors/ investment funds, emerging and developing economy country governments, advanced economy country governments, hydropower consultants, contractors or equipment suppliers, and hydropower operators or developers.

These chambers will elect representatives to a governance committee tasked with, among other things, ensuring that assessments constitute appropriate applications of the Protocol and considering and approving formal training material for use with the Protocol. Dr Joerg Hartmann, Water Security Leader, WWF International, is the first chair of the Protocol Council's Governance Committee. In addition to the governance committee, a management entity exists to manage the day-to-day operations relating to the Protocol, including ensuring compliance with the terms and conditions for use. The management entity currently resides within IHA's central office in London.

Protocol Application

The core strength of the Protocol is that it provides decision-makers, both internal and external to a project in development or a facility in operation, with a powerful tool to guide informed decision-making. An assessment using the Protocol provides a clear snapshot of a project's strengths and weaknesses based on a rigorous analysis of a wide variety of verbal, visual, and documentary evidence. It also allows the decision-makers in question to compare their own regulatory or financing requirements with the results.

Sustainability Partners

In initial discussions with potential Protocol stakeholders it became clear that a package of Protocol activities would be most beneficial to potential participants. It would enable them to see the process of continued improvement multiple Protocol applications lead to. Accordingly, a package was developed whereby project participants would work with IHA as Sustainability Partners and receive the following:

Pre-assessment visit and training

This is a workshop for participant organizations and nominated external representatives (e.g. from NGOs or relevant regulators) to ensure that participating staff are sufficiently prepared for the Protocol assessments, and that the inofficial Protocol assessment can be conducted in accordance with guidelines for official assessment. The intent of including external representatives is to both communicate information on the project to a wider range of stakeholders and to demonstrate the participating organizations' sustainability commitment to organizations, such as external stakeholders, agencies or regulators, and assist in the building of on-going relationships. It is also intended to embed Protocol systems into participating organizations' systems.

Inofficial Protocol assessment

This is, in essence, a test run of the Protocol assessment of a specific hydropower facility. Engagement around this assessment will enable staff of the participating organization to not only (a) conduct further internal Protocol assessments but also to (b) prepare for official assessments, (c) to understand project sustainability weaknesses and strengths, and (d) to address them, as well as (e) to promote the incorporation of sustainability criteria into management and reporting systems. This unofficial assessment provides a valuable opportunity to implement the knowledge gained during the in-country training and capacity building phase of the partnership.

Official Protocol assessment

Subsequent to the unofficial assessment, an official Protocol assessment of the project will be conducted. An official Protocol assessment is defined in the Protocol's terms and conditions [6] and must meet key conditions. These include that the assessment is carried out by an accredited assessor and with the written support of the project developer or owner. At the partner organization's discretion, this assessment can include the participation of regulators to demonstrate broader regulatory compliance. This engagement is intended to more generally increase knowledge and capacity around the Protocol and hydropower sustainability. Publicizing the results of this assessment is encouraged as it can serve as a powerful indicator of commitment to sustainability, and will promote more informed dialogue and decision-making.

Life+

In 2010, the European Parliament approved substantial funds to enable application of the Protocol. This project is called Hydro4LIFE [7] and comprises a €1.2 million investment over three years (2010-2013), 50 % of which is co-funded by the European Commission's Life+ Environment Policy and Governance programme, and 50 % is sponsored by IHA, focusing on implementing the Protocol within the European Union. Sustainability Partners operating within the European Union will participate in Hydro4LIFE.

Development of a database based on past assessments on basic good and proven best practices

In order to share experiences and knowledge of good and best practices, an assessment database is being developed. This database will be available online and capture the results of all official Protocol assessments. The intent of the database is to present the results of Protocol assessments and provide information to allow the Protocol and its implementation to be improved over time. This database will also enable operators to

benefit from lessons learned during other projects and to liaise with the operators on potential impact mitigation and benefit maximization opportunities.

Further to the database, which will be an ongoing tool for practice sharing, past findings on sustainable hydropower are presented online[8] as a guidance and learning tool for operators, researchers, practitioners, policy makers, and regulators.

Case Evaluation

The Protocol from a Sustainability Perspective

The sustainability principles upon which the Protocol is founded include the critical concept of considering synergies and trade-offs between economic, social, and environmental values. The balance between these trade-offs should be achieved and ensured in a transparent and accountable manner, taking advantage of expanding knowledge, multiple perspectives, and innovation. The approach of the Protocol can be considered a hard sustainability approach. It calls for key natural and social assets, such as biodiversity or cultural heritage, to be addressed. They should not be considered convertible into physical or financial capital, which is part of the so-called soft sustainability approach. Other core sustainability principles include social responsibility, transparency, and accountability. It is also noteworthy that the Protocol takes an integrative approach and encourages the consideration of aspects of hydropower that cannot be easily categorized as economic, social or environmental.

It is critical to assess the sustainability of hydropower because, if it is developed and managed in a sustainable manner, it can provide national, regional, and local benefits, and has the potential to play an important role in enabling communities to meet sustainable development objectives.

The Protocol allows consideration of hydropower given traditional sustainability perspectives. With regard to environmental considerations, the Protocol promotes improved performance in environmental and social assessment and management, hydrological and sedimentation management, and water quality and biodiversity, for example. Social and poverty alleviation impacts are addressed through improved performance in a wide range of social issues, e.g., project-affected communities, resettlement, indigenous people, working conditions, and cultural heritage. From an economic point of view, the Protocol promotes improved performance in financial and economic viability of hydropower projects, as well as sharing of project benefits. By providing a common platform for dialogue on sustainable hydropower, the Protocol promotes the contribution that sustainably developed hydropower will make to economic development.

All countries and organizations that adopt and support this Protocol respect the need for institutions to have their own policies and positions on acceptable performance for a hydropower project. All organizations expressing support for the Protocol recognize that a Protocol assessment can make a substantial contribution towards understanding and achieving sustainable projects. In producing a sustainability profile, the Protocol can foster informed decision-making on projects by individual institutions and organizations or even country governments.

The Protocol for Capacity Building

There are three aspects related to the use of the Protocol and capacity building.:

- Firstly, any Protocol assessment is accompanied by training on sustainable hydropower, which is provided to industry partners, local NGOs as well as relevant regulators. This is being done under the Sustainability Partnership model, which has been developed as part of Protocol implementation.

The training builds capacity of the participants and thus enables them to apply the Protocol to other projects. It also allows the operator as well as local regulators and civil society to understand requirements a sustainable hydropower project would be required to meet. Sustainability considerations can thus be incorporated in a broad range of stakeholder activities.

- Secondly, it is an integral part of the requirement for an official protocol assessment that the assessor is officially accredited to carry out Protocol assessments. The Protocol governance committee is currently developing a process for the qualification and accreditation of assessors. There will be an incentive for existing assessors with relevant experience to receive training in order to become accredited to carry out Protocol assessments on a variety of sustainability considerations.
- Thirdly, since the Protocol is freely available and written in accessible language, it has the added value that it can be used to provide general guidance. For example, it may be used in training, in internal objective-setting or provide inspiration for hydropower sectoral guidelines for environmental impact assessment. Thus, the Protocol provides guidance to operators and regulators beyond the concrete projects that are assessed.

Context of Hydropower in the Green Economy

If well-managed, hydropower provides many solutions for energy and water management in a green economy. With regard to climate change mitigation, hydropower as a clean, renewable energy source contributes directly to global low-carbon energy goals, and therefore to climate change mitigation. Hydropower's capacity to enable the further development and use of other renewable energy sources, such as wind and solar, means that it has a vital role to play in further mitigation strategies. Climate adaptation is now increasingly considered on a par with climate change mitigation as being critical to the success of international efforts to deal with climate change. It is often acknowledged that extreme weather events will become more frequent. World economies will be increasingly vulnerable to the devastating consequences of droughts and floods if their development agendas exclude investment in water management. Hydropower offers a number of benefits by enabling current and future adaptation to the effects of climate change. A reservoir, as part of hydropower infrastructure, has the advantage that it offers multiple services at once. Besides providing clean, renewable energy, a hydropower reservoir can enhance water security and management, provide flood mitigation, water storage for irrigation and other purposes, and contribute to the stabilization of downstream flow regimes. Other services a hydropower reservoir can offer include tourism and recreational facilities, habitats for biodiversity, and increases in income generation options, for example, through fisheries.

Lessons learned from Implementation

The single most important lesson from the development of the Protocol is that consensus on sometimes controversial sustainability challenges can be achieved, with some persistence and a willingness to engage on the part of all involved. The diversity and amplitude of stakeholders – some with highly divergent views and previously entrenched positions – agreeing to the detailed content of the Protocol documents (and the terms and conditions for its use and governance mechanisms) is unprecedented. Only one area of non-consensus remains, which is the issue of consent of project-affected communities, displaced persons, and indigenous peoples.

Since agreement on the Protocol document was reached in late 2010, one Protocol assessment has been

carried out, offering useful lessons for protocol implementation. The assessment of the Shardara multi-purpose project in Kazakhstan (in support of the German Agency for Technical Cooperation (GTZ) programme Transboundary Water Management in Central Asia Programme) provided important experience in the applicability of the Protocol assessment, confirmed the need for clearly-defined roles during Protocol assessment and detailed preparation, which is critical to evidence-gathering, and highlighted the importance of carefully scheduling consultations with local communities. These lessons have been used in the compilation of a series of training and reference manuals which guide the lead assessor, the assessment team and the project developer/operators (and others) during a Protocol assessment. These lessons and manuals will be drawn upon in up-coming Protocol assessments scheduled in the near future in Australia, Southeast Asia, Europe and Latin America.

Global Application and Relevance for Developing and Transition Countries

The Protocol was actively designed to be a globally-applicable framework, applicable to all types and sizes of projects. The utilization of the Protocol is particularly important in developing countries in Asia and Africa, where there is significant un-tapped hydropower potential and yet there are highly significant sustainability risks and weaker institutional capacity to manage and deliver sustainable outcomes. IHA is looking for Sustainability Partners to implement the Protocol in developing countries and elsewhere. Sustainability Partners are organizations that are keen to take on the challenge of continuously improving hydropower sustainability performance. Sustainability Partners receive training and capacity building on the Protocol, an unofficial assessment of a chosen project/facility, and finally an official assessment of the same project.

Conclusion

Sustainable water resources development will be crucial for implementation of a green economy in all countries. Hydropower development or review of existing practices will be important in many countries. The Hydropower Sustainable Development Protocol provides a means to build capacity, learn from past lessons, and implement future hydropower projects where the needs of local communities are taken into consideration, benefits from multi-purpose development are maximized and the broader sustainability topics are addressed.

1 http://hydrosustainability.org/

2 http://hydrosustainability.org/Hydropower-Sustainablility-Assessment-Protocol/Phase-1--Protocol-development-%282007-2010%29/About-the-Forum.aspx

3 Hydropower Sustainability Assessment Protocol 2011, http://www.hydrosustainability.org/

4 http://hydrosustainability.org/Hydropower-Sustainablility-Assessment-Protocol/Phase-2--Protocol-implementation-%282007-2010%29/T-C.aspx

5 http://hydrosustainability.org/Hydropower-Sustainablility-Assessment-Protocol/Phase-2--Protocol-implementation-%282007-2010%29/Interim-Governance-Committee.aspx

6 http://hydrosustainability.org/Hydropower-Sustainablility-Assessment-Protocol/Phase-2--Protocol-implementation-%282007-2010%29/T-C.aspx

7 http://hydrosustainability.org/Hydro4Life.aspx

8 Sustainable Hydropower Website, http://www.sustainablehydropower.org/

8 | CASE 6

GREEN ECONOMIC PRACTICES OF THE THREE GORGES PROJECT

THE THREE GORGES HYDROPOWER COMPLEX PROJECT, COMMONLY KNOWN AS THE THREE GORGES PROJECT (TGP), IS THE ESSENTIAL BACKBONE ENGINEERING PROJECT FOR RECTIFYING AND DEVELOPING THE YANGTZE RIVER, PRODUCING SIGNIFICANT INTEGRATED BENEFITS, INCLUDING FLOOD CONTROL, POWER GENERATION, AND NAVIGATION FACILITATION. THE TGP WAS A CENTURY-OLD CHERISHED DREAM OF THE CHINESE NATION. IT'S AN ICONIC PROJECT WHOSE FEASIBILITY WAS STUDIED VIGOROUSLY FOR ALMOST A CENTURY AND WHICH REPRESENTS THE HIGHEST LEVEL OF CHINA'S EXISTING TECHNOLOGY DEVELOPMENT AND INTEGRATED MANAGEMENT EXPERTISE.

Technological Innovations

The TGP is built on the strength of advances in science and technology and has, in turn, driven the advancement of science and technology. The project construction has led to the establishment of more than 100 sets of quality standards and technical codes, over 700 patents, 14 National Awards for Advances in Science and Technology, and more than 200 Provincial or Ministerial Awards for Advances in Science and Technology. Moreover, a number of world records have been set in river closure, deepwater earthwork cofferdam construction, rapid roller compacted concrete cofferdam construction, continuous high-intensity concrete placing, temperature control and crack prevention in massive concrete blocks, and installation of large-scale turbine generating units. The project's operations are also based on advances in science and technology, as reflected by the project's hydrological forecasting system, the optimized operations of the project's five-stage ship lock, and research on optimized reservoir operations.

Economic Development

Since the commencement of the operations of its first batch of generating units in July 2003, the Three Gorges Hydropower Plant has produced a cumulative total of 450 billion kWh of electricity (as of the end of 2010), equivalent to one-tenth of China's total power production in 2009, contributing tremendously to the rapid

growth of China's economy. Water storage in the Three Gorges Reservoir has also strongly facilitated navigation along the Yangtze River and the development of the regional economy.

Environmental Impact

The TGP's environmental impact is complex. Research on the impact started in the 1950s. In 1992, researchers published "The Report on the Assessment of the Environmental Impact of the Three Gorges Hydropower Complex", which was subsequently accepted by the National Administration of Environmental Protection. The report covered local climate, quality and temperatures of the river, environmental geology, land plants and vegetative covers, land animals, aquatic organisms, potential reservoir sedimentation, potential scouring of the lower course of the waterway, potential impact on the lake district on the plains in the middle reaches of the river, estuary environment, potential impact of reservoir inundation on the environment, residents, natural landscapes and cultural heritage sites, impact of project construction on the environment, and other environmental issues of public concern (including whether the project would increase the risks of floods in the upper reaches of the river and threaten species and habitats, how to prevent soil erosion in the upper course of the Yangtze River, what shelter forest systems would be required to buttress the upper and middle reaches of the river, and whether the dam has the risk of collapse).

In accordance with the environmental impact assessment report, the Chinese government has raised funds through various channels, and all segments of society (including government agencies, business enterprises, and social groups) have been making concerted efforts in the TGP's ecological and environmental protection. In the reservoir area, systematic geological hazard prevention and mitigation works have been carried out, joint monitoring and prevention systems have been instituted, and water pollution prevention and treatment programmes have been launched in the reservoir area and in the upper reaches of the river. At present, 49 % of household sewage and 70 % of waste in the towns in the reservoir area receive treatment, which is higher than the national average. Various biodiversity protection programmes have also been launched. And the trans-regional, cross-sectoral, multidisciplinary and multifaceted TGP Ecological and Environmental Monitoring System has been operating with high efficiency since its inauguration in 1996. Data collected by the monitoring system has laid a solid foundation for the ecological and environmental protection in the middle and lower reaches and estuary of the river.

Poverty Reduction

Funding for the resettlement of residents relocated for the TGP, dedicated domestic air programmes for the affected areas, and the facilitation of navigation along the Yangtze River have created opportunities for transforming the mode of economic growth in the reservoir area and for lifting local residents out of poverty and improving their living standards. By taking advantage of resident resettlement and town reconstruction, the Three Gorges Reservoir area has engaged in structural adjustment, significantly transformed its model of economic growth, further upgrades and optimized the structure of its economic sectors, and continues to optimize its economic structure. In 1996, agriculture, industry and service accounted for 29 %, 40.4 % and 30.6 % of the reservoir area's economy, with agriculture remaining a sizable portion of the local economy. The development of the TGP has helped speed up industrialization in the reservoir area, the industrial sector as an engine of growth has been playing a stronger role in driving local economic growth, and the service sector has grown by leaps and bounds, accounting for a rising proportion of the local economy. In 2009, non-agricultural sectors

accounted for 87.5 % of the reservoir's economy, up 16.5 % from 1996. Also in 2009, industry became a pillar of the local economy, accounting for 54.3 % of the local economy, up 13.9 % from 1996; thus, agriculture, industry and service made up 12.5 %, 54.3 % and 33.2 % of the local economy, respectively. In the same year, the area's GDP hit RMB 276.466 billion, representing a 515 % growth from 1996 and an average annual growth of 12.1 %; and per capita GDP surged to RMB 19,518, up 524 % from 1996, but remained far below the national average. Nevertheless, in terms of development foundation and starting conditions, the area's economy has been catching up quickly, narrowing the gap with the nation's average level. Moreover, education, public health, and culture in the area have significantly advanced, and a large number of high-standard schools, hospitals, and cultural establishments have been built.

Flood Control and Disaster Reduction

The Three Gorges Reservoir has a flood storage capacity of 22.15 billion cubic meters, and is therefore able to effectively control floodwaters from the upper reaches of the river and reducing flood crests in the middle and lower reaches of the river, thereby providing a protection against flooding. With the TGP in operations, the embankments in the middle reaches of the Yangtze River and along the main course of the river are now able to withstand floods of a magnitude that occurs once every 100 years, compared with its previous ability to withstand floods of a magnitude that occurs once every 10 years, thus protecting the areas across the Jing River from devastation and ensuring the safety of the 20 million residents and 1.5 million hectares of farmland in the Jianghan Plains and towns along the river. In the event of floods of a magnitude that occurs once every 1,000 years or floods of the magnitude of the catastrophic flood of 1870, the TGP, along with floodwater diversion facilities on the Jing River and other floodwater diversion and impoundment works, can ensure the safe passage of floodwaters through the Jing River, reduce the risk of the Dongting Lake area being flooded by the Yangtze River, save the 75 million residents, 6 million hectares and large and medium-sized towns in the plains in the middle and lower reaches of the river from inundation, and avert flooding and environmental deterioration and epidemics arising from and floodwater control measures.

In June 2006, the RCC cofferdam was successfully removed and the Three Gorges Dam started blocking water across the river. In early November 2008, trial water impoundment in the Three Gorges Reservoir hit 173 meters, ushering in the TGP's functions of flood control. In late July 2007, the TGP successfully conducted its first proactive flood control operation, impounding a total of 1.04 billion cubic metes of floodwaters and clipping the flood crest by nearly 5,100 cubic meters per second. In late July 2008, in a flood control operation that reduced the flood crest by 52,500 cubic meters per second, the TGP held back downward flows by 48,000 cubic meters per second, and impounded 1.33 billion cubic meters of floodwaters. In 2009, the TGP clipped the flood crest by up to 15,000 cubic meters per second. In 2010, the Three Gorges Reservoir conducted seven flood interception operations, impounding a cumulative total of 26.43 billion cubic meters of water, and clipping the flood crest by up to 30,000 cubic meters per second; as a result, water level dropped by as much as 2.5 meters at the Shashi Station and at least one meter at the Chenglingji Station. During the entire flood season, the water level at the Shashi Station on the Jing River never rose above the warning level, thereby ensuring the safety of the middle and lower reaches of the Yangtze River.

Reduction of Greenhouse Gas Emissions

As a form of clean energy, hydropower production can help reduce greenhouse gas emissions. From July 10, 2003, when the Three Gorges Hydropower Plant's first generating unit was integrated into the power grid for operations, to December 31, 2010, the TGP produced approximately 450 billion kilowatt-hours of electricity; if the same amount of electricity were produced by coal firing, about 380 million tons of carbon dioxide would have resulted. Water shipping is also the most energy-efficient mode of transport and can save huge amounts of energy, thereby contributing further to the reduction of carbon dioxide emissions. With the improved navigational conditions between Yichang and Chongqing on the Yangtze River as a result of water impoundment by the TGP, shipping costs along this segment of the river have dropped by 35 to 37 %, and the unit energy consumption has decreased by 46 % per ton of goods. Water replenishment by the TGP during the dry season has also significantly improved navigational conditions on the segment of the river downstream of Yichang. From June 16, 2003, when the Three Gorges Ship Lock began trial operations, to the end of 2010, a total of 443 million tons of cargos passed through the dam, with about 361 million tons going through the ship lock. The amount of cargos passing through the Three Gorges Ship Lock during that period of time was more than double the 210 million tons of cargos passing through the Gezhouba Ship Lock over the 22-year period from June 1981 to June 2003 prior to the TGP's water impoundment.

Ecological Water Replenishment

Since its initial phase of water impoundment, the Three Gorges Reservoir has been replenishing water in the lower reaches of the river during dry seasons, thereby improving water quality and navigational conditions, reducing salinization at the estuary, and increasing water supply for industry, agriculture and other sectors in the lower reaches of the river. From 2006 to 2010, the Three Gorges Reservoir supplied more than a cumulative total of 27 billion cubic meters of water to the lower reaches of the river. For 107 days from January 1 to April 11, April 18 to April 20, and December 29 to December 31, 2010, the Three Gorges Reservoir supplied 12.19 billion cubic meters of water for navigation facilitation and ecological water replenishment, averaging 1,477 cubic meters a day and increasing the average depth of the waterway by about 0.47 meter. This significantly improved the productive, household and ecological water consumption and navigational conditions in the middle and lower reaches of the Yangtze River.

Aside from fully harnessing hydro-energy resources, the TGP has also made painstaking endeavors to eliminate poverty, reverse ecological damage, preserve biodiversity, and reduce greenhouse gas emissions, scoring remarkable achievements. It has explored paths to eco-friendly utilization of water resources for the green economy as well.

9 | ANNEX 1

A WATER TOOLBOX OR BEST PRACTICE GUIDE TO ACTIONS, INSTRUMENTS AND POLICIES TO PROGRESS TOWARDS A GREEN ECONOMY FOR SUSTAINABLE DEVELOPMENT AND POVERTY ERADICATION

UN-WATER DECADE PROGRAMME ON ADVOCACY AND COMMUNICATION

THE "SYNTHESIS REPORT ON BEST PRACTICES AND LESSONS LEARNED ON THE OBJECTIVES AND THEMES OF THE UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT" (A/CONF.216.PC/8) FROM JANUARY 2011 HIGHLIGHTS THE IMPORTANCE OF A GREEN ECONOMY IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT AND POVERTY ERADICATION. THE REPORT CONSIDERS THAT INTERNATIONAL PREPARATIONS FOR THE CONFERENCE SHOULD STRENGTHEN SUPPORT FOR SUSTAINABLE DEVELOPMENT AND PROVIDE A PLATFORM FOR EXCHANGING BEST PRACTICES AND LESSONS LEARNED.

The Synthesis report contends that in the transition towards a green economy it is important to look at existing experiences and to consider a variety of approaches, assessing how they contribute to sustainable development and poverty eradication, with no one-size-fits-all solutions. Policies to strengthen incentives to adopt more sustainable consumption and production, public and private investments, job creation (additional green jobs, substitution and elimination, reorientation of skills) can be considered. The report identified among the challenges for accelerating progress towards sustainable development the preparation of a toolbox or best practice guide to actions, instruments and policies to advance the green economy for sustainable development and poverty eradication. The goal of the United Nations Conference on Sustainable Devel-

opment (UN CSD) is to ensure that resources, technical assistance and technology transfer are made available. The UN-Water conference on 'Water in the Green Economy in Practice: Towards Rio+20' has prepared proposals for a toolbox that was presented as an input to the UNCSD in October 2011. The objective was to provide proposals based on the analysis of existing practice, reflecting specifically on lessons from implementation, scaling up and the relevance for LDCs, developing and transition countries.

This draft was prepared on the basis of the documents and papers submitted and prepared for the conference. It was to be discussed by conference participants and amended during the course of the conference.

The Issues

Water plays a fundamental role in the green economy as it interacts with poverty, food security, health and many other sustainable development issues. The UN-Water conference identified four priority water-related issues where the change towards a green economy needs to take place: agriculture, industry, cities and watersheds.

Agriculture can play an essential role in achieving a green economy since it accounts for 70 % of global water withdrawals and provides employment for 40 % of the global population. Food security for an expanding population should be achieved, but by using less natural resources.

Challenges:

- Rising food prices
- Vulnerability of small-scale farmers
- Growing population, food production and dietary habits
- Approaches to address the challenges: improving agricultural practices; food production chain; food markets; land management; water management practices; improving knowledge; building capacity; improving water governance.
- Industry is critical for poverty alleviation, the delivery of goods and services, job creation and improving standards of living. As the prime manufacturer of the goods and services that societies consume, industry has a critical role to play in creating more sustainable production and consumption patterns. It can promote the green economy by decoupling the consumption of materials and energy from production, so doing 'more with less'.

Challenges:

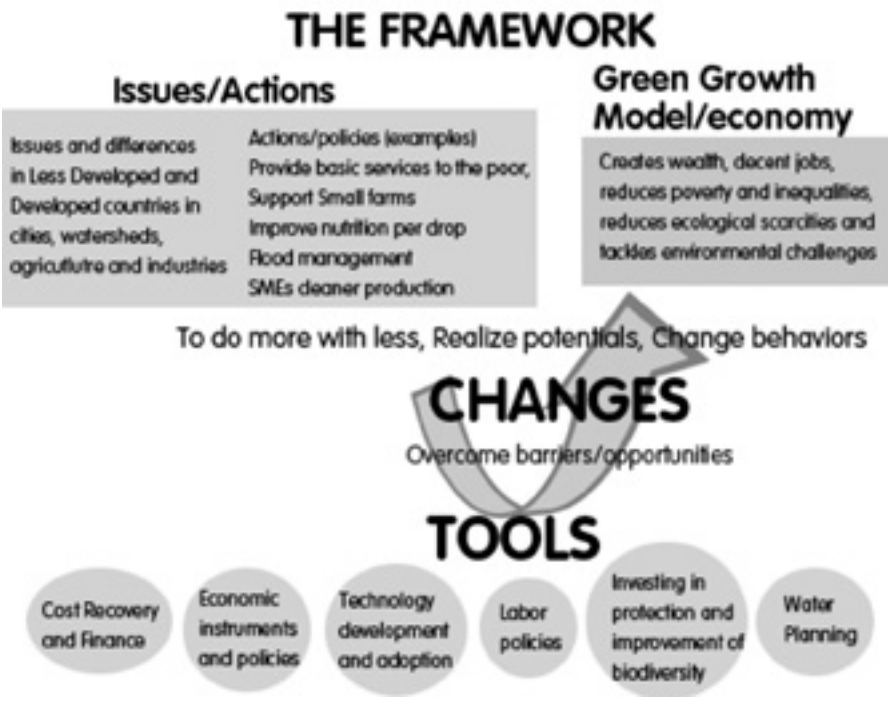
- Exploitation and contamination of freshwater
- Low capacity in developing countries
- Inefficient and unsustainable production
- Approaches to address the challenges: normative framework; improving knowledge; building capacity; water management practices; management of waste water and pollution; business sector; financing; technology.

Cities have a central role to play in the green economy, since the majority of the world's economic activity and now over 50 % of its population is concentrated in urban areas. Developments in cities have far-reaching effects upon the world's economies, energy use and climate change. As centers of social interaction and economic activity, cities are the critical spatial platform for the formulation and implementation of policies across sectors.

Challenges:

- Adequate water and sanitation facilities for growing urban population
- Meeting basic needs in slum areas
- Water pollution
- Water loss in supply systems

Approaches to address the challenges: sustainable urban development; protecting ecosystem services; governance; sustainable urban water management; waste water and pollution management; economic instruments; awareness-raising.



Watersheds:

Freshwater ecosystems provide services that are crucial for human survival. As well as providing clean water for household use, agriculture and industry, they support fisheries, recycle nutrients, remove waste, replenish groundwater, help prevent soil erosion, and protect against floods. This is particularly the case for the world's poor, as they often depend directly on water and other ecosystem services provided by rivers, lakes and wetlands for their livelihoods.

Challenges:

- Environmental degradation and loss of freshwater ecosystems
- Overexploitation of water resources
- Climate change
- Approaches to address the challenges: biodiversity; ecosystem services; aquifers; integrated management; managing climate variability; management of waste water and pollution.

The Tools

Transitioning to a green economy requires a shift from current practice. This toolbox proposes six tools which can be used to promote change and support the transition towards a green economy: (1) green jobs; (2) investments in biodiversity; (3) water technology; (4) cost recovery and financing; (5) economic incentives; and (6) water planning. The tools considered are those identified in the United Nations Environment Programme (UNEP) Green Economy report. These tools are essential to overcome the current barriers that obstruct the transition to a green economy; to harness opportunities; and to address important issues such as inequalities. They enable us to do more with less, to realize potentials and to change behaviors in order to create a green economy.

1. GREEN JOBS

Greening growth will see new jobs created, such as skilled jobs in emerging green industries and services. However, some jobs will be at risk, so there is a need to facilitate the re-allocation of workers from contracting to expanding sectors and firms, such as those that replace polluting activities with cleaner alternatives or those that provide environmental services.
Green jobs can play a key role in socially inclusive development if they provide adequate incomes, social protection, respect for the rights of workers, and give workers a say in decisions which will affect their lives. The promotion of green jobs is central in the transition towards a greener economy. Climate change and the excessive use of scarce resources are calling for proactive policies to respond timely and avert the worse and create pathways to sustainable development – with decent work for all.

CASES

Philippines – Maynilad Water District
Panama – Employment-Intensive Investment Programme

APPROACHES	LESSONS FROM IMPLEMENTATION
Active labor policies and actions in order to: • Maximize the potential of green growth to push the demand of new green skills from the labour force. • Foster labour market dynamism. • Promote an inclusive labour market. • Create opportunities for productive employment and decent jobs for all. **Active education and human capital policies in order to:** • Adapt workforce skills in advance to the transition from the grey to green job market. • Promote investments in "green skills". • Minimize the costs of acquiring competence in green technologies. **Improvements of governance/ institutional arrangements in order to:** • Enhance social dialogue and collaboration.	Many social effects of the transition towards a green economy depend critically on the coordination, or lack of it, between the destruction and the creations of grey and green jobs and on the facility with which workers are redeployed .from declining to growing industries and firms. For this transition to be smooth, labour market institutions need to be reshaped. Potential conflicts and social contest can be effectively prevented if the unavoidable disruption of the labour market is anticipated by workers and firms, so they are able to find the way to reconvert their skills and production processes in advance. Most of the negative effects of the unavoidable creative destruction of employment opportunities can be avoided, minimized or managed. The main responses consist in labour market reform, programs to help firms to adapt and education and training programs to adapt the labour supply in advance. Promoting social dialogue is more effective than leaving these options to the individual initiatives of those involved. This may help building a social safety network and providing a coordinated and anticipated response rather than a competitive, individual and reactive answer to the labour market disruption. Project managers need to respect cultural differences, including particular consultation mechanisms and the time needed to make decisions. Including traditional leaders in conservancy committees avoids conflict and delays. Consensus is needed to implement environmental activities within the project framework, particularly when party staff and politicians want to control projects in order to reach their own goals and to secure votes. Political actors and project managers must respect agreed time frames and previously prioritized actions and activities.

- Improve management practices.
- Promote participatory approaches and empowerment for managing change.
- Provide social protection during the transition.

De-privatization is not an end in itself, but should seek quality improvements and participative decision-making (The Deputy Mayor of Paris stated that "Local and Public Authorities . . . need to set the example and implement efficient management of a resource that is both fragile and indispensable.")

Differences of culture and idiosyncrasies of each region, province and district must be observed. A focus on a few neighbourhoods, as opposed to whole municipalities, may allow the process to evolve with more freedom.

2. INVESTMENTS

Freshwater ecosystems provide services that are crucial for human survival. As well as supplying clean water for household use, agriculture and industry, they support fisheries, recycle nutrients, remove waste, replenish groundwater, help prevent soil erosion, and protect against floods. Human well-being therefore depends critically on the health of freshwater ecosystems. This is particularly the case for the world's poor, as they often depend directly on water and other ecosystem services provided by rivers, lakes and wetlands for their livelihoods. Investing in improvement of biodiversity is critical for sustaining or restoring the water-related services provided by ecosystems.

CASES

Ecuador – Fund for the Protection of Water (Fondo para la Protección del Agua – FONAG)
Kenya – Payment for Environmental Services pilot project in Lake Naivasha Basin.

APPROACHES	LESSONS FROM IMPLEMENTATION
Investing in biodiversity protection and improvement is a means to improve prospects of economic growth, provide security, sustain development and create opportunities for the poor. Investing in conservation of biodiversity to foster its potential for the provision of valuable environmental services. Implementing properly designed payment for Ecosystem Services (PES) as instruments to align individual actions with the goals of recovering and protecting valuable ecosystems. Deciding on and implementing sound strategies addressed to restore degraded river systems, guaranteeing environmental flows, recovering floodplains, etc… not only from an environmental perspective but also as an integral part of an economic development strategy.	Payment for ecosystem services (PES) schemes offer a real opportunity to bring nature values into the economic arena and thus to promote improvements in natural capital. Lessons learnt from PES schemes are the following: **PES schemes design:** No one size fits all solutions. Successful PES schemes are very demanding in terms of design effort depending on the economic and institutional/governance framework and the intended environmental outcomes they must deliver. To be effective PES schemes need to have predefined and easily observable objectives, clear indicators of success (and failure). Pilot projects provide a valuable means of testing and adapting internationally or nationally proven PES approaches to local conditions. Poorly designed PES schemes are not only ineffective but they are associated with excessive administrative and implementation costs (further lengthy work may be needed to lobby for and secure the necessary changes). **The need to monitor and have a baseline scenario.** Environmental outcomes can only be attributed to a PES scheme provided there is a clear baseline scenario allowing for the comparison of situations with and without the PES scheme. Comparing situations before and after is uninformative because of the lack of a counterfactual demonstration that the observed outcome would not have occurred in the absence of the PES scheme. A transparent and technically designed monitoring programme is an integral part of any PES scheme and needs to be designed and agreed upon in advance. The need of a proper baseline and clear monitoring provisions is easily forgotten in the midst of complex negotiations to establish workable financial mechanisms.

Investing in conservation of biodiversity to foster its potential for the provision of valuable environmental services.

Implementing properly designed payment for Ecosystem Services (PES) as instruments to align individual actions with the goals of recovering and protecting valuable ecosystems.

Deciding on and implementing sound strategies addressed to restore degraded river systems, guaranteeing environmental flows, recovering floodplains, etc… not only from an environmental perspective but also as an integral part of an economic development strategy.

Public information and awareness to promote PES schemes.

Education, public campaigns and dissemination of robust studies on the challenge at hand are required to increase the public and private awareness of the importance of the environmental services as they might be providers and beneficiaries as well as the entire community. Better information on the importance of ecosystems services for anyone can be important in sensitizing stakeholders to upstream–downstream environmental linkages and to the economic significance of the ecosystem services provided.

The recognition of how individuals' actions and welfare are interconnected through water ecosystems is a key element in promoting the willingness to engage in negotiations to find mutually beneficial agreements in order to cooperate in the conservation of ecosystems. This is also important to gain social acceptance of PES as instruments for water management.

Information is essential to convince downstream water users that they should contribute financially to protection, maintenance or restoration/rehabilitation of ecosystem services by upstream landowners/managers. Thus, downstream water users, who already pay fees or taxes for their water consumption, may be 'forced to pay twice' by any additional levy or charge for ecosystem services.

It is important to identify 'beneficiaries' and 'suppliers' of ecosystem services and representatives of each group who are able and willing to participate in discussions/negotiations on behalf of others. Stakeholders may include different categories of 'actors', some of whom are direct suppliers/sellers or users/buyers.

Start small and scale up.

In most of the situations PES are innovative instruments and their successful implementation requires overcoming an adaptive trial and an error and learning by doing process. 'Starting small' and 'scaling up' is better than trying to implement a fully fledged financial mechanism from the beginning.

PES is not a panacea. It is normal to be confronted with a range of challenges and to require continual adaptation. Building trust and a spirit of partnership or mutual 'buy-in' among stakeholders is a critical ingredient for success.

Achieving both environmental and social objectives.

The corner stone of PES's success relies on its ability to provide suppliers of environmental services with better economic prospects. Sustainable provision of ecosystem services can be achieved through changes in land-use practices that are both equitable and supporting of existing opportunities of economic progress. Charges paid by water users must be set at a level that is acceptable to the water users but which still generates sufficient income to finance planned investments in upstream environmental protection measures.

Payments to upstream land/water managers must be set at a level that is equitable and sufficient to act as an incentive to conserve natural resources (regardless of the stipulations of any contract or sanctions for non-compliance) rather than to continue exploiting them unsustainably.

3. TECHNOLOGY

Innovative water technologies contribute to job creation and economic development. They may also help to close the increasing gap between water supply and demand. There are many water technologies that merit attention for increasing the amount of water available for drinking, agriculture, and manufacturing or which enable more efficient use of water.
Most of the necessary water technologies for promoting the sustainable management of water resources are already approved and ready for application on larger scales. However, the implementation of these tools is lacking behind. Possible reasons for this are the economic and financial crisis, which lowered the financial potential of many countries to implement innovative water technologies, and the lack knowledge dissemination. Although the know-how is readily available it might not be accessible on-site.

CASES

Namibia – Industrial wastewater reclamation technology for urban irrigation
MENA – Web-based System for Water and Environmental Studies
Burkina Faso – Improvement of water supply through a GIS-based monitoring and control system for water loss reduction
India – The Role of Water Technology in Development in Gujarat State

APPROACHES	LESSONS FROM IMPLEMENTATION
Improving technology choice abilities in both the public and the private sector. Technology transfers from developed to developing countries Adoption of existing water efficient technologies. **International financing sources to support clean technology adoption.** Use of success stories Learning from other sectors Expanding access to technologies Reform of global intellectual property regime Improvement of skills and trainings Knowledge transfer through information technology	There are many available, proven but still not completely diffused technologies that are strong enough to tear down barriers and water governance-deficits.(as for example online monitoring of wastewater effluents with real-time data transmission to address the problem of poor law enforcement). Technology choices need to be adapted to local conditions and especially to existing financial constraints, abundance or not of labour supply, management abilities, etc. Knowing these constraints helps to find the proper balance between both small-scale and large technologies that may yield optimal results. (e.g. both micro-harvesting and large water resources development projects in agriculture). Success stories can transfer lessons learnt from one case to another with comparable location, situation or site-conditions. There are important "avenues for leapfrogging" open to least developed countries' (LDCs) to foster the productive transformation at the same time as the advance in energy and resource efficiency. The experience with information and communication technologies demonstrates the capacity of poor countries and poor communities to achieve a jump in the technological development process. Water usage is often technologically determined and changing behaviour requires replacing the current technology being employed with an alternative technology. Capital costs can often be significant.

International cooperation and local collaboration in research and development (e.g. through networks or clusters) contribute to developing, absorbing, adapting, nurturing and diffusing innovation and green technologies.

Information and Communications Technology (ICT) applications can reduce environmental impacts and also affect how other products are designed, produced, used and disposed of. ICT can also contribute to making information easily and globally accessible, to standardizing problem solving approaches and avoiding repetition of failures.

Political governance and donor finance have been able to open up opportunities to unlock greentech development potentials to launch pilot projects for water loss reduction under a public-private partnership scheme, generating savings for the benefit of the utility which exceed the expenses (even though, due to low water tariffs, the utility has not yet reached the level of financial sustainability).

The lack of dissemination of knowledge may hinder the application of water technologies and the implementation of procedures and technique.

Water technology researchers, project developers and project takers can learn from other sectors of industry that are technologically more developed than the water sector, e.g. (1) network construction and management for precious chemical gases, (2) the technological set-up of the supply change in automotive industry, like monitoring and control systems in industry etc.

4. WATER PLANNING

Green growth requires that welfare improvement and economic growth are made compatible with the conservation of water related ecosystems. Water planning is a powerful social tool for identifying the best way to use water resources to meet the competing needs of different users. Planned and anticipated responses are needed to preserve the flows of water services for the functioning of the economic system. Water planning is also necessary to cope with environmental constraints resulting both from previous pressures of economic development that resulted in increased water scarcity, degraded water quality and higher vulnerabilities and also from climate change and its impact on water quantity and quality. It is essential to build governance and institutional capabilities to agree on, design and effectively implement long-term integrated water management plans in order to support the transition towards green growth.

CASES

Lao PDR – Water Planning
Korea – The Four Major Rivers Restoration Project
Spain – Water planning towards a green economy in the Ebro River Basin

APPROACHES	LESSONS FROM IMPLEMENTATION
Making a social agreement on the desired balance between water use and water resource conservation Tackling development opportunities and coping with water and development challenges Building Governance and Institutional capabilities Coordinating public policies Stakeholder engagement and public participation Aligning private decisions with collectively agreed goals Establishing collective Responses to Scarcity and Risk	Setting the objective of reaching a good or fair ecological status of the water bodies as the main objective of River Basin Management Plans has been an important element in water planning and has proved to be an element to make economic development compatible with the chosen environmental objectives. Adopting a set of international compromises regarding the environmental status of various international rivers has been a central element to coordinate national development policies among them and all of them with water planning. Clear objectives in terms of the recovery of river ecosystems have been a critical element for the approval and gaining social acceptance and legitimacy to extended programs of investments in infrastructure and natural capital in many developed and underdeveloped countries. **Water planning has played an essential role in:** • The development of the agro food and energy complex that now represents a competitive advantage and a defining characteristic of the Ebro River Basin in Spain. • The success of Laos regarding the Millennium Development Goals and in the ongoing transition from a rural to an urban economy. • The overall economic transition in Korea where water planning has also helped develop an anticipatory strategy to foster economic growth, preserve the welfare gains already obtained and provide water security in the future. Transparency, the rule of law, the acquisition of the technical competences required from stakeholders and public institutions are key elements for these strategies to succeed as proven in the countries with mature water management institutions and as perceived in some LDSs (see Laos).

Water planning may be a powerful instrument to coordinate advances in many areas such as agriculture, energy, manufacturing, tourism, land settlements, population growth, etc. All that in the range of the limited water resources available. Green growth requires considering water management as a horizontal axis of economic public policy.

Agreed compromises in international river basins regarding water policy might become central elements in the national development plans and might contribute to the coherence between objectives in the different economic areas with the general objectives of water policy.

Active participatory mechanisms have made real and verifiable contributions to the design, implementation and assessment of water management plans in many countries.
Both The Water Framework Directive and the Mekong Agreement are good promising examples of collective responses that have helped develop systematic efforts at a national and local level to respond to water challenges.

When present, the acquisition of technical skills, the development of information systems, the building up of reporting strategies, and so on are all elements that have contributed to the reputation and credibility of river basin authorities.
In LDCs enhancing the national and local capacity to manage their own water compromises is a critical element to give credibility to their commitments in the cooperation agreements and to improve their position with respect to other national partners.

5. ECONOMIC INSTRUMENTS

There is a need to increase the use of economic instruments, enforce them and share experiences in order to improve water efficiency in water supply and sanitation services and in water use. Economic instruments in water management yield a number of benefits. They can (i) avoid costly investments and make the case for low-cost, non-technical measures (e.g. ecosystem services to secure water or protect against floods); (ii) generate revenues to fund water management functions and water-related infrastructures; (iii) align incentives and strengthen policy coherence across the board (water, energy, food, land use; and (iv) provide information on the costs of status quo, the benefits of reform, and the distribution of these costs and benefits.

CASES

South Africa – Subsidies for water infrastructure as an engine of growth
Australia – trading and step by step legal reform on water use rights in the Murray-Darling Basin
Israel – Water pricing and command and control for water demand management in cities and agriculture

APPROACHES	LESSONS FROM IMPLEMENTATION
Environmental or green taxes Water and sanitation charges Fees Subsidies Trading Market based instruments such as payment of ecosystem services Consumer driven accreditation and certification schemes Arrangements to send scarcity signals (including trading of water and emission rights, and offset schemes) Insurance schemes	Many decisions regarding water are made by households, firms, farmers and other economic agents that use water resources to satisfy individual demands. EPIs have the potential to make all these individual actions need compatible with the ability of water ecosystems to continue providing the services demanded in the economy as well as with the public goods (such as security, health, recreational amenities, etc.) and the services and functions required to preserve the water environment. There is no such thing as the wrong or right price of water services. The right incentive is the one that allows individual decisions concerning water use to be in accordance to the collectively agreed goals of water policy. Economic policy instruments are all incentives to modify individuals' behaviour in a predictable way such as, for example, saving a certain amount of water, reducing pollution loads or adopting a modern irrigation technique. Water users respond to incentives and there is an important potential to introduce a variety of EPIs as accompanying instruments to support the transition towards a Green Economy. Innovative EPIs need to be adapted to the pre-existing institutional frameworks and to local conditions. Any economic policy instrument offers many design options (water prices can be flat or volumetric rates, fix or variable per unit of consumption, etc.). The potential of any EPI to deliver its intended environmental outcome depends on its design (flats rates do not change behaviour and progressive prices are better to discourage excess water consumption).

EPIs are effective when intended behavioural changes can be properly observed at reasonable monitoring and enforcement costs.

In spite of recent improvements in information and communications technology, inspection and enforcement costs are still high in many contexts of water policy.

Compared with prescribed behaviour, EPIs have the advantage of reducing information and search costs (for example when users are, for example, more able than governments to find the most efficient ways to save water or to develop innovative alternatives to reduce pollution).

Nevertheless EPIs' benefits can be compensated by high transaction costs resulting from implementation, monitoring, enforcement, bargaining costs, and so on. Transaction costs might be even higher than the potential efficiency gains delivered by EPIs.

The use of water markets and trading needs to be properly regulated to safeguard public, third party interests and preserve environmental objectives of water policy.
agreements and to improve their position with respect to other national partners.

6. WATER COST RECOVERY AND FINANCING

In the transition to the green economy, financing means mobilizing the funds required to alleviate global poverty; bridge the inequalities between developed and least developed countries; foster innovation and new green technologies; create new job opportunities (green jobs) to compensate the losses in 'brown economy'; reduce scarcities; and enhance the eco-efficient use of existing resources. The financing challenge of the green economy is to promote growth patterns that avoid the environmental costs experienced in the past to prevent us from locking ourselves into unsustainable patterns of consumption and production in the future.

CASES

India – Social contract formulas in rural areas: the India Naandi Foundation water treatment plants
Morocco – Output-based Aid: extending water and sanitation services to the poor in peri-urban Morocco

APPROACHES	LESSONS FROM IMPLEMENTATION
Financial strategies adapted to the context of economic development. Incentives and funding to cover basic water and sanitation needs. Focused subsidies for poverty reduction and equity improvement. Social contract formulas of financing in urban areas and rural areas Funding in response to climate change and water scarcity. Funding diversification and demand management. Funding governance, institutional reform, management and information. Small-scale financing Improving the effectiveness of existing financing Pro-poor cost recovery Output-Based Aid	In spite of poverty and low saving ability, financial mechanisms for water development do exist in LDCs. For example: small scale finance can mobilise savings when they are scarce. Rural households are willing and able to pay for water services. However the implementation of volumetric water prices requires community awareness campaigns, especially when a cost recovery tariff is a novel concept. Mechanisms are needed to match the interests of potential investors and those who can make the best possible use applying the financial funds to water investments. SMEs, small holders and municipalities often have difficulty in accessing capital. WUAs may have similar problems. Revenue security is not only a way to guarantee the financial sustainability of water services but also to reduce risk and hence the cost of loans. There are considerable gains involved in making the best use of the scarce capital available. Reducing capital requirements or substituting capital with other inputs (e.g. voluntary labour – the Orangi approach, or land – lagoon treatment of wastewater) are means to reduce costs and then cope with tight financial constraints. Significant efficiency gains can be obtained from separate charges for water supply, wastewater discharge, and surface water runoff, provided the transaction costs are not too high Low cost revenue recovery mechanisms with the potential to generate secure streams of revenue are still required in the agricultural sector. The use of performance-based subsidies for water services provision helps refocus service provision on household demand, which can increase accountability, strengthen partnerships between local authorities and operators, and make monitoring of service delivery a priority.

Subsidies on outputs effectively transfer procurement and financial management-related risks to service providers.

An OBA approach can play an important role in overcoming financing barriers, mobilizing stakeholders, and making sure funding reaches the targeted people.

10 | ANNEX 2

OVERVIEW OF WATER-TECHNOLOGY CASES

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	ECONOMIC BENEFITS
(1) Improvement of water supply through a GIS-based monitoring and control system for water loss reduction in Ouagadougou, Burkina Faso **Africa** **Source:** **Case study paper, Zaragoza Conference** **Issue: Cities**	Water Technology	Pilot project to reduce water losses in the distribution system of the municipal utility, with leak detection devices, pressure and flow control sensors with real-time and online data transmission, and automated pressure valves, all controlled by a GIS-based computerized system. Implementation was supported by intensive capacity development programme to secure the necessary change process.	Local jobs created from the investment in and operation of the water loss reduction program.
(2) The Role of Water Technology in Development: A Case Study in Gujarat, India **Source:** **Case study paper, Zaragoza Conference**	Water Technology	'State Wide Water Grid' and water filtration treatment plants to provide assured drinking water to 10:501 villages and 127 towns in Gujarat suffering from water scarcity or water quality problems. Creation of the Water and Sanitation Management Organisation (WASMO) and a new water governance model, empowering village level institutions and extensive capacity building of women for recovery of water charges. Sardar Patel Participatory Water Conservation Project for Micro Water Harvesting and creation of over 350,000 theckdams, village ponds etc. Jyotigram (lighted village) Scheme for pioneering a real time co-management of electricity and ground groundwater for the agriculture.	Wider job creation from the knock-on effect of improved water supply on the local economy and public and environmental health.
(3) Web-based system for water and environmental studies **MENA** **Source:** **Case study paper, Zaragoza Conference**	Water Technology	EU-funded web-based Learning Management System (LMS) for water and environmental studies, initiated by a partnership of institutions from Germany and Egypt. Online courses on sustainable water management, and the interrelationship between technical, social, economic and environmental aspects. The LMS offers communications tools to ensure social learning Provides training to professionals from Egypt's Ministry of Water Resources.	Transparent structures and reduced water theft.

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Following improvements in water efficiency, the environmental situation will improve step by step, provided that the development in sanitation will follow the development in water supply efficiency.	Improved water supply, where before the project there would be no supply in certain town areas and at certain times. Improved attitude amongst customers, awareness of the importance of protecting water resources and caring for public water supply property.		The scaling up of such water loss reduction technologies and programmes in other developing and transition countries could be done. Lessons learnt from project have been disseminated to other utilities through an African Water Association conference and through UN-Water DPC.	Implementation was successful for a limited zone within the city and service area of the utility. Due to instable political situation in the country, and due to other issues gaining higher priority over water loss reduction (politically as well as financially), implementation could not yet be completed throughout the whole service.
Reduction in fluoride contamination of water. Reduction in carbon footprints in water supply due to substantial electricity savings. Increase in Ground Water Tables.	Safe and secure water supply for about 65% of the State's population in drought-prone and poor water quality areas. Increase in opportunities of women education and self employment. Reduction in household drudgery of women.	Creation of the WASMO shifted the role of governance from provider to facilitator, providing an enabling environmental for communities to take ownership of their water service delivery and water resources management at a decentralised level.		
Developed online modules included many environment related courses which helped thousands of people to enhance their environmental capacities and knowledge.	eLearning systems include social networking tools that bring not only people from the same country to communicate and work together but also people from all over the world who have common interests.		Developed LMS and training materials of this project were used by different other Egyptian universities. The Ministry of Higher Education realized the acceptance of such technologies for education and capacity development. The government started to promote using such technologies for the undergraduate students by motivating the professors to develop their undergraduate courses using web-based techniques	

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	ECONOMIC BENEFITS
(4) Three Gorges project Asia **Source: Case study paper, Zaragoza Conference**	Water Technology	The Three Gorges Hydropower Complex Project, commonly known as the Three Gorges Project (TGP), rectifies and develops the Yangtze River, producing significant integrated benefits, including flood control, power generation, and navigation facilitation.	Since July 2003, 450 billion kWh of electricity (as of the end of 2010) was produced, equivalent to one-tenth of China's total power production in 2009. Water storage in the Three Gorges Reservoir strongly facilitates navigation along the Yangtze River and the development of the regional economy. In 2009, the area's GDP hit RMB 276.466 billion, representing a 515 percent growth from 1996 and an average annual growth of 12.1 percent; and per capita GDP surged to RMB 19,518, up 524 percent from 1996.
(5) International Hydropower Association's Hydropower Sustainability Protocol **Source: www.hydrosustainability.org**	Water Technology	The Hydropower Sustainability Assessment Protocol provides a globally-applicable framework for assessing the sustainability of hydropower projects according to over twenty vital topics. Developed through multi-stakeholder initiative over 2008-2010 including developed and developing country governments, social and environmental NGOs, Equator Banks, the World Bank and hydropower industry. Now endorsed by leading NGOs and financial institutions, and governed by a multistakeholder governance structure. Provides an unprecedented framework for stakeholder dialogue on sustainability performance of hydropower projects assessed using the Protocol. Consists of four separate tools corresponding to four stages of hydropower project development. Builds on lessons learnt from previously existing tools as well as from an extensive trialling period.	Promotes improved performance in financial and economic viability of hydropower projects, and sharing of project benefits. By providing a common platform for dialogue on sustainable hydropower, the Protocol promotes the contribution that sustainably developed hydropower will make to economic development.

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Hydropower helps reducing Greenhouse Gas Emissions The project includes systematic geological hazard prevention and mitigation works, and joint monitoring and prevention systems. Water pollution prevention and treatment programs launched. 49 % of household sewage and 70 % of waste in the towns in the reservoir area receives treatment, higher than the national average Various biodiversity protection programs launched, including the replenishment of water in the lower reaches of the river during dry seasons improving water quality and reducing salinization at the estuary.	Opportunities for transforming the mode of economic growth in the reservoir area and for lifting local residents out of poverty and improving their living standards through funding for the resettlement of residents relocated for the TGP. Resident resettlement and town reconstruction upgraded and optimized the structure of the economic sectors of the Three Gorges Reservoir.			
Promotes improved performance in environmental and social assessment and management, hydrological and sedimentation management, and water quality and biodiversity.	Promotes improved performance in a wide range of social issues, e.g. project-affected communities, resettlement, indigenous people, working conditions and cultural heritage. Assessment will score the performance of a project in relation to basic good practice, and proven best practice.	The Protocol has been developed in a multi-stakeholder process. Protocol implementation is governed by a multi-sectoral Governance Council, which is currently chaired by an environmental NGO.	Demand for Protocol application is already very high from the hydropower industry in all parts of the world. Very high relevance to Asia and Africa which have the largest untapped hydropower potential, but also where sustainability is critical.	

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	ECONOMIC BENEFITS
(6) Industrial wastewater reclamation technology for urban irrigation in Windhoek, Namibia Africa **Source:** **Case study paper, Zaragoza Conference**	Water Technology	Wastewater reclamation plant based on cost- and energy-efficient technologies to purify urban and industrial wastewater which may not be suitable for drinking water, for reuse in irrigation. The technical components of the process are conventional mechanical treatment (buffer tank, robust type screening and sand trap), advanced biological treatment (membrane bioreactor, equipped with instrumentation for remote control, automation and easy operations onsite), compact final settlement tank and post-disinfection through UV (with additional chlorination on request). Implemented through a BOOT-type contract (build, own, operate and transfer) with a contractors consortium of companies from Africa and Europe	Increase in land value in project area (dry land with no water resources for irrigation is worth little, whereas irrigated land has higher value). Additional land will be ready for utilisation, after reuse water is available for irrigation. This land will generate business activities, contributing to the economic development of the City of Windhoek.
(7) Water harvesting project for water supply and agriculture in rural districts of the Republic of Djibouti, Africa	Water technology	Construction of hydraulic structures including 14 underground storage tanks, surface reservoirs and diversion works. Improved knowledge of the hydrogeologic conditions in the project zone. Capacity building of government water resource engineering departments. Sector assessment and preparation of bankable projects for funding.	

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Reducing the quantity of water abstracted leaves more to meet environmental requirements. Ecosystems benefit from a reduction in discharge of contaminated wastewater.	The project does not directly focus low income settlements or poverty alleviation. Anyhow, it will generate a considerable social benefit, as the stimulation of the local economy will serve the public budgets, including those for social welfare. River contamination will be reduced after the reuse plant comes into operation. This will decrease the pollution of the drinking water (raw water), which the poor downstream use.	Without cooperation of professional technology providers from the private sector, and a very active public utility as employer, both focusing on greentech business development in their local water sector, the scheme could not have been realised. Technological progress, as well as BOOT and good municipal governance and national finance, were essential to go forward with this greentech project.	Good potential for scaling up once project demonstrates success and once water tariffs and wastewater charges reflect a reasonable proportion of real costs (whereas a scale-up would be difficult wherever water and wastewater are free of charge, and represent no or little value to the consumers and decision makers).	
Study on the initial environmental status of the project area completed.	Expected: Improved access to water for multi-purpose uses by the rural nomad populations (2,400); better knowledge of the available water resources in the project area. Achieved: 37 rain water harvesting structures constructed and utilized for drip irrigation and water supply for vulnerable populations and sites for construction of new structures identified; feasibility study on the use of solar energy for pumping completed; two farmers associations trained on irrigation technologies.		Expected: Increased investments through scaling-up of the new technologies in water harvesting at the country level.	

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	ECONOMIC BENEFITS
(8) Improved Sanitation and Water Supply Service Delivery to the Urban Poor in Ghana through Tripartite Partnerships **Africa** **Source: http://www.africanwaterfacility.org/fileadmin/uploads/awf/projects-activities/Appraisal%20report%20TPP%20Ghana%20v5%2041.pdf** **Issue: Cities**	Water technology	Test a range of different innovative management models, approaches and technologies for providing WASH services to the urban poor. Innovative technologies and approaches tested, including: multi-purpose water / sanitation / washing facilities, EcoSan, biogas; micro-financing for household latrines; social marketing for sanitation; intensive hygiene education, franchised management of public facilities; private sector entrepreneurs and facility operators, re-use of treated excreta by farmers; Capacity developed for sustained management of the facilities. Provide infrastructure in three pilot areas (two small towns and one urban slum) under the new management models. Support development of a more enabling environment by undertaking knowledge and advocacy activities.	Demonstration of more cost effective approaches will lead to increased output from available funds. Improved financial management and effective cost recovery. The project will learn from the community water and sanitation sector in Ghana which has a long history of applying policies for sustainable cost recovery.
(9) Kisumu District primary schools water and sanitation project. **Africa** **Source: http://www.africanwaterfacility.org/fileadmin/uploads/awf/publications-reports/Kisumu%20Case%20Study.pdf**	Water technology	Construct rainwater harvesting systems, EcoSan toilets and solid waste management systems in the 6 selected schools Train pupils, teachers and parents in hygiene and environmental sanitation; Increase the capacity of the schools, local Governments, artisans and other stakeholders to manage and maintain the facilities.	Savings in medical bills due to reduced incidences of diseases especially those related to water and sanitation.

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Three pilot project target towns / slums provided with improved infrastructure for sanitation, solid waste and water supply (including public, institutional and household latrines; improved drainage and waste disposal facilities; new waste containers and collection points).	Baseline surveys conducted, designs prepared and WSS infrastructure put in place in the 3 pilot zones, impacting 15,000 people in an urban slum and 30,000 in two small towns. The projects will impact the transient population, farmers who will make use of the by-products from EcoSan facilities and conservancy labourers.	The study was sponsored by the NGO Platform of the Netherlands Water Partnership (NWP) and conducted by a Team of institutions comprising the Training, Research and Networking for Development Group (TREND), a local NGO, WaterAid and the Private Utility Service Providers Association (PRUSPA).	Enabling environment improved for replication and scaling up of pro-poor WASH service delivery in Ghana.	There is a risk that replication and up-scaling may be hampered due to attrition and turnover of local Government staff. The TPP approach will widen the available pool of skilled support staff from Community Based Organisations (CBOs) or NGOs that could be recruited into MMDAs so that experience gained will not be lost.
Contribute towards improved health and better environment, and at the same time contribute to meeting the water supply and sanitation needs of the schools in a sustainable manner	Improvement in the quality of life in the community, where the drudgery of fetching water of doubtful quality daily from long distances (mostly by women) is replaced by easily accessible water sources, even if available to only children and teachers in some of the communities. In respect of sanitation, the near absent open defaecation not only raises the dignity of the beneficiaries but more importantly reduces the incidence of sanitation-related diseases within the communities.	The presence of several actors in Kenya" s WASH sector means that small interventions must be implemented through partnerships with other senior actors and the key ministries if they are to be visible in a way that will inform national policy. The Kisumu Project's lessons had a better chance of informing policy if key national level ministries and agencies had been brought on board at its inception.	Serve as a demonstration for scaling up of the project model in nearby districts and throughout the country. One of the international NGOs working in the Kisumu area planned to use the ECOSAN designs in their interventions.	Challenges posed by natural characteristics such as swamps, floods and rocky conditions makes reliance on traditional pit latrines unsatisfactory. Adaptations for more appropriate technologies for household level toilets need to be explored. The toilets are suitable for school going children of about 10 years and above. They are unsuitable for very young pupils, physically and mentally challenged and the elderly.

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	ECONOMIC BENEFITS
(10) Pilot project for the introduction of water harvesting techniques in Bugesera Africa **Source: www.rema.gov.rw**	Water technology	Introduction of appropriate low cost systems for the collection of rainwater for irrigation and drinking water. Increase productivity of the land through proper management and sustainable conservation. Reinforce the capacities of local farmers and support agencies to implement and manage techniques for RWH and protection of natural resources.	Productive use of rainwater for vegetable gardening (small scale irrigation). Productive use of rainwater for home-based economic activities such as livestock, beer brewing, brick making etc. Money saving for concerned schools and households due to water availability by the pilot CUEP project in Bugesera District. Income generating activities may also be the result of the utilisation of time saved in collection of domestic water. Improvement of vegetables cultivation through irrigation by harvested rainwater.
(11) Ecological sanitation in Central Asia **Sources: http://www.unece.org/env/documents/2011/ece/cep/ece.cep.s.2011.l.2.e.pdf http://www.afghan-web.com/environment/sanitation.html** **http://www.wecf.eu/english/about-wecf/issues-projects/countries/kazakhstan.php**	Water technology	Ecological sanitation uses recycled human waste as fertilizer for agriculture. Ecological sanitation implemented in form of dry toilets in 5 schools in villages of Kostanai and South Kazakhstan oblasts and under the program 'empowerment and local action' carried out by Women in Europe for a Common Future.	Supply of cheap fertilizer (mainly among farming-orientated households).

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Direct and indirect environmental benefits include runoff management, soil and water conservation and agro-forestry trees planting.	Direct and indirect capacity building (skill development, knowledge building, organisational development), reduction of vulnerability, strengthening of social and physical infrastructure, all have helped to alleviate poverty in CUEP project intervention zone. Children and particularly young girls may be deprived of education due to the need to assist their parents in collecting water from far-away sources. The time saving in collection from the close to home source will allow them to attend school.	The project intervention areas ware specified to be in Bugesera and Rwamagana Districts of the East Province and Nyaruguru in the South Province for activities supported by FAO-MINITERE agreement while only Bugesera District was covered by ADB-MINIECOFIN Agreement.	Beneficiaries from CUEP project in Bugesera District are now well informed on the practice of rainwater, water harvesting and environmental protection, it is highly recommended that these practices are up scaled and replicated throughout Rwanda, in particular in the Eastern province where water scarcity problems mainly are encountered.	The quality of rainwater harvested from rooftop does not usually meet the WHO guidelines for drinking water quality, particularly for bacteriological quality. One adverse social impact concerns the risk of accident for children, domestic animals and livestock if the ponds are not properly fenced to keep them off. The potential serious environmental problem is the erosion of catchments leading to increased sedimentation, which reduces the storage capacity of the reservoirs and periodical excavation is becoming necessary.
Prevent of groundwater pollution with nitrates and bacteria from use of pit latrines.	Access to adequate sanitation for populations in remote areas.	Kazakhstan still receives foreign aid, while 55% of the population are supplied with drinking water through a central water and sanitation system (CWSS). The rural population in particular suffers from poor access to safe drinking water and sanitation.	Experience in Kazakhstan has shown that dry latrines are especially useful for rural schools and in the recovery of destroyed housing after disasters. Experience in Kazakhstan has shown that dry latrines are especially useful for rural schools and in the recovery of destroyed housing after disasters.	The successful introduction of such a new technology requires a change in behavior and must be accompanied with awareness raising, training and motivated local partners

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	
(12) Drip irrigation technology in Israel **MENA** **Sources:** **http://www.worldwatch.org/node/6544** **http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_WI99.pdf** **http://www.biu.ac.il/Besa/waterarticle7.html**	Water Technology	Over half irrigated area is now under drip irrigation in Israel. Modern drip technology includes computerized systems, fertigation by applying fertilizers directly to plant roots, and pressurised drippers enabling stable distribution of water.	Drip irrigation has played a major role in improving water use efficiency. Drip irrigation technology forms a major part of Israeli water technology exports (estimated that by 2017, Israeli companies will control about 50% of the global market).
(13) Sustainable water management in Singapore **Southeast Asia** **Sources:** **http://www.working-withwater.net/view/934/water-management-**	Water Technology	Historically, Singapore has been dependent on external sources of water because it has a limited amount of land area to store rainfall. In order to reduce its dependence on external sources of water, Singapore has developed and implemented extremely efficient demand and supply water management practices. Singapore's approach involves integrating a water demand management program that emphasizes the proper handling of the transmission and distribution network, with water conservation measures. This strategy is a combination of rainfall storage, desalination and very sophisticated technology for recycling used water.	Federal investment in desalinization, reuse of wastewater, catchment management, public education programs, water-related recreational activities. Supply and demand water management policies. Water conservation fees Water conservation tax for domestic and non-domestic water users Water-Borne Fee is levied to offset the cost of treating used water and finance the maintenance and extension of the public sewerage system. Sanitary Appliance Fee (SAF) is also levied per sanitary fitting per month.

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
SDI allows manipulation of root distribution and soil conditions in arid climates to better manage environmental variables, e.g. nutrients, salinity, oxygen and temperature. conserves water, controls weeds, ; minimizes runoff and evaporation, increases longevity of piping and emitters.	Sub-surface drip irrigation (SDI) accounts for 5-10% of irrigated area, and eases use of heavy equipment in the field, prevents human contact with low-quality water.	In the future, the amount of water consumed for the irrigation of agricultural crops will be first and foremost affected by the government's policy on agriculture. A policy of an unsubsidized market economy, which does not protect agriculture, will result in a decline in the area of farmed agricultural land and a clear decrease in the amount of water for irrigation of agricultural crops. The government can decide upon extensive agriculture, which will be supported by water prices that are lower than production costs.	Israeli institutions are leading the way by showing that sharing expertise and replicating innovative strategies can be a powerful tool in helping to sustain livelihoods of small farmers in dry areas.	Emitters can potentially clog, affecting the uniformity of application. Temporary use of sprinklers or other surface irrigation may be necessary during plant germination period. It is difficult to monitor and correct potential emitter clogging. Effects of freezing temperatures on drip systems and applying wastewater to frozen ground is still the subject of study and debate.
Improvements in water quality.	Improvements in water security. Education/training in water conservation for Singapore's citizens. Decreased reliance on foreign water supplies. Increase in recreational water activities.	It is very important to have correct policies and good leadership, otherwise the policies won't be consistent or last long.	PUB has initiated numerous innovative approaches to manage the total water cycle in Singapore. Many of these approaches can be adopted by developed and developing countries to improve their water management systems. If the MDGs that relate to water are to be reached, the example of Singapore needs to be seriously considered for adoption by developing countries concerned and the donor community, after appropriate modifications.	Alternative sources of water such as seawater desalination have a high energy footprint. Future water supplies and treatment will probably be more energy intensive.

CASE AND REGION	TYPE OF TOOL	DESCRIPTION	
(14) ZINNAE: Zaragoza Urban Cluster for Efficient Water Use **Europe**	Drip irrigation has played a major role in improving water use efficiency.	The city of Zaragoza has made important collective efforts for the efficient use of water to all social sectors. The combined process of institutional and technological change and adoption has lead to the creation of specialised companies and to accumulating important experience. The city has become a space of permanent demonstration and innovation from the creation of projects related to the use of urban water. Two external global trends guarantee the timeliness of this initiative: 1. The water market is one of the first five markets of the world, with a turnover reaching US$400 billion and an annual growth rate of 7%, according to data disseminated by Watertech Online. 2. The amount of water demanded in the world will have an ongoing increase, largely due to the growth of urban population (in 2020 "over 50% of the population in developing countries will be urban").	Allow economic resource savings both to the citizens, the public administrations, big companies and consumers.

ENVIRONMENTAL BENEFITS	SOCIAL /POVERTY ALLEVIATION BENEFITS	GOVERNANCE CHANGES	SCALING UP AND RELEVANCE FOR DEVELOPING/ TRANSITION COUNTRIES	CONCERNS
Expected: To boost efficiency and sustainability in water use and management as well as in the associated energy consumption of the city of Saragossa.	Expected: To turn the efficient use of water into a driver of quality employment for the city.	ZINNAE integrates in 2011 twenty six public and private entities which take part of the hydrological cycle management in the urban area. They are all part of the Water efficiency Sector in Zaragoza.	Both the cluster development and Waterlabs project increase the innovation potential of business sector, and identify RTD projects for Research Centers. This is relevant for developing countries in two ways: Launching Research and Technology Development projects for water solutions. Favouring the cluster working methodology which involves joining efforts between Research sector, business sector and local and regional authorities.	

‘Adding value in water-related capacity development’

Adding Value in Water-Related Capacity Development

The UN-Water Decade Programme on Capacity Development (UNW-DPC) is a joint programme of UN agencies and programmes cooperating within the framework of UN-Water and hosted by the United Nations University.

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