Water and the Green Economy

Capacity Development Aspects

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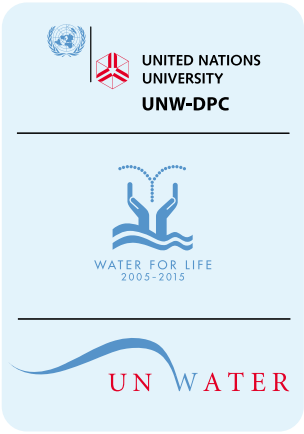
Water and the Green Economy

Capacity Development Aspects



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Foreword

Leading up to the occasion of the UN Conference on Sustainable Development (Rio+20) in June 2012 and based on the assertion that capacity development is key to the transition to a green economy, in particular when it comes to effectively addressing challenges in knowledge and technology transfer, UNW-DPC has placed a major emphasis on a series of "green economy" related activities throughout 2011 and 2012.

Clean water and sanitation are essential to human well-being and social equity, and given the current political momentum, inter-agency mechanisms working towards improving these conditions, such as UN-Water, have a unique opportunity to step up to the plate with coordinated, timely, cross-sectoral messages and actions that address the wide spectrum of issues that achieving a green economy will require.

To bring the areas of "capacity development" and "water" together under the green economy umbrella, UNW-DPC put out a call for contributions and best practices to all UN-Water members and partners in order to produce this state-of-the-art publication on capacity development for water and the green economy.

We are pleased that so many answered our call, and that this book can showcase excellent global examples from nearly a dozen UN-Water member and partner organizations worldwide.

Specifically, the book fills a gap in current knowledge when it comes to connecting capacity development, water, and green economy practices. Of particular importance are capacity development practices for knowledge transfer and adaption/adoption; capacity development practices for technology development/adoption/transfer; individual capacity development practices; and institutional capacity development practices.

We are very pleased to present this publication to you, and wish you an interesting read.

Reza Ardakanian
Director, UN-Water Decade Programme on Capacity Development (UNW-DPC)

Overview of the Book

More and more societies are looking to transfer their economies into green economies. This begs questions such as what are the characteristics of a green economy, and what will it take to accomplish it with respect to capacity development needs within the water supply and sanitation sector?

While the "green economy" concept still needs to be defined and agreed in detail, UNEP's working definition considers a green economy to be one which results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities: "In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive" (UNEP)[1].

Furthermore, the green economy approach "seeks, in principle, to unite under a single banner the entire suite of economic policies ... of relevance to sustainable development" (Ibid.). As such, this approach includes already approved holistic management approaches such as integrated water resources management and combines principles of social inclusiveness, resource and energy efficiency, while assuring biodiversity and sustainable ecosystem services.

In its Green Economy Report, UNEP[2] (2011) provides six key messages with respect to water:

1. Water, a basic necessity for sustaining life, goes undelivered to many of the world's poor.
2. The existing inadequacies in provision of water and sanitation services generate considerable social costs and economic inefficiencies.
3. Continuing current practices will lead to a massive and unsustainable gap between global supply and demand for water withdrawal. This is exacerbated by failure to collect and treat used water to enable subsequent uses.
4. The availability of an adequate quantity of water, of sufficient quality, is a service provided by ecosystems.
5. Accelerated investment in water-dependent ecosystems, in water infrastructure and in water management can be expected to expedite the transition to a green economy.
6. When investment is coupled with improvements in institutional arrangements, entitlement and allocation system, the expansion of Payments for Ecosystem Services (PES), and the improvement of water charging and finance arrange-

1 http://www.unep.org/greeneconomy/AboutGEI/WhatisGEI/tabid/29784/Default.aspx

2 http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/4.0-WAT-Water.pdf

ments, the amount that needs to be invested in water can be reduced significantly.

Capacity development has a core role in the improvement of water supply and sanitation. Furthermore, the meaning of "capacity" has evolved with respect to target groups and scope, from a formerly narrow definition of capacity in the sense of strengthening administrative personnel "to plan implement, manage or evaluate policies, strategies, or programs designed to impact on social conditions in the community" (Shafritz,[3] 1985).

More inclusive definitions (Zinke 2006[4]) define capacity as "the emergent combination of attributes that enables a human system to create development value" and "the overall ability of a system to perform and to sustain itself: the coherent combination of competencies and capabilities." In addition, UNDP defines capacity as the ability of individuals, institutions, and societies to perform functions, solve problems, and set and achieve objectives in a sustainable manner. Accordingly, capacity development (CD) can be understood as the process through which the abilities to do so are obtained, strengthened, adapted and maintained over time (UNDP)[5].

The aim of this book is to give special attention to the needs related to capacity development for water resources management, including water supply and sanitation, in the context of the green economy. This is done by showcasing theoretical and practical approaches which have proved to be successful. Most of the contributions come from members and partners within the interagency mechanism known as UN-Water. As such, the book is in line with the mandates of UN-Water and the UN-Water Decade Programme on Capacity Development, which are to strengthen coordination and coherence among UN entities within UN-Water as they deal with issues related to all aspects of freshwater and sanitation. Along these lines, UNW-DPC aims to support not only capacity development related to water, but also education, training and institutional development. The 11 case studies in this book cover the entire range from innovative design and delivery of CD programmes related to water in the green economy, market mechanisms, and quality control procedures supporting CD success towards the practical implementation of programmes to enhance individual and institutional capacity.

How is CD in water and sanitation contributing to the transitioning process towards green economy? Considering the core features of green economies, enhanced resource and energy efficiency, it becomes obvious that water use efficiency is a central aspect of green economy. Therefore, regional and locally adapted water management strategies are crucial to underpin the transition towards the green economy in the water sector. Institutional capacity is seen as a pre-requisite for the implementation and enforcement of such measures to shift from "business-as-usual" practices to green water economies. The extent to which institutional capacity will be developed will determine the actual implementation of reforms in

3 Shafritz, J.M. 1985. The Facts on File dictionary of public administration. Facts on File, New York, N.Y.

4 Zinke, j. 2006. Monitoring and Evaluation of capacity and capacity development. Series. 38.

5 http://www.undppc.org.fj/_resources/article/files/19.pdf

all sectors (Chapter 1). As a platform to foster this process, capacity-building networks such as Cap-Net are designed to contribute to sustainable water management and thus recognize multiple water users and a variety of institutions which constitute water governance. These networks at the national, regional, and global level are driven by agreed principles on how water resources should be managed, which include:

i) The right to safe and clean drinking water and sanitation as a human right, and the critical importance of water resources for sustainable development, including poverty and hunger eradication, public health, food security, hydropower, agriculture and rural development;

ii) The necessity of setting goals for wastewater management, including reducing water pollution from households, industrial and agricultural sources and promoting water efficiency, wastewater treatment and the use of wastewater as a resource, particularly in expanding urban areas;

iii) The commitment made in the Johannesburg Plan of Implementation (JPOI) regarding the development and implementation of integrated water resources management and water efficiency plans; and

iv) The need to address the interrelationship between water, energy, food and climate change in order to achieve synergies as well as to minimize conflicts among policy objectives, being particularly sensitive to impacts on vulnerable populations.

These principles are included in all contents and capacity development delivery, and the impact of this delivery is monitored at the recipient level to measure specific impact in terms of concrete changes in water resources management, as well as access to water and sanitation. These changes are found in new practices, policies, laws, and institutional arrangements, which are in turn in line with sustainable water resources management, green economy development, and contributions to improved access to water and sanitation (Chapter 3).

Methodologies such as the Transfer of Environmentally Sound Technology (TEST) (Chapter 4) help to improve water use efficiency and waste water treatment at the company level by analyzing the production process for water inefficiencies and suggesting improvements with related costs and savings.

Enhanced water use efficiency and water quality are also core topics of other case studies dealing with the safe use of wastewater in agriculture (Chapter 5), rainwater harvesting (Chapter 6), the eco-tank model for sanitation and improved water quality (Chapter 9), the management of natural infrastructures (Chapter 11), and the importance of public policies with emphasis on commitment, efficiency, equity and sustainability (Chapter 7).

Other characteristics of a green economy are reduced carbon emissions, socially inclusive approaches and reduced environmental impacts. In order to accomplish this, it is suggested to implement policy reforms towards better water management on the demand side (as opposed to water supply policies) and to

increase water productivity by unlocking soil water potential through integrated land and water management (Chapter 1). Other solutions favour CD interventions explicitly addressing sustainability as a crosscutting issue from institutional, regulatory, social, financial, commercial or operational perspectives (Chapter 2). Using capacity-building networks such as Cap-Net also supports these green economy features by fostering open partnerships based on principles such as equity, gender balance and environmental sustainability, which are low carbon because of minimized travel (Chapter 3). In Chapter 10 the complete cycle of resource use helped to reduce environmental impacts: biogas production from dairy farming in Indonesia reduced deforestation, as wood was replaced by biogas for cooking purposes. Environmental education is seen as essential for generating capacity with respect to environmental awareness with the goal of creating environmentally-sensitized citizens. For social inclusiveness, special focus needs to be given to the expansion of water services to low income groups while using subsidy systems that guarantee low income groups access to basic water services (Chapter 7).

Interdisciplinary thinking and problem-solving for integrated solutions are also core elements of a green economy. The process of transition to the green economy can be associated with a process of structural change that will entail difficult choices and tradeoffs to be made, therefore requiring interdisciplinary thinking. These strategies will also have to be integrated into broader environmental and development policies, and treated as strategic priorities, especially in water-deficit economies (Chapter 1). Interdisciplinary thinking is accomplished by capacity development programmes which offer interdisciplinary content, bring people together from different organizations, disciplines and hierarchical levels, and foster joint learning experience, i.e. by developing joint action plans. It is also fostered by capacity development networks that are open and inclusive and assemble skills and knowledge from different disciplines (multi-disciplinary and trans-disciplinary approaches) (Chapter 3). Other case studies demonstrate the benefits of training all levels of employees within a company, ensuring ownership of the changes introduced and their successful adoption (Chapter 4); of joint training of experts from different professions (i.e., water, agriculture, health, socio-economic experts for the safe use of wastewater, Chapter 5); or of training different stakeholders from diverse backgrounds such as government officers, private sector, NGOs and the public (Chapter 6). Interdisciplinary thinking is a pre-requisite for holistic and integrated solutions (Chapters 7 and 10) and, as such, for establishing interlinked management approaches.

Interlinked management approaches are important to successfully address the challenges of balancing the requirements of service coverage expansion and quality improvement, and advancing towards financial sustainability, while at the same time ensuring social equity, promoting economic efficiency, protecting the environment and coping with increasingly limited water availability and growing energy costs. It is furthermore recognized that drinking water supply and sanitation services, macroeconomic and social policies, energy and food sectors, perspectives of export-led economic growth and tourism development, as well as integrated water resources management and watershed protection are all closely interlinked, and that solving the problems of the future requires an integrated and holistic approach

(Chapter 7). Interlinked management of land, rainfed and irrigated agriculture is of particular importance for economies transitioning towards green economies to accomplish necessary structural changes. These changes require coordination and integration into wider environmental and development policies (Chapter 1). In general, interlinked management benefits from vertical integration (individuals, institutions, system) and horizontal integration (health, water, agriculture departments), as witnessed in Chapter 5. Interlinked approaches in water resource management involving the government, private sector, NGOs and the public sector proved to be more efficient and effective than the traditional top-down approach whereby the government is the sole water supplier without considering the needs of consumers and the public (Chapter 6).

Some characteristics of innovative CD approaches for water and the green economy which contribute to the enablement of the transition towards a green economy include:

- Interdisciplinary, on-the-ground identification of issues (problem definition);
- Inclusion of multiple aspects and multiple stakeholders in the analysis of the issues and in the design of the CD programmes;
- Delivery of a CD programme that comprehensively addresses issues, brings together and empowers all local stakeholders;
- Comprehensive CD programmes for all stakeholders, encouraging the preparation and implementation of (joint) action plans to increase the impact and sustainability of water, sanitation and solid waste investments; and
- Follow-up of the action plan implementation and addressing constraints in its implementation (Chapter 2).

Other criteria for success are:

- Specific attention is paid to macroeconomic and social policies, including complementarities between sector reform and benefits in terms of economic development, poverty reduction and environmental protection;
- Solutions are based on time-proven empirical solutions adapted to local conditions;
- Systematic consideration of best practices is combined with long-term historical analysis;
- Holistic approaches are used, based on sound principles of economics of service provision with specific attention to environmental restrictions (in particular, water and energy), social viability and integrated water resources management (Chapter 7);
- Locally available materials and local man-power (village community) are utilized where possible – reducing carbon footprints and creating jobs for locals; and

- Local communities are trained – ensuring sustainable operations and maintenance (Chapter 10).

Special emphasis is given to locally relevant content of CD programmes, i.e., action plans to improve local conditions, in order to establish local ownership, demonstrate demand responsiveness and enable anchoring capacities at the local level (Chapter 3). Capacity development programmes requiring co-funding proved to increase the engagement of participants in the training ("it makes users and recipients understand they also need to invest in capacity development as a means to drive a better future" Chapter 3). With respect to water resources management and related policies, innovative CD approaches need to shift their focus areas from water supply management by mobilisation of blue water through large-scale engineering projects towards water demand management strategies (Chapter 6). Supply-based solutions have already shown their limits (economic, social and environmental). Moreover, they make use of only a small part of the water available for agricultural production (so-called "blue water"). A focus on water demand policies and a re-thinking of the way (green) soil water is used, is argued to have much more potential for promoting better use of available resources and reducing externalities, while intensifying agricultural outputs (Chapter 1).

Other aspects of innovative CD programmes include vertical integration of target groups and thorough needs assessment at local levels. Using CD to introduce changes at all levels of a company ensures that the whole staff, from managers to operators, is aware that economic and environmental performances are closely linked (Chapter 4). To ensure relevance of CD programmes, it is important to assess the capacity needs at the local level, and then carry out the knowledge sharing and training activities at an international and regional level to reach wider target groups (Chapter 5).

There are quite a few lessons learned from the case studies, a brief overview of which is provided below:

1. During the transition process towards a green economy, changes in "hardware" (technology) need to go hand-in-hand with changes in "software" (people). Water and sanitation play a core role in this process.

2. A green economy cannot be totally green unless it addresses water issues. In other words, a blue economy is a pre-requisite to a green economy.

3. Governments need to take the lead in the transition process: necessary infrastructure for service provision will not materialize without public investment. As such, political priorities are better reflected in government budgets than in statements to the press. While taking the lead, governments need to involve multiple stakeholders for effective solutions (horizontal approach).

4. Diverse political economies, varying water endowments and different socio-economic capacities to tackle water issues mean that there are no CD programmes that fit all needs. Programme adaptation to specific local conditions is a pre-requisite for the success of CD. In this respect, capacity development and social learning through open and inclusive networks can help to deal with

diverse learning environments and the increasing complexity of cross-sectoral approaches. Learning platforms like the Cap-Net network for professional and social innovation and adaptive management can enable horizontal and vertical policy coherence.

5. Web-based learning management systems are of increasing importance since they are very effective for disseminating and sharing knowledge.

6. Any CD intervention needs to include a monitoring and evaluation component for assessing the impact and success of the activity.

7. With respect to CD at an institutional level a two-tier approach targeting individuals and the organization or system level proved to be successful.

8. In an industry setting, innovative management approaches such as the Transfer of Environmentally Sound Technology (TEST) methodology can be implemented in many different industrial sectors and from micro to large enterprises. However, implementation in small and medium sized enterprises proved to be most successful because of the owners' direct involvement.

9. Specific attention is needed to develop and retain local capacity for sustainable maintenance of green technologies since the availability of local engineering or technical staff is often low to none. This in addition to local stakeholder involvement will also contribute to local ownership of the operation and maintenance of water and sanitation services.

The case studies presented in this book highlight approved methodologies and practices which contribute to green economies. Of course, much of the work in the transition to green economy principles still needs to be done. However, as the case studies in this book demonstrate, there is already a good base to build on.

Dirk Jaeger
UN-Water Decade Programme on Capacity Development (UNW-DPC)

Chapter 1:

The transition to the Green Economy in the Mediterranean region: Water demand management strategies and market efficiency

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Abstract

This study explores the role that water demand management (WDM) in agriculture can play in the transition to the Green Economy in the arid and semi-arid Mediterranean region. In particular, it will investigate the potential for WDM strategies to contribute to the development of green economies, through the adoption of demand-regulating market mechanisms and improvements in water use efficiency. The study argues that, first, for the aim of achieving optimal solutions, it is paramount to ensure the alignment between individual and collective interests by means of the enhanced capacity of markets to convey signals of the relative scarcity of different resources. The extent to which water price/cost reflects relative water scarcity has a great potential to influence actual performances in agriculture and to discourage unsustainable water use. Second, the study suggests that, while there is large scope for improving overall water use efficiency in both irrigated and rain-fed agriculture, the greatest potential lies in upgrading rain-fed crop production, which supports the largest share of food production globally. Finally, it is argued that institutional capacity-building can be regarded as a fundamental prerequisite of the whole transition to the Green Economy; but that socio-political imperatives and circumstances determine which options are available to local decision makers.

Keywords
Water demand management
Mediterranean region
Green Economy
Water markets
Water pricing
Rain-fed agriculture

A. Introduction

This study investigates the role that water demand management (WDM) in agriculture can play in the transition to the Green Economy in the Mediterranean-rim countries. The purpose is twofold: first, to identify the scope of the Mediterranean

countries' water question vis-à-vis the demographic, economic and environmental challenges the region is now facing; and second, to analyse the potential for WDM interventions in agriculture – namely, the adoption of demand-regulating market mechanisms and the increase in water use efficiency – to stimulate the development of green water economies.

Water scarcity is a common predicament in many arid and semi-arid Mediterranean economies.[1] The availability of water has become a limiting factor or even a constraint on the activities of economic development that are water-intensive. The water shortage brings very difficult challenges for those using, allocating and managing water in the region. As agricultural production requires between 65 and 85 per cent of total water withdrawals, the region's water deficit has brought about relevant food security challenges, especially in the southern and eastern economies. The region as a whole is a net importer of food; the largest volumes of virtual water "flows" are associated with the import of cereals, vegetables, oil and sugar by the southern and eastern-rim countries (Yang, Wang and Zehnder, 2007). Irrigated crop production is a very attractive option for farmers because of the prevalence of high temperatures throughout the region's territory, but it has also caused land degradation and water resource overexploitation. The situation is also likely to get worse as freshwater availability is expected to drop as a consequence of current social, economic and environmental trends. In this context, responding to the water crisis and "adjusting" current practices is a non-negotiable requirement for ensuring that future demands will be met.

The study is structured as follows: the next section outlines the scope of the Mediterranean region's water challenge. The following section is concerned with the suggested WDM strategies in agriculture, namely irrigation water charging systems, and water use efficiency in both rain-fed and irrigated agriculture. A further section is devoted to exploring the issue of capacity-building in the context of water resources management. The final section draws some conclusions and offers specific policy recommendations.

B. The case of the Mediterranean region

The concern over water in the Mediterranean basin has prominently come to the fore as the region's economies are now facing major social, economic and environmental challenges. With water withdrawal increasing rapidly and exceeding the internally renewable resources, water scarcity and its implications for food security have become a primary concern in most Mediterranean countries, especially those in the south and east which are the most vulnerable to water crisis.

The Mediterranean region hosts a rich mosaic of landscapes and is a hotspot for biodiversity. The countries in the region are characterized by limited water en-

1 The Mediterranean region, as considered here, includes the northern-rim economies of Albania, Bosnia and Herzegovina, Croatia, France, Greece, Italy, Malta, Monaco, Serbia, Montenegro, Slovenia and Spain; and the south-eastern countries of Algeria, Cyprus, Egypt, Israel, Lebanon, Morocco, Libya, Occupied Palestinian Authority, Syria, Tunisia and Turkey.

dowments and climate variability as well as by a significant development of (water-consuming) anthropogenic activities. The region's water resource challenges are mainly three. First, water is unequally distributed in space and time, within both the region and its national economies. It is relatively abundant in the north, but scarce in the south and east. Second, climatic variability and erratic rainfall patterns exacerbate the disparities in resource availability. Future scenarios indicate an increase in temperature of 2° C by 2050, a decrease in precipitation and an increased vulnerability to extreme events such as floods and droughts (Milano and others, 2011). Third, water demand in the region has increased twofold since the second half of the twentieth century, reaching 280 km^3 per year in 2000 (Plan Bleu, 2006), and is expected to continue to grow as a result of population growth, dietary changes towards a higher intake of animal-derived calories, the expansion of irrigated land and urban areas, and economic development (Plan Bleu, 2005). The bulk of the (eastern and southern) economies in the region are already experiencing a major water deficit.2 Water extractions currently exceed the limit threshold of renewable resources in many southern and eastern countries, and under a "business-as-usual" scenario this proportion might reach 75 per cent by 2025 (Plan Bleu, 2006).

Industrial activities are mainly concentrated in the north of the region and they contribute significantly to increasing the pressure on the resource base, both directly and indirectly. Direct impacts involve pollution and contamination of water resources at the site level; indirect impacts relate to site-specific effects affecting industrial complexes in a number of hotspots throughout the region (Ganoulis, 2007). The regional water stress is also magnified further by the rapid increase in water demand by urban agglomerations, which requires more water to be diverted from agriculture. The region-wide overall urbanization rate amounted to 64.1 per cent in 2000 and is projected to reach 72.2 per cent by 2025; a major share of urban population growth is concentrated in the southern-rim countries (Plan Bleu, 2004). As a result, urban population is expected to reach 520–570 million in 2030, 600 million in 2050 and 700 million at the end of the twenty-first century (Plan Bleu, 2006). Additional pressure on water resources also arises from tourism, which concentrates in urban agglomerations and peaks in the summer season. High numbers of tourists bring about significant increases in water consumption, as a result of the additional demand for water from tourism services and leisure activities. Moreover, it is in the summer months that the competition for water grows more intense, as natural water recharge and availability is at its lowest level but the demand from both tourism and irrigated agriculture peaks.

Agriculture is by far the most intense water user in the region. The region-wide average of agricultural water withdrawal is approximately 65 per cent, with significant variations between the northern, eastern and southern-rim economies, where agricultural water use accounts, respectively, for 45 per cent, 78 per cent and 83 per cent of total abstractions (Plan Bleu, 2007 in Plan Bleu, 2010). Accord-

2 We use the term "water deficit" here as it is commonly used in water research, namely by comparing estimates of "sustainable" water supply with estimates of water demand, which are obtained by applying reference standards to human and industrial consumption. This contrasts with the economic approach, where both supply and demand are seen as functions of price or cost, not as single values.

ing to FAO (2000), irrigated surfaces are also likely to increase substantially – by 38 per cent in the south and 58 per cent in the east in 2030 – and if present trends persist, this will result in further pressure on the resource base. Irrigated areas are also expected to continue to expand in the future from nearly 260 million hectares in 1995 to 330 million hectares in 2025 (Shiklomanov, 1999). The region's agricultural policy has affected water consumption for irrigated agriculture to a large extent. In many Mediterranean-rim countries, irrigation water is indeed provided at low or zero cost, funded by public subsidies to farmers. As a consequence, the region has experienced a continuous expansion of irrigated areas, overexploitation of both renewable and non-renewable water and suboptimal allocation of available resources (Chohin-Kuper, Rieu and Montginoul, 2003). Moreover, agriculture is probably the least efficient water-consuming sector in the region: average losses in irrigation water systems account for 55 per cent of total water losses (FAO, 2000). Addressing the issue of water management in irrigated agriculture is fundamental to avoid the impairment of the region's water resource base and irreversible degradation of soil. Improved water management could bring about considerable water savings – about 86 km^3 per year in 2025 – where the potential for water savings in agriculture accounts for 65 per cent of total water savings in the region (Plan Bleu, 2006).

The reasons why the Mediterranean's water-related challenges are particularly urgent mainly stem from current water resources planning and management, or rather the lack thereof. The Mediterranean countries' agricultural water policy and the failure to convey signals of the relative scarcity of the resource have resulted in highly subsidized irrigated-agricultural production and a suboptimal utilization of water resources both within and between sectors. This has generated, in turn, water resource overexploitation, salinization and land degradation. Decisions concerning water policy reforms and reallocation between sectors have proved to be politically challenging in the region. The tendency to procrastinate over sound policy reforms in the water sector is a common feature of the southern and eastern countries in the Mediterranean. Large-scale (blue) water mobilization projects have been preferred to politically hazardous reforms and the "import" of virtual water has provided policymakers with a "silent, cheap, (and) politically non-stressful solution" to local water resource deficits (Allan and Olmsted, 2003, p. 65).

The *hydraulic mission*[4], however, has shown both its economic and environmental costs, and this has raised the need for a new approach towards water resources planning and management. In the next section, it will be argued that acting on the demand side of water management is the most viable avenue for preserving (or re-establishing) the balance between limited resource supplies and burgeoning demands. The study maintains that there is much scope for aligning individual and collective interests, by (i) means of the introduction of market-mediated signals

3 "Blue" water is the water existing in surface water flows and aquifers, as opposed to "green" (soil) water in the unsaturated zone.

4 The concept of *hydraulic mission* refers to water resources management aimed at increasing water supply through large-scale infrastructure, such as such as dams, irrigation schemes and groundwater extraction projects.

that reflect relative water resource scarcity, and (ii) for pursuing new public and private investments towards the maximization of water resource use efficiency.

C. Water demand management in agriculture

Water demand management (WDM) can be defined as "a set of technical, political, institutional, economic, training, awareness-raising and communication tools intended to encourage *better* use of existing supply before considering increasing supply" (Plan Bleu, 2010, p. 4, emphasis added). In its broad definition, WDM policies encompass any intervention aimed at increasing the efficiency of available supplies, while considering the mobilization of additional water resources as the *ultima ratio*. This study suggests that WDM is the most appropriate strategy to cope with supply–demand induced imbalances, and that the progressive and consistent implementation of such measures can provide solid ground for the transition to green water economies. A Green Economy is an economy that results in enhanced human well-being by respecting the carrying capacity of the environment. This goal can be reached by decoupling economic growth from natural resource overexploitation. Applied to water, this translates into the "sustainable intensification" of agricultural production. Consistently with this conceptualization of green economies, we argue that there is a large unexploited potential lying in the development of WDM policies aimed at achieving *more* efficiency in water use – through both market-based mechanisms and enhanced agricultural practices. Water demand management has also been recognized, by the Mediterranean Commission on Sustainable Development in 1997, as "the route for achieving the most significant progress in Mediterranean water policies" (Plan Bleu, 2009, p. 4), "given its potential for improving efficiency" (Plan Bleu, 2008, p. 2). The integration of water management and demand policies has also been recognized as a priority of the 2005 Mediterranean Strategy for Sustainable Development's framework, aiming at i) achieving "more value per drop" and ii) stabilizing demand by limiting water losses and overexploitation (Plan Bleu, 2008).

1. Conveying signals of relative scarcity for water resources

Water is a scarce resource performing positive economic functions. In a world of "first-best" solutions, its use should be reflected in a value corresponding to the social opportunity cost of the resource, so that any externality is internalized[5] and the allocation of water resources is made "socially efficient". Water prices, however, do not normally reflect the marginal economic value of water and there is an extreme disjuncture between individual and collective interests. Establishing efficient pricing systems is both a politically sensitive issue and a technical challenge, and consequently water is generally offered at low or zero cost. This applies to the case of the Mediterranean-rim countries, where water misallocation and overexploitation are commonplace.

5 An externality is a cost (or benefit) that affects other parties without being reflected in the cost of goods or services involved. Internalizing an externality means correcting its price or cost (e.g., through taxes or subsidies), so that the price reflects the full social value of the resource.

Nonetheless, this study argues that the first condition to promote the transition to green water economies in the Mediterranean region is the establishment of appropriate pricing, charging and allocation systems that convey signals of relative resource scarcity to users. At the core of this argument is that the extent to which the social opportunity cost of a resource is reflected in its price has an immense potential to influence actual performances and to encourage a more efficient use of available supplies.

Improving water efficiency, in agriculture and elsewhere, normally requires costly investments. An investment will be undertaken only if it is expected to generate positive returns, which in this context means potential savings on a valued resource (water). However, if the resource is not sufficiently priced, the economic value of the savings will be low, and socially desirable improvements in water efficiency will not be achieved.

More generally, properly working market mechanisms are essential for decentralized decision-making in complex systems, such as those related to the use and distribution of water. Instead of market mechanisms, there is a long-standing tradition, especially in water scarce countries of the Middle East, of centralized planning of infrastructure and water distribution schemes. The control over water resources is conceived as a primary source of political and economic power despite the fact that distributional justice as well as technical and economic efficiency can hardly be achieved this way. Rent-seeking, regulatory capture and corruption are unavoidable corollaries of flawed water management systems. Furthermore, vested interests and lobbies, most notably among farmers' organizations, are active in pursuing and securing privileges, such as easy and affordable access to precious water resources. As in other contexts, lobbying works through strong economic and political pressure exercised by limited groups with high stakes. The negative effects generated are diluted over a very large number of people, so that the consequences of inefficiency are barely felt at the individual level.

Inefficiency in water management is reflected in inefficient land use, production patterns, trade and consumption. On the one hand, for example, the reason why watermelons are cultivated in some semi-arid regions is that it is economically advantageous to do so. This is a direct consequence of price distortions and (explicit or implicit) subsidies on inefficient agricultural production. This makes evident the existence of a wide divergence between private and public interests, which can be seen as a result of the action of relatively small but very active political pressure groups.

On the other hand, it is true that economists usually propose water pricing as a panacea for all problems related to water resources, but in the real world implementing a pure water-pricing scheme often proves to be impossible. Political resistance is an obvious implication of the points discussed above. Technical difficulties, for example in metering water consumption, should not be underestimated as well. However, the fact that perfect pricing is impossible to implement should not be an excuse for not trying to fill the currently very wide gap between private and social valuation of water resources. In other words, a pragmatic implementa-

tion of second-best measures is essential for improved WDM, especially in areas like the Mediterranean.

In practice, there are a number of different modes through which the "internalization of externalities" can be pursued. First, a uniform user charge can be introduced, i.e., charging for water irrespective of the level of utilization. Second, area-based or crop-based charges can be applied. Third, government incentives and regulations can be provided to encourage the adoption of best practices. This is the case in Israel, where a large-scale water conservation policy embarked on from 1975 to 1982 has increased low volume irrigation equipment up to 700 per cent (Shevah and Kohen, 1997). Fourth, volumetric charging can be applied, associated with a quota. This is common in the southern and eastern Mediterranean-rim countries, as well as in the USA, Australia and Mexico (Molle and Berkoff, 2007). Fifth, excessive use is discouraged by setting up tariffs varying with the different levels of consumption. A sixth measure is to introduce a market-based price and, finally (indirectly), charge farmers implicitly through the price of other inputs (such as land) or decreasing subsidies for agricultural output.6 These measures (second-best solutions) will improve overall water use efficiency, but will also generate social costs.

2. Increasing water use efficiency in agriculture

The second avenue through which better WDM in the Mediterranean can progress is the increase in water use efficiency – defined as the agricultural output per unit of water used – in both irrigated and rain-fed agriculture. At the core of this argument is not only the inherent inefficiency and suboptimal utilization of water resources in the agricultural sector, but also the need to make the most of available resources rather than relying on additional mobilization. The proposed alternative WDM strategy includes several key interventions aimed at increasing the efficiency of both green and blue water use. It is also argued here that higher water-use efficiency is not alternative but rather complementary to better water pricing, and sometimes even a precondition.

The first required intervention is to enhance the efficiency of existing irrigation systems through the reduction of water losses. Overall water use efficiency in the region is far from being satisfactory. In 2005, average total water use efficiency in the region stood at between 50 and 85 per cent, with considerable variations between the northern, southern and eastern economies (Plan Bleu, 2009). A major share of water losses occurs in irrigation systems (87 per cent), accounting for 95 km^3/year (Plan Bleu, 2009), which is about 34 per cent of total water demand. If the efficiency gap were addressed purely in terms of technological improvement, water savings would reach 86 km^3/year by 2025 (Plan Bleu, 2008), which is almost 27 per cent of projected total water demand. For instance, deploying

6 Subsidies in agriculture often take the form of a "guaranteed price" through which a government or a supranational entity (such as the European Commission) covers any possible gap between a target price and the actual market price, thereby ensuring extra revenues to farmers, associated with the immunization against market variability and price oscillations. In this case, reducing subsidies would amount to reducing the guaranteed price.

micro-irrigation techniques would improve water delivery to plants considerably. A major constraint in their application is, however, the high maintenance cost of such equipment.

The second intervention concerns unlocking the potential of "green" (soil) water use in rain-fed crop production. As green water is highly correlated to a country's precipitation pattern, soil profile and climate, it is relatively scarcer than blue water in arid and semi-arid environments. Global food security is almost totally reliant upon it (Allan, 2011). It has been estimated that green water accounts for 84 per cent of total water use in agriculture and 94 per cent of the water "embedded" in agricultural exports globally (Fader and others, 2011). Increasing its productivity would make blue water available for higher-value uses while reducing the impacts on the environment. This argument is supported by consideration of the low opportunity cost associated with green water use and the relatively few negative externalities it causes on the environment (Aldaya, Allan and Hoekstra, 2010). Although the use of both types of water in agriculture is generally associated with an overall degradation of water quality due to the use of fertilizers and pesticides, the impact of rain-fed crop production is indeed considerably smaller than irrigated agricultural systems, which, conversely, change irreversibly the natural course of water flows (Yang and others, 2006). As suggested by Falkenmark and Rockström (2006), the maximization of green water potential in rain-fed agriculture goes hand in hand with an improvement in soil conditions through integrated land and water management (ILWM). By optimizing land use, green water productivity would be considerably raised, while water salinization, soil erosion and desertification would be reduced.

Finally, additional methods for increasing water-use efficiency in agriculture are water harvesting through both micro and macro water catchment techniques, supplementing rain-fed agriculture with freshwater and tailoring cropping patterns to the site-specific conditions and availability of water and land.

D. Capacity-building for water resources management

The challenge posed by the Green Economy is to balance economic, social and environmental goals for the aim of achieving economic growth, social equity and environmental stewardship. Rather than being in opposition, these three aspects complement each other and must be integrated holistically. The process of transition can be associated with a process of structural change requiring "adaptation" strategies to be developed and trade-offs to be calibrated. The enabling condition of the transition is, in turn, the development of "adaptive" human and institutional settings to support such change at all levels.

Achieving green water economies will require WDM policies to be translated into a set of concrete policy measures. Institutions can be regarded as "the set of rules governing water use and to the specific organizational arrangements involved in the formulation and implementation of water resources laws, policies, strategies and programmes …enabling environment for water resources management"

(Hamdy, Abu-Zeid and Lacirignola, 2009, p. 129). Building institutional capacity is a fundamental precondition of the transition to the Green Economy. Capacity-building for water sector development has been defined as the "umbrella concept" (Morgan 1998 in Lusthaus, Adrien and Perstinger, 1999) that links previously isolated approaches to water resource planning and management into a broader, result-oriented, long-term strategy. It is, therefore, the ongoing process through which societies enhance their abilities to perform in terms of water allocation, planning and management by both developing new institutional arrangements and strengthening those in place.

Successes and failures in water policy reflect the extent to which societies have enhanced the functioning and flexibility of institutions in order to address problems, formulate solutions and finally implement reforms. Capacity-building can be regarded as the "missing link" in water resource development in the bulk of water-deficit Mediterranean economies whereas in other cases, such as Australia, it has proved to be key in underpinning the effective and coherent reforms of the water sector. Since the mid-1990s, this country has embarked on a broad, market-oriented water policy reform in pursuit of increased water use efficiency and sustainability. Traditionally, the use of water resources was tied to land rights and provided at low or zero cost, on a first-come-first-served basis. As the country entered into a "mature water economy stage", the gap between water demands and available supplies was bridged through public investments at the expense of environmental assets and river flows (Freebairn, 2005, p. 10). A first fundamental shift in water policy occurred in 1994, with the Council of Australian Governments (COAG) statement, pushed further in 2002 and 2004, and complemented by the Green and White Papers, released by the Victoria State Government (2003 and 2004). A major aim of the different water policy agreements was to address the nation's water resource (mis)management in an integrated fashion, and to prevent further uncoordinated and fragmented activities across the country's territories (Stringer and Wittwer, 2001). Australia's ongoing water policy reform includes greater use of market instruments; implementation of minimum public regulation, according to the principle of subsidiarity; introduction of a system of tradable water property rights; and allocation of river flows and recycled water to meet social goals, such as environmental flow requirements, through publicly-funded investments (Freebairn, 2005; McKay, 2005).

For a new, holistic approach in water resource management to be embraced, institutional capacity-building must be developed at all levels (both horizontally and vertically) and needs to permeate every phase of water policy: from allocation to planning and management. Water management strategies must be integrated into broader environmental and development policies, and treated as strategic priorities, especially in water-deficit economies. As in the case of Australia, this would entail a major shift from centralized planning and public intervention, towards decentralized (and more efficient) decision-making. In this case, the public sector would play a key role as a market regulator, not as a player. This transition has occurred in many other economic sectors that have been liberalized and made open to competition. However, in comparison with other liberalized industries, the water sector poses additional technical, economic and political challenges. Even if

a comprehensive discussion of these difficulties is beyond the scope of this work, we nonetheless argue that: i) reducing the gap between social and private value of water resources is a prerequisite for the implementation of investments promoting water efficiency, especially in agriculture; and ii) pragmatic, second-best solutions are available, and should therefore be pursued and tailored to local contexts.

To sum up, the development of more effective institutional arrangements is a precondition for efficient, result-driven and adaptive water management. There is no single pathway for developing institutional capacity targeted at reforming the water sector. The choice and mix of strategies fundamentally depend on the site-specific political and social conditions, which determine both the acceptability and the viability of the required solutions.

E. Conclusions

The concern about redesigning water resources management has come to the fore as traditional water supply management strategies have shown both their costs (financial, environmental and social) and inherent inefficiencies. The main lesson to be drawn from the present analysis of the Mediterranean region is that a shift from supply-oriented to demand-oriented water management can act as a driver for change in the water sector and promote the transition to green water economies. This policy transition requires a move from centralized planning to harmonized and decentralized decision-making, which is, in turn, possible only to the extent that water resources are correctly valued from a social point of view.

Pursuing water security requires a balance between water supply and demand to be found. The core of efficient water demand management is trying to achieve this balance in a *sustainable* way, i.e., avoiding the irreversible environmental damage caused by the mobilization of additional water through large-scale infrastructures. The proposed demand-side water strategies include: the establishment of appropriate pricing, charging and allocation systems that convey signals of relative resource scarcity to users; and the adoption of technical measures aimed at increasing the efficiency of water use in both irrigated and rain-fed agriculture. The implementation of such measures will mean difficult choices to be made and trade-offs to be calibrated between different stakeholders.

The study has also argued that institutional capacity development is a fundamental prerequisite of the whole transition to the Green Economy. Flawed or successful water policies indeed reflect the extent to which societies have developed the necessary institutional capacity in order to address problems, formulate solutions and finally support the implementation of sound reforms.

The process of transition to the Green Economy, rather than being "power-neutral", will also require a fundamental paradigm shift in the water discourse. A water decision is a *political* decision first. The consistent implementation of the advocated policy reforms will depend on the extent to which politics accepts these changes to be made. Sociopolitical acceptance of the suggested reforms will thus

determine whether the transition will take place or not, despite the soundness of economic prescriptions or environmental recommendations.

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Chapter 2:

Towards sustainable and equitable water and environmental services delivery: Capacity development for multiple stakeholders from 11 towns around Lake Victoria

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Abstract

Around 2,200 stakeholders representing six major stakeholder groups from 11 towns in Kenya, Tanzania and Uganda were trained as part of the Lake Victoria Region Water and Sanitation Initiative (LVWATSANI), a programme that is being promoted by UN-HABITAT. The capacity development (CD) component of LVWATSANI aims to develop and empower local stakeholders with a view to securing their active interest and participation towards the sustainable and equitable delivery of water and environmental services.

The CD interventions were designed in response to the specific challenges in the towns. These challenges were surfaced through town-by-town inquiries that mapped the local actors, their relationships and the issues that constrain services development. The identified shortcomings were grouped under five headings: focus on disadvantaged people; town institutions and organizations; service coverage and quality; public engagement and access; and procurement and contracting. The ensuing programme of 21 different CD interventions comprised 98 events of about two days each that were implemented over a 10-month period. The interventions were organized once or several times, at town, national or regional level, the choice of which depended among others on the learning objectives and the size and characteristics of the target groups. In general, the 98 events brought together all local actors and emphasized joint understanding and ownership of the challenges and action to resolve these.

The CD interventions were output-focused and concluded with an action plan whereby each participant or group of participants identified and programmed local actions that were within their authority and capability to implement and that would make a contribution to the improvement of local water and environmental services. The impact of the CD interventions was measured by a second round of inquiries in all 11 towns that not only inventoried the appreciation for the CD interventions but also particularly set out to collect evidence of action plan implementation. The latter showed that individual and small-scale action plans had been started and some had even been successfully implemented. As could be expected at such an early stage, the larger and more complex plans were encountering problems requiring more time for consultation, resource allocation and alignment with local developmental programmes and processes. The project was concluded with one top-level consultation in each country that provided an opportunity for presenting the developmental challenges in water, sanitation and environment,

the contributions that were being made by implementing the action plans and for inviting senior stakeholders to commit to actions that would resolve constraints in implementing these plans.

Keywords:
Training
Capacity-building
Drinking water supply
Sanitation and environment
Small towns
Sub-Saharan Africa
Equity, Sustainability

A. Background

The Lake Victoria Region Water and Sanitation Initiative (LVWATSANI) supports the governments of the riparian states to achieve the Millennium Development Goals for water supply and sanitation, with emphasis on innovative solutions and speedy delivery in small towns in the Lake Victoria basin. The LVWATSANI includes infrastructure investments and capacity development. All activities were completed in an initial group of 11 towns in Kenya, Tanzania and Uganda with a joint population of about 390,000 and preparations are now under way to start with a second group of 15 towns in an expanding number of riparian countries.

Lake Victoria is the second largest freshwater lake in the world and the largest lake in Africa. The Lake catchment provides the livelihood of about one third of the combined populations in the three countries or about 30 million people, of which more than 50 per cent lives below the poverty line. The rapidly growing urban centres in the Lake Victoria basin are playing an increasingly important role in the economic development of the region. Most of these towns are experiencing unplanned growth and this is negatively affecting basic infrastructure, living conditions, the environment and the fragile ecosystem of the Lake.

Water-related challenges in the towns around Lake Victoria include recent water sector reforms that have not yet fully matured, run-down infrastructure where no major investments have been made in the past decades and the lack of recognition for the different needs of women, men, children, minorities and vulnerable groups. The water distribution networks usually cover less than 30 per cent of the urban area and there is a heavy dependence on unsafe water sources causing a high prevalence of water-related diseases. Also, high rates of leakage, high energy and water treatment costs, and low billing and collection ratios form a large constraint. Sanitation and solid waste management have very low priority as utilities and municipalities struggle to address the problems of water supply (Goodwin, 2010). The LVWATSANI investments in the 11 towns have been largely completed. These included: the rehabilitation of water-supply infrastructure; construction of distribution mains including water meters, valves and water kiosks; the construc-

tion of rainwater tanks; public latrines in schools, institutions and public spaces; the establishment of microcredit facilities for household latrines; the supply of solid waste tractors with trailers and bins; the construction of waste transfer stations; the supply of computers, lab equipment and tools; and some fast-track capacity -building for water providers.

B. Project design

With a growing awareness of the benefits of a regional approach among East African Community countries, the capacity development initiative emphasizes regional networking as a model to protect and manage Lake Victoria as a shared resource. Capacity development is considered an essential tool to increase the local "ownership" of environmental (drinking water, sanitation, solid waste) services. The capacity development interventions were started after the infrastructure investment projects had been largely completed and aimed to develop and empower local stakeholders in order to secure their active interest and participation in the sustainable and equitable delivery of the services.

1. The ownership concept

Increased local ownership of environmental services does not relate to the legal ownership of the provider or the assets, but rather to the insight among local stakeholders that sustainable services provision can only be realized if and when they assume responsibility for the services, in their roles of local facilitator/regulator, asset owner/operator, interest group or customer. In the LVWATSANI and in many other donor-inspired interventions for improved services provision, the well-intended local "ownership" is quite an issue as the new or improved assets are often considered to be initiated externally and, by implication, externally "owned". This perceived foreign ownership implies that the local stakeholders are of the opinion that the care for the upkeep and operation of the assets should be undertaken by the same foreign "owner". In an extreme case, the user of a rainwater harvesting tank with a broken tap in one of the project towns was waiting for a new tap to arrive from UN-HABITAT, meaning that the user was not assuming full responsibility for the upkeep of the asset. In another case, proposed investments in water abstraction capacity had been accepted by the "recipient", a local service operator, but without the strong conviction that these investments were in fact the most needed ones considering the very poor state and low population coverage of the water distribution system. Here also, the perception of the concerned board members was that of foreign "ownership" of the project.

The notion of local ownership includes aspects of regulation, sustainable operation, and the use and benefits associated with the operation of the assets. It therefore involves local government and relevant supra-municipal agencies and bodies, the operator of the assets and the population in its many manifestations: as institutional, commercial or residential users of the services and as interest groups (e.g., as employees, youth, women, community-based organizations (CBOs), private entrepreneurs, NGOs). These parties each have to contribute and take respon-

sibility for decision making in the areas of services development and sustainable and beneficial operation and use of the assets. Among other challenges, it is the perception of local ownership and its implications in terms of the required capacities to assume responsibility by the various target groups in the community that need to be addressed by capacity development.

2. Social inclusiveness

This approach is based on the understanding that women and men have different interests, needs and tasks in their use of water and sanitation facilities. This means that they have different knowledge, insights and requirements for skills. In poor urban areas, traditionally women and girls are more affected by inadequate access to water as they have the core responsibility of collecting water and taking care of the household's sanitation such as the disposal of solid waste and human wastes. The equal participation of women and men is critical to the efficiency, success and sustainability of water and sanitation services. Special attention is not only necessary for poor women, but also for other vulnerable groups that abound in the project towns such as those affected by HIV/AIDS, households headed by orphans or grandparents, physically disabled persons, albinos, orphans and the institutions that cater for these groups. This insight would need to be mainstreamed throughout the capacity development interventions by using an approach that promotes gender equity and provides for vulnerable groups.

3. Integrated approaches and solutions

The project takes place at a point in time when the three East African countries are implementing significant water sector reforms directed at improving water governance and water services delivery. Invariably, these reforms embrace decentralization and devolution and have thus created huge capacity demands at the level of the local stakeholders, in areas such as governance, resource mobilization, management, negotiation, gender mainstreaming, equitable access, social inclusion and local economic development. The contribution to be made by the project has to be seen in the context of these reforms, and was designed to focus on specific themes: pro-poor governance, water, sanitation and solid waste management, local economic development, gender mainstreaming and the inclusion of vulnerable groups. These themes promote the active participation of the urban poor in the planning, implementation, monitoring and management of proposed interventions; support local government and others to create an enabling environment for development; improve the efficiency and effectiveness of water and sanitation service provision and solid waste management and ensure financial sustainability; create economic opportunities to develop market goods and services associated with improved access to and quality of water and sanitation services and solid waste management; facilitate equal participation of women and men and a gender equity approach; and ensure attention for vulnerable groups to include those with least access to services and with a lack of opportunities to empower themselves.

4. Partnership

The capacity development (CD) programme was developed by a group of international partners that each brought in a specific area of expertise. These partners comprised the UNESCO-IHE Institute for Water Education (water, sanitation and environmental management), the Federation of Canadian Municipalities (pro-poor governance), the Gender and Water Alliance (gender and vulnerable groups) and the SNV Netherlands Development Organisation (local economic development). The CD programme was delivered by NETWAS International, a regional capacity builder based in Nairobi. For the purpose of developing the project, a partnership agreement was signed between UN-HABITAT and each one of the four international partners by mid-2008. By the end of 2009, a contract for delivering the capacity-building activities was agreed between UN-HABITAT and NETWAS. The four international partners operated as a consortium from the beginning of 2008 when they jointly developed the project's approach and technical proposal. NETWAS joined the consortium at the end of 2009. The Partners Meeting was initiated as a platform for joint planning and decision making between the five partners.

5. Approach

The international partners implemented a systematic approach to the capacity-building assignment that consisted of eight steps.

Step 1: Initial inquiries were conducted in the 11 towns to find the specific issues in water, sanitation and environment, and to assess the various town actors and their capability to address these issues.

Step 2: On this basis a tentative programme of CD interventions (CDI) was developed and the ability of the NETWAS facilitators to deliver this programme was assessed.

Step 3: Whilst finalizing the CD programme and its materials, a programme for enhancing the capacity of the facilitators was set up.

Step 4: A training of trainers workshop was organized with a specific focus on issues of content, training methodology and desired outputs.

Step 5: During the implementation of the CDIs further inquiries were conducted in the towns to examine the quality of CDI delivery and the status of implementation of the action plans.

Step 6: Two coaching events were conducted and peer relationships between individual course developers and facilitators were established.

Step 7: The processes and activities that were documented by the international partners were summarized in a Knowledge Management Paper Series.

Step 8: The key actors from the towns were invited to a top-level consultation to learn about the results of the programme and to appreciate and intervene in support of the town-level action plans that had sprung from the programme.

C. Design of the CD interventions

1. Capacity gaps

The CD interventions were to be designed in response to specific on-the-ground issues in each town, in relation to their unique circumstances, specific problems and organizational competences. These issues were surfaced through a town-based inquiry during which a multidisciplinary team of experts conducted transect walks, visited facilities, made observations and conducted in-depth interviews with all stakeholders in the project town. The inquiry used the systemic action research (SAR) methodology that was developed to literally "map" the (mostly) local actors and their relationships, the issues in the concerned area of investigation, the points of fact and the observations. The town map (see figure 1) that was generated during the inquiry was shared and discussed with the Multi Stakeholder Forum (MSF) in the concerned town, in an effort to validate the findings. The MSF is a platform that was established in each town at the initiative of UN-HABITAT at the very start of LVWATSANI.

Figure 1: Systemic action research map of Mutukula, one of the project towns

From the map generated during the field inquiry, the team developed a town capacity-building plan that responded to each one of the town-specific findings. These plans contained anything from 20 to 80 capacity-building activities (see table 1 for a section of one sample town CD plan) and, moreover, differed from one town to the next.

Category	Issues to be addressed	Capacity development intervention	Capacity	Target groups for CD
Incomplete conceptualization of MSF regarding sustainability and legal status	• Sustainability of MSF in the absence of UN-HABITAT intervention • MSF as a legal entity	• Strengthen the capacity to dialogue and engage on the future of the MSF	• Capacity to conceptualize the MSF	• UN-HABITAT, MSF
Poor quality of water	• Poor quality of water (tap and open sources) • High prevalence of water-borne diseases leading to high level of deaths among the under fives • Pollution of stream from council slaughterhouse	• Strengthen the capacity of local actors to promote hygiene and ensure safe water availability	• Capacity for water quality monitoring and assessment • Capacity for household hygiene promotion and education	• Capacity for pollution prevention and control SIBO, BTC, LVSWSB
etc.				

2. CD programme

It soon became obvious that the CD programme needed to take into account the hundreds of very specific local capacity gaps and the related interventions at an aggregated level whilst empowering the participants and encouraging them to work out detailed actions to address the specific issues. Also, the CD programme needed to fit the field days actually available to NETWAS for the delivery of the CD programme. The 11 town capacity-building plans were analysed by the CD consortium and the findings were grouped into five major issue headings that covered all capacity gaps. The major issues were: focus on disadvantaged people; supra-town institutions and organizations; service coverage and quality; public engagement and access; and procurement and contracting (details shown in table 2).

Table 2: Major issues emanating from the town inquiries

Issues	Topics
Focus on disadvantaged people	• Pro-poor and gender-sensitive focus • Landlord–tenant relationships
(Supra) Town institutions and organizations	• Institutions, legal and regulatory frameworks • Coherence and relations at town level • Stakeholder interactions • Organizations and systems • Planning systems and municipal performance
Service coverage and quality	• Service coverage • Quality of services • Quality of infrastructure • Development of services • Operation and maintenance by WatSan providers • Drainage and waste management by local government • Town planning and land ownership
Public engagement and access	• Promises and expectations • Ownership of project and assets • Attitude, transparency and integrity • Impact on health and environment • Communication and sensitization • WaSH* awareness and practices
Procurement and contracting	• Investments and procurement processes • Time requirement for investments and operational arrangements • (Quality of) Contracts

Abbreviations: WaSH, water, sanitation and health

3. Target groups

On this basis, and together with the study of related project documents, the international partners designed a CD programme that consisted of 27 different CDIs aimed at about 3,000 people in the 11 towns. At a later stage the programme was further rationalized to comprise 21 CDIs and 2,200 people. The target audience was made up of six stakeholder groups and 29 specific target groups. The six stakeholder groups included the water utility, the local government, other government bodies, CBOs and vulnerable groups, the private sector and other groups. The 29 target groups represented the different entities, task groups and/or hierarchical levels within the six stakeholder groups. For example, in the case of the water utility, four specific target groups were distinguished: the board and managing director; senior managers; middle-level managers and professional staff; and technicians and operators (see table 3 for details).

The CD interventions were designed to have durations of between 1 and 3 days, with some being implemented once and others more often, depending on the anticipated demand and the size of the target group. The CD programme as designed included a total of 110 CD events. Some of these were to be carried out in each of the 11 towns, whilst others were to be conducted at national and su-

pranational levels. The set of 27 interventions included: 10 interventions on water, sanitation and solid waste management; 4 on pro-poor governance; 3 on gender and vulnerable groups; and 10 on local economic development. The target groups were defined for each intervention including the proposed number of participants from each target group.

Table 3: Stakeholders and target groups for the CD interventions

Stakeholder	Target group
Water utility	Board and managing director (1), senior managers (2), middle-level managers and professional staff (3), technicians and operators (4)
Local government	Councillors and town clerk (1), HoDs* – engineering and public/environmental health (2), other council HoDs (3), middle-level professionals – engineering and public/environmental health (4), middle-level professionals – other departments (5), technicians/operators (6)
Other government	District and other supra-municipal government (1), government agency (2), environmental committee (3), tender committee (4)
CBOs and vulnerable groups	CBOs (1), HIV/AIDS (2), physically challenged (3), albinos (4), youth (5), women (6)
Private sector	Small and medium enterprises (1), microfinance institutions (2), technicians/artisans (3), vendors (4)
Other	MSF (1), schools (2), NGOs (3), UN-HABITAT HQ staff (4), UN-HABITAT field staff (5)

Abbreviations: HoD, Head of Department

4. Ensuring effectiveness

During the design phase, three checks were carried out to guarantee the effectiveness of the programme. One check was to ensure a fair distribution of the anticipated trainees over different social and professional echelons to avoid the common problem of overtraining senior officials and community members whilst neglecting representation from lower social strata. The second check was to make sure that attention in the programme was fairly distributed over the five major issues and related topics. The third check was to see if the different stakeholders had good access to the CD programme. The latter check is demonstrated in table 4.

Table 4: Sample of the CD interventions and their target groups

Code	CD intervention	Water utility				Local government						Other government				CBOs + vulnerable groups						Private sector				Other				
		1	2	3	4	1	2	3	4	5	6	1	2	3	4	1	2	3	4	5	6	1	2	3	4	1	2	3	4	5
WS1	Governance and management of WatSan services	■	■			■	■	■				■	■	■																■
W4	Household water supply systems								■	■						■					■					■	■	■		
S1	Solid waste management and treatment		■	■			■		■				■	■	■							■								
E2	Protection of the urban environment			■			■						■																	
G3	Municipal land issues, planning systems and legislation	■	■			■	■	■	■	■		■	■			■				■	■	■			■	■				
GVG2	Community capacity-building for responsible action															■	■	■	■	■					■		■	■		
LED1	LED opportunities in SWM and WatSan					■	■		■							■	■	■	■	■	■	■	■	■	■	■				

Note: the numbers shown with each target group correspond with those shown in table 3
Abbreviations: LED, local economic development; SWM, solid waste management

5. Action planning

The CD interventions were designed to be issue-based, problem-oriented and output-focused. The interventions used the participatory learning and action approach and included presentations, skits, role plays, group discussions, field visits and transect walks to deliver the content. All interventions concluded with a personal action plan that required each participant or a group of participants to generate a set of activities that was within their authority and capabilities to implement and that would make a contribution to the improvement of water and environmental services. The action plans included short- and longer-term actions and emphasized "quick wins" that would demonstrate the ability of empowered stakeholders to achieve immediate results. A simple format was developed for the action plans (table 5).

Table 5: Format for the action plan

Town issue	Change if the issue is addressed	Strategic action	Implementation steps	Output	Time frame	Team leader	Team members
.....	.....	.....	.....	.....	.....	.....	.....

6. Validation

Just before the start of the delivery of the CD programme, a validation mission was fielded to visit all 11 towns. The objectives of the validation were to provide information to the stakeholders in each town on the impending delivery of CDIs, to ensure that the proposed schedule of CDIs did not conflict with national or local calendars, and to obtain support for the participatory learning and action approach, which was to be used in the delivery of the CDIs. By the end of each town's validation process, the local stakeholders had established a CD Coordinating Committee that was set up to select the participants, coordinate the delivery of the CDIs and also as a means for follow-up in ensuring that the training would benefit the town and not just the individual trainees.

D. Implementation and completion

1. Implementation of the CD interventions

During the implementation, the programme of 27 different interventions was reduced to 21 (shown in table 6). In fact 10 very short local economic development (LED) interventions were reduced to four longer events for the practical purpose of saving both participants' and facilitators' travel time and expenses. Consequently, the 110 training events were reduced to 98. These events were delivered by a group of 11 facilitators. The participant evaluations showed that expectations had been met and that learning objectives had been achieved. No less than 85 per cent of the participants said that they would bring about changes in their places of work with the help of the action plans and with the new skills acquired during the training.

Table 6: The CD interventions

Developer	Theme	Code	CD intervention
UNESCO-IHE	Drinking water, sanitation and solid waste management	WS1	Governance and management of WatSan services
		WS2	Financial and commercial management of WatSan services
		W1	Management of water losses in the distribution system
		W2	Operation and maintenance of water treatment plants
		W3	Water quality management and water treatment
		W4	Household water supply systems
		S1	Solid waste management and treatment
		S2	Design and operation of decentralized sanitation systems
		E1	Environment, public health and hygiene
		E2	Protection of the urban environment
FCM	Pro-poor governance	G1	Revenue mobilization for services delivery
		G2	Partnerships for improved services and better governance
		G3	Municipal land issues, planning systems and legislation
		G4	Conflict management, resolution and team building in LG
GWA	Gender and vulnerable groups	GVG1	Inclusive participatory water and sanitation management
		GVG2	Community capacity-building for responsible action
		GVG3	Equitable demand management for WASH
SNV	Local economic development	LED1	LED opportunities in SWM and WatSan
		LED2	Procurement processes and contract management
		LED3	WatSan business appraisal
		LED4	Creation of enabling environment for business development

Abbreviations: LG, local government; SWM, solid waste management; WaSH, water, sanitation and health; WatSan, water supply and sanitation

2. Training and coaching

Despite their prior experience, the knowledge and skills of the facilitators needed to be enhanced for the delivery of the CD programme. This was concluded after a training needs assessment (TNA), which included a self-assessment on content and training methodology by each facilitator relative to each person's assignment and an assessment by the international partners based on the CV, an interview and a presentation by each facilitator. After this event, NETWAS reviewed and made some adjustments to the team of facilitators. The TNA was followed up by a training of trainers (ToT) workshop, two coaching events and the establishment of peer relationships between the individual facilitators and the experts that had developed the CD intervention concerned.

3. Further inquiries

Further inquiries were conducted in the 11 towns about halfway through the implementation of the CD programme. They primarily aimed at establishing whether the CD programme had been able to empower stakeholders, to achieve short-term components of the action plans and helped to address the real issues in the towns. The inquiries also served to inform on the quality of preparation and implementation of the CD interventions. On the impact of the CD programme, the inquiries established that many of the participants felt empowered and were working on the implementation of their action plans (for examples see box 1).

Box 1: Examples of action plan implementation

Water supply: Ongoing actions by one **water utility** include the establishment of an O&M Task Force, the metering of larger customers; reducing illegal connections; taking up of outstanding work items on the water treatment plant; formation of new teams, improving registration and faster reaction to leaks and bursts; improving management systems including financial management, performance assessment and record-keeping.

Sanitation: One **school** acquired a loan from a microcredit facility to install additional facilities for sanitation, hand washing, and for beautification of the school compound. A **restaurant owner** acquired a loan for the construction of a pour-flush sanitation facility with four units, two of which are for the clientele of the restaurant and the other two are available to the public. The unit is in operation, with an attendant/cleaner, and charges the public for use.

Solid waste: One town council was paying the equivalent of € 1,300 per month to a neighbouring municipal council to dump waste at its site plus another € 1,000 per month on hauling charges. During the training the participants from this town were challenged to buy their own piece of land for use as a dumping site. Since then the council actually bought a 1-acre site in town, is using this as a dumping site and realizes considerable savings.

Gender and vulnerable groups: One **municipal council's** department of social services has identified and mapped the vulnerable groups. Other initiatives include the increased participation and involvement of **women and youth** in solid waste management, the provision of free water to vulnerable customers and the submission by women of tenders for municipal contracts.

Many of the smaller, short-term action plans had been successfully implemented with noticeable impact on communities, organizations and services. However, there were issues regarding the consolidation and implementation of the larger, longer-term action plans in many of the towns. Among others, these plans were facing challenges in resource availability and integration into regular planning and budgeting cycles of local government institutions. These challenges were brought forward by the implementers and shared with the MSF and senior municipal politicians and administrators at the formal closing session of the further inquiry in each town, for their information and follow-up. On the preparations for the implementation of the CD programme some deficiencies surfaced around the communication and promotion of the CD activities in the towns, the selection of participants and the receipt of invitations. The feedback on the delivery showed that the CD interventions had been highly appreciated including their conduct, materials, methodologies, trainers and venues. Whilst hotels and meals were generally good, there were some problems with daily allowances and transportation arrangements.

4. Top-level consultations

The top-level consultations (TLC) were conceived as a solution-finding platform designed to create opportunities to share experiences and lessons learned, to show successes with action plan implementation, to discuss related challenges and possible solutions and to identify partners to assist with the implementation of such solutions. One TLC was organized in each country towards the end of the delivery of the CD programme. The TLCs were implemented primarily as a local event with invited presence from key stakeholders including mayors, MPs, councillors, senior municipal administrators, managers of water utilities, district-level functionaries and locally active (I)NGOs. The participants of the trainings that had been most successful in drafting and implementing action plans – the champions – were invited to present their experiences, as were town representatives with an overview of the developmental challenges and the contributions that were being made by the various action plans to address these. The TLC was a two-day event consisting of one day of preparation with the champions and one day of actual consultation. The consultation had three distinct components, starting with a session that presented an overview of town-level initiatives and progress. This session enabled a good understanding of the multitude of post-training initiatives and their take-up in the various towns. During the second session, some of the most active participants presented and discussed their issues, action plans and the challenges they faced in their towns to achieve sustainable results. This provided an opportunity for exchange between the champions from the various towns and for learning by invited local officials. The TLCs ended with a session where the participants jointly formulated a declaration that called upon the various stakeholders to act on issues that proved a constraint in implementing the action plans. This last session produced a Kisii Declaration for Kenya (shown in box 2), a Bukoba Declaration for Tanzania and a Masaka Declaration for Uganda.

Box 2: The Kisi declaration

Municipality/Council level

Delegates committed that councils will:

1. Allocate suitable land for dump sites, crematoriums and incinerators
2. Embrace modern solid waste management (SWM) technology and adopt an entrepreneurial approach to SWM
3. Partner with relevant stakeholders to improve service delivery
4. Provide evidence that will guide the review and harmonization of laws governing essential service provision and development in the areas of water, roads, physical planning and registration of land title
5. Engage and educate communities to take care of their environment
6. Propagate capacity development as about enhancing resourcefulness and not philanthropy
7. Effectively utilize all resources and equipment available to them

Water utilities

Delegates agreed that access, quality and reliability of water services should improve. Consequently, they asserted that water utilities should:

1. Address issues of non-revenue water
2. Establish and properly administer special tariffs for the poor and vulnerable
3. Lobby for social (as opposed to commercial) charges for electricity to reduce cost build ups that will make safe water expensive for the poor

National level institutions

National level institutions have a role to play in:

1. Mainstreaming of vulnerability issues in national development
2. Supporting water and other utility companies in revamping decaying infrastructure, which for water contributes to the high volumes of water unaccounted for
3. Harmonizing levies and tariffs on services to reduce cost build up. Examples include NEMA charges for waste collection and for water the burden of levies effectively falls on the consumer
4. Building the capacity of subnational public institutions e.g. NEMA.

Abbreviations: NEMA, National Environmental Management Authority

E. Discussion

Under LVWATSANI, capacity development was considered an essential project component to ensure sustainable delivery of water and environmental services from the preceding infrastructure investments. The CD interventions were approached from a holistic perspective and engaged with all local actors and their interrelations, with organizational and individual capacity gaps, with all WaSH components including water, sanitation, solid waste and hygiene, with the short- and long-term perspectives, and with all issues that were encountered on the ground during the

inception. The CD process was characterized by being responsive to the needs of all local stakeholders, by the integration of relevant technical, economic, behavioural and management disciplines, by being issue-based and output-focused, and by aiming both at the creation of effective and learning-oriented individuals and organizations and at improved levels of cooperation between stakeholders. Despite the complexities and challenges involved in implementing the CD programme, the strong and complementary partnership among the international partners, NETWAS and UN-HABITAT serves as an important leading practice for implementing similar CD programmes.

The capacity development programme comprised 21 different interventions that were implemented through 98 CD events with an average duration of about two days each. They reached out to approximately 2,200 participants from the higher, intermediate and lower organizational levels and social strata and from all stakeholder groups. The CD events resulted in hundreds of action plans, the implementation of which had started even as the CD interventions were still ongoing. A considerable number of the individual and small-scale action plans had even been successfully completed. As could be expected, the larger and more complex plans were encountering problems requiring more time for consultation, resource allocation and alignment with local developmental programmes and processes.

1. Success factors

The good results of the CD project can be attributed to a number of factors, as follows (UNESCO-IHE, 2011):

- About 2,200 persons from the 11 towns participated in the programme, took ownership of the WaSH problems in their town and took up the formulation and implementation of individual and joint action plans.
- There was a high level of appreciation of the courses by those who had been trained. Training was conducted professionally and by knowledgeable trainers, materials were good and offered much desired opportunities for further learning. Also, the participatory methodologies were highly appreciated and venues were appropriate for learning.
- Participants were and are interacting with and learning from each other (across stakeholder groups, across hierarchical and social strata and across towns and nations) during the delivery of the CD programme, the subsequent exchange visits and the top-level consultation sessions.
- Leading practices were adapted and applied and inter-town and inter-country exchanges were established as a basis for continued learning and practice.
- The programme of town-wide CD interventions was developed by the international partners and NETWAS based on a shared understanding of WaSH, enabling prerequisites and a jointly agreed CD approach and methodology.
- The process and methodologies used by the international partners proved quite effective. These included the SAR methodology used for the inquiry, the regular

partner meetings, the training needs assessment, the training of trainers (TOT) and coaching sessions, the participatory learning and action orientation of the CD interventions and, last but not least, the devotion of the participants to the implementation of their action plans.

- Knowledge activities focused on bringing out evidence-based knowledge from experience in the field with LVWATSANI actors, documenting experiences through the systematic action research methodology in the inception phase, identifying cases of best and worst practice encountered during the inquiries and capturing the whole capacity-building programme in the LVWATSAN Initiative (e.g. Blokland, 2011).

Finally, the top-level consultations indicated the large number of initiatives and innovative solutions that had been successfully embarked upon by local stakeholders whilst the declarations drawn up during the same meetings also highlighted constraints that needed to be overcome to achieve the somewhat more complex initiatives. The TLCs also demonstrated the importance and effectiveness of the cooperation of the various non-state actors and state actors. This confirmed the CD consortium's perception that a much-needed paradigm shift was under way whereby partnership, equity and sustainability were hence considered to be indispensable ingredients for the provision of effective environmental services.

2. Lessons learned

The systematic approach that was implemented by the international partners proved effective. The initial inquiries brought out the issues faced by the multiple stakeholders in the towns and provided a good basis for designing the capacity development interventions. The partnership with the local capacity builder that included the training, monitoring and coaching of the facilitators ensured the delivery of participatory and action-oriented learning. Although the programme of CD interventions was somewhat curtailed by resource constraints, it did retain its resolve to address all issues, bring together all stakeholders and enhance their capacities for preparing and implementing action plans directed at sustainable and equitable delivery of water, sanitation and environmental services. The conclusion of the project through the top-level consultations provided an opportunity to showcase successful action plans and to call upon key stakeholders to enable and commit to the more complex plans.

A key to success was the partnership of UN-HABITAT, the four international partners and the local capacity builder. This partnership was built on shared objectives and a common approach to CD, on respect for the mandate, expertise and experience of each partner and on the principle of equality of the partners that was practised throughout the project. This partnership was able to build on, improve and expand the quality of the relationships with and between the 11 towns and all the stakeholder groups that had been initiated by UN-HABITAT in the investment phase of the project. Basing the project on the realities found on the ground and the practical and action-oriented nature of the CD interventions helped to cement good relations between the towns and the developing partners.

The partners also faced some challenges. One was that the cooperation between partner organizations that are rooted in different experiences and continents, and between their natural and social scientists requires a strong coordinator on issues of content and logistics, frequent partnership meetings and a particular attention to team dynamics. Another challenge was to deal with the mostly inevitable staff changes among the partners and in some cases with staff deficiencies. This was overcome by regular reviews of each individual's performance by the partners, good documentation of the project and access to these records, the transfer of experience from one staff member to the next one by the concerned partner, and by flexibility in allocating the coordination role between partner organizations.

F. Conclusions

A number of conclusions can be drawn from this experience relative to water sector capacity development and the Green Economy. Even though this CD project was designed to address local issues that constrain the delivery of sustainable water, sanitation and solid waste services rather than promote measures in support of the Green Economy, many of its elements aim to achieve similar objectives.

The more efficient use of water and the improvement of water quality for a better environment were at the heart of the LVWATSANI and, by consequence, most of the 21 CD interventions addressed these issues, whether from an institutional, regulatory, social, financial, commercial or operational perspective. The issues of sustainability and social inclusiveness were decided to be cross-cutting subjects for the entire CD programme and were an integral component of all CD interventions. In addition, three interventions were specifically directed at social inclusiveness. Six interventions were specifically concerned with the environmental impacts related to drinking water, sanitation and solid waste management by service providers and users. Without exception, the CD interventions promoted interdisciplinary thinking and problem-solving and interlinked management approaches. They achieved this by delivering and discussing interdisciplinary content, by bringing people from different towns, organizations, disciplines and hierarchical levels together, and by sharing experiences across participants and across organizations, towns and countries. But most of all, this was achieved by the participants themselves when they sat down together to draw up town-based action plans and then jointly stood in for their implementation.

The innovative approaches by this CD project can be summed up as follows:

- First, the broad, interdisciplinary and on-the-ground identification of issues that was undertaken together with the stakeholders;
- Second, the inclusion of multiple aspects and multiple stakeholders in the analysis of the issues and the design of the CD programme;
- Third, the delivery of a CD programme that addressed the key issues and brought together and empowered all local stakeholders;
- Fourth, the resolve by the stakeholders to prepare and implement (joint) action plans; and

Fifth, the active follow-up of action plan implementation and the active pursuit of constraints that were faced when implementing these plans.

The partnership arrangement of UN-HABITAT, the four international partners and the local capacity builder was another innovative aspect of this project. It aligned a broad international expertise base in the thematic areas and in capacity development with a wealth of local knowledge and experience that was accumulated in the same and earlier projects. Whilst formalized through contracts and partnership agreements, the mode of operation of the partnership was based on equality of the partners, on shared objectives and approaches for project implementation, on respect and trust, on consensus-building for decision making, on the use of interdisciplinary approaches and methods, and on the wide variety of expertise and experience that the partners brought to the project.

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Chapter 3:

Capacity development for a changing world

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Abstract

There is considerable need for capacity-building in the water sector. Water is a key resource for sustainable development and poverty reduction. Challenges faced by more and more countries in their struggle for economic and social development are increasingly related to water. The water sector shows an emerging global crisis presenting shortages, quality deterioration, flood impacts, increased competition for use and governance problems. The paper explores lessons learned from 10 years of experience of capacity-building networks for sustainable water resources management operating within the Cap-Net UNDP framework. Networks constitute innovative and cost-efficient collective strategies to facilitate the achievement of the Millennium Development Goals (MDGs) and to reinforce sustainable development. Through their structure, networks are in accordance with the principle of common but differentiated responsibilities and support local ownership and development by anchoring knowledge and responding demands. Being open and inclusive, networks drive participatory decision-making. Networks membership rests on centres of excellence, which provide the base knowledge and specific views to build interdisciplinary thinking and problem-solving. Through the use of innovative information and communication technology (ICT) tools and web-based knowledge platforms, networks work towards universal access to ICT to facilitate access and knowledge transfer to multiple target groups. Through their decision-making and operational frameworks, networks enable capacity development in line with the basic principles of the Green Economy: resources efficiency; social inclusivity; and low carbon emission. The Cap-Net network has demonstrated that assembling skills and knowledge from different disciplines (multi- and trans-) is possible, thereby building a critical mass of competence for action; all this leading to rapid development, adaptation and transfer of knowledge. The strategies and tools adopted by networks forming the Cap-Net global network are available for sharing and replication.

Keywords:
Capacity development
Knowledge management
Networks
Information and communication technologies (ICT)
Water
Green Economy

A. Introduction

The world is facing development challenges (population growth, rapid urbanization, poverty and climate change) which demand action in terms of the high level of inequities which persist, such as inadequate access to water and sanitation, or low incomes which affect the health and quality of life of billions. The demand for development is transversally cut by the recognition of the need for changing our paradigms. The demand is no longer about doing more of what we do, but achieving more in a completely different way.

Despite substantial progress in many areas, human development has been inequitable: around a seventh of the world's population – the so-called "bottom billion" – does not have a secure food supply and has only limited access to clean water, sanitation or modern sources of energy. At the same time humans are overexploiting natural resources in many regions. Human beings have severely modified or completely replaced many terrestrial and aquatic ecosystems, and many ecosystem services are degraded (Hoff, 2011).

Water resources management now needs to recognize multiple and competitive water users, which include environmental sustainability and equilibrium, in order to no longer contribute to climate change. In the framework of integrated water resources management (IWRM), the change has been from water development to water governance, recognizing the unique nature of water as a natural resource; from increasing supply to managing demand and satisfying the water supply, food and energy securities.

Our economies are also shifting attention to the micro-level. Companies are measured in terms of their social responsibility, and consumers are beginning to understand they too have a role and may become responsible consumers. Revisiting frameworks such as IWRM to resonate with the new complexities is essential. Stronger institutions that are better interlinked are required to handle the increased level of complexity. New knowledge, datasets, analytical tools and consistent data need to be developed and above all capacity development and social learning are critical.

Both economic growth and increased access to water and sanitation are very much needed. But a call for change indudes "green", "clean" and "compact" technologies and practices which do not harm the environment. Cross-sectoral management can boost overall resource use efficiency. In multi-use systems in particular waste and by-products can be turned into a resource for other products and services, e.g., in green agriculture, wastewater-energy integration or multi-use reservoirs. Capacity development comes as a renewed strategy, backing the change process.

A new way of managing water resources as well as a new economy will be the result of a process of learning, transferring, acquiring and using new abilities to replace the old way of doing things. Capacity development means that knowledge has been created, shared and anchored, and is available and in effective use by a variety of stakeholder groups (OECD, 2006).

Capacity development in support of paradigm shifts captured in processes such as IWRM also needs to become acquainted with a new perspective. Working through open networks drives interdisciplinary thinking in an accessible and participatory scheme, and helps to leverage and share scarce resources such as staff time, knowledge products and funds. Combined with the use of new technologies, the result is efficient in terms of time and fund allocation, reduces environmental impact and has the capacity to reach and anchor capacities at the local level, making capacity development a responsible action on its own.

B. Open networks and a new perspective for capacity development

Capacity-building networks such as Cap-Net UNDP, the International Network for Capacity Building for Integrated Water Resources Management, and regionally e.g. LA-WETnet, Latin America Water Education and Training Network, have emerged globally in recent years as strategic responses to the demands for increased skills and capacities in the water sector leading towards the implementation of integrated water resources management (IWRM). These types of network constitute inclusive alliances – at country, regional or global levels – formed by institutions such as universities, resources centres, associations, NGOs, government departments, water management agencies and United Nations bodies, all deeply involved and committed with capacity development in the water sector.

Networks are usually presented under three categories (German Agency for Technical Cooperation, 2006). First, social networks are the basis on which formal networks are built; there are maps of personal, friends or business relationships. They generally do not have a defined purpose, nor are actively planned and managed. Second, communities of practices (CoP) are groups of people sharing a common interest. Members come together to share and develop their knowledge, solve common problems and support each other. Third, formal networks are interrelated groups of individuals and/or organizations that are established according to a specific design or need. Members share a common vision, objectives and rules, and they carry out a set of common activities. In contrast to CoPs, formal networks are not only based on the needs of members, they also have the goal of achieving changes in their own contexts.

Established capacity-building networks for sustainable water management, with or without legal status, are formal networks (Cap-Net, 2011a).

The relevance and potential of capacity-building networks is found in the experience, level of activities, outreach and knowledge of its members. Because of this, one of the principles for networks is that they remain open and inclusive. The element of success in such alliances is the ability to combine all of these values and resources and invigorate the capacity of each member and the network as a whole.

Another principle for networks is that they should remain purpose-driven and demand-responsive. The ultimate purpose is to generate specific changes in a broader context. These changes will be seen in new practices, policies, laws and institutional arrangements, which are in line with sustainable water resources

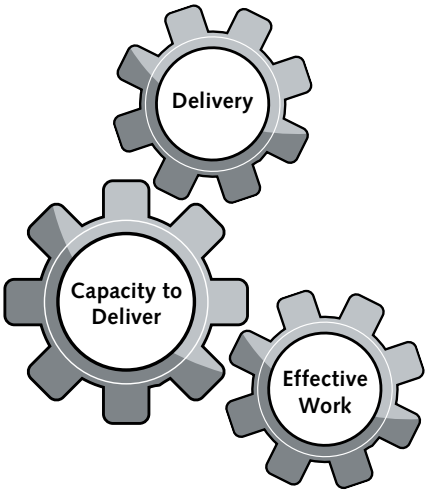
management, Green Economy development and contribute to improved access to water and sanitation.

As figure 1 shows, key elements for networks to be successful are their management arrangements combined with specific skills like partnership development, leadership, and work planning. An open and skilled membership – which is largely responsible for the network activities and the delivery in itself – is equally important, as networks will only be sustainable and positive for their members and other stakeholders when they prove to be generating impact.

1. Networks' added value for capacity-building in water

- Networks can create the multidisciplinary base necessary for the introduction and support of complex approaches, such as IWRM and Green Economy
- By combining scattered strengths of institutions into a critical mass, networks can maximize use of local skills and enhance local ownership and relevance of capacity-building
- By sharing knowledge and expertise through communication and collaboration, networks combine strengths, and each member becomes stronger. Networking develops in a learning environment
- Networks enhance the impact of the delivered products by coordinating and making use of other members' capacity, skills and experience (Cap-Net, 2011a).

Figure 1: Cap-Net building blocks for effective capacity development in IWRM and Green Economy



C. A knowledge management cycle for green societies

Knowledge management for capacity-building networks means facilitating knowledge at different levels and for different targets. Knowledge management in networks is about how a particular understanding is created, shared with capacity-building institutions and finally transferred to target groups which are part of the water sector. The knowledge content changes as new knowledge is being developed and demands are attended, but the cycle grows positively bringing relevance and sustainability for these alliances.

A closer understanding of capacity development explains the relevance and applicability of knowledge management, not as an ad hoc activity, but at the core of continuous capacity development through networks:

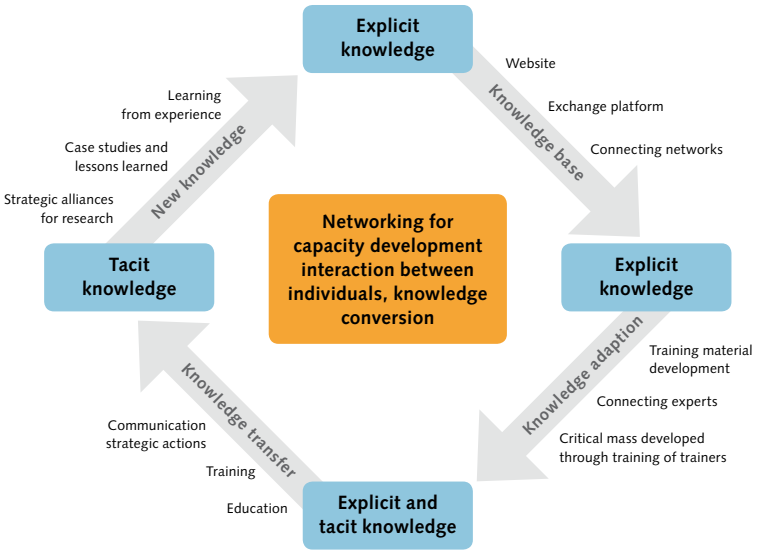
Capacity-building is the process of implementing institutional development. It provides tools and knowledge to initiate, guide and support institutional development. Most of the activities under institutional development concern knowledge transfer, skills development and facilitating the use of these capacities. Capacity has been defined as the ability of individuals and organizations or organizational units to perform functions effectively, efficiently and sustainably. This implies that capacity is not a passive state but part of a continuing process (Alaerts, Hartvelt and Patorni, 1996).

For knowledge to become an effective contribution for social change, knowledge has to be reflected in action shown in concrete and measurable changes in the way water resources are managed, in water governance, and by water uses and users.

The knowledge that is required embraces both tacit and explicit knowledge. Explicit knowledge is knowledge that can be expressed in words and numbers. Personal, or tacit knowledge, is very important for human cognition, because people acquire knowledge by the active re(creation) and organization of their own experience. This interaction is called conversion. Nonaka and Takeuchi went further and noted that this conversion does not take place within individuals but between individuals (Nonaka and Takeuchi, 1995, cited in Beijerse, 1999).

A network framework enables this process to take place through a cycle which has been identified as the knowledge management cycle in networks (figure 2). The cycle results in knowledge creation, as a capability for action implementation of IWRM. It is a social cycle, where partnerships and networking allow knowledge flow and conversion.

Figure 2: Knowledge management cycle for capacity-building networks (Cap-Net, 2011b)



The knowledge management cycle is a mechanism for linking people and enabling the interaction of explicit knowledge (information) with tacit knowledge (experience, skills and attitude) (Indij, 2005). The result is interdisciplinary knowledge, generated for strengthening capacity-building institutions and for empowering target groups for IWRM and Green Economy implementation.

The knowledge cycle is an open social cycle, where (action) knowledge to support IWRM implementation is being created within a framework of interactions. The cycle is virtuous, as it allows the creation of new knowledge as a result of practice (IWRM implementing experiences) and research. That new information – in the form of new explicit knowledge – is then available to flow in the cycle again.

D. Tools for knowledge management

This section describes different approved tools for accessing the knowledge base, for knowledge adaptation and sharing, for knowledge transfer and for knowledge generation (Cap-Net, 2011b).

1. Tools to access the knowledge base

- **Strong network membership.** The real strength of the network is in the skills and capacity of the members. Open and inclusive membership results in the availability of multidisciplinary thinking. Mapping the distribution of competencies and knowledge in the network can be a useful tool.

- **Broader coalitions, alliances and partnerships.** Participating in international events is always relevant to accessing knowledge and being at the cutting edge of current thinking. However, networks enable the outcomes of participation without the need to be physically there, at least not all the time. As long as one member of the network or secretariat attends, then knowledge is available to be shared with all. This saves time and resources which are then available to support on-the-ground processes, and diminishes carbon emissions by reducing travel.
- **Hub sites** such as www.cap-net.org and www.ais.unwater.org/ais/ stand as entry points to a number of organizations and databases where documentation can be found. Under the principles of sharing and openness, knowledge becomes socially inclusive and funds are better allocated as there is no replication in building such databases.

2. Tools for knowledge adaptation and sharing

In order to support delivery of capacity-building, which is appropriate for the region or country, relevant to the target group and of good quality, the knowledge base needs to be adapted.

- **Form multidisciplinary task forces.** These could include a balance between local, regional and international specialists. Prepare a work plan with them and have a clear vision of the end-result aimed for: the type of knowledge needed to respond to the specific demand (theme, target group, current issues at the local level). Begin by establishing the knowledge base.
- **Training of trainers.** This is an efficient activity for adapting and sharing knowledge at the level of the capacity-builders. Specific knowledge (usually training manuals and tools with a global focus) is adapted for its applicability at regional or country levels to be transferred to the various target groups on the ground.
- **Have efficient communication systems.** Communications need to be fluid and easy. A website offering platforms to post documents and serve as virtual "meeting rooms" is highly operational and not expensive. Such tools limit the need for face-to-face meetings, and therefore are in line with Green Economy principles and better allocation of (scarce) development funds.

3. Tools for knowledge transfer

Networks will see their knowledge transfer as effective when they are addressing the following areas:

- **Training and education: i) Regular and/or tailor-made capacity-building delivery.** Networks should have a set of courses available to be delivered as well as the capacity to offer tailor-made training responding to specific demands. **ii) Curriculum development.** This is an efficient means to anchor knowledge and strengthen capacity-building institutions. For this networks need to be working with universities and schools.

- **Information dissemination.** Sessions or conferences at meetings or forums are a means to transfer knowledge. These encounters need to be tailored to each occasion, considering the audience and type of event. Who will be there? What message should be put across?
- **Advisory support.** Networks also need to understand such services as a means to transfer knowledge.

4. Tools for knowledge generation

As the process advances, new knowledge will be generated, in the form of best practices, lessons and compiled experiences. The research activity by capacity-building institutions also has a direct relation to this process, as it aims to find answers for implementation problems or questions. Knowledge may be generated and assimilated through the following routes:

Research on various aspects of water management contributes significantly to our understanding of how to implement IWRM and contribute to Green Economy principles.

Case studies, best practices, lessons learned and process systematization serve to document and convert experience into knowledge which can be shared. By documenting these experiences, the implicit knowledge is captured and made explicit to be secured and shared.

Monitoring, evaluation and learning plans, a vital form of knowledge generation for increased impact and efficiency in capacity development. Recognizing that there are many factors that affect performance of individuals and institutions, it is particularly challenging to monitor and evaluate the results of capacity development initiatives.

E. Innovative capacity-building tools

New and innovative learning tools such as virtual courses, online tutorials and knowledge sharing websites contribute all to knowledge transfer and to a more efficient and responsible allocation of scarce development funds.

Today's technologies allow a combination of face-to-face and virtual knowledge sharing which saves travel (cars, flights and hotels) and results in a low-carbon approach to capacity development.

The possibility for participation is open to anyone with a computer or smartphone and average speed Web connection. The rate of growth in connections worldwide and decreasing computer prices is so rapid that what was a limitation only a few years ago, with Web connections by phone and limited Web access, is part of the past. The level of accessibility makes these tools socially inclusive, generating learning opportunities that were not possible before.

However, not all stakeholder groups have access to these technologies and tools. But these tools are not meant to replace traditional face-to-face courses and other capacity-building meetings. Virtual and face-to-face training do not need to compete, and one does not need to replace the other. They complement each other in transferring knowledge to a variety of target groups with different needs and possibilities. Together, virtual and face-to-face training constitute a complete demand-responsive approach and support for capacity development.

Virtual training is cost- and time-effective, as participants may follow contents at different moments and from different places, with some exceptions where conferences take place and participation at a given moment is required for all.

1. Virtual courses

Virtual training facilitates access to updated knowledge contents; an interactive learning process; a group setting which motivates exchange between participants and between participants and trainers; and the permanent guidance given by qualified trainers, tutors and technical support.

Today's platforms for virtual learning comprise a variety of tools, which include video, facilities for group conferences where speech and documents can be shared and worked on together, online forums, library, calendar, comments and others, all in a user-friendly design.

Even though many training materials are available, this does not mean they are ready to be used directly in virtual courses. The way messages are given, contents and examples presented, questions raised, and participants are guided along virtual courses needs careful editing by specialists in virtual education and communication.

Virtual courses usually integrate (not necessarily all of the following):
- A clear guide showing course methodology and platform functioning, including FAQs
- Contents organized in modules (usually two weeks per module
- Videos where trainers address participants
- Other types of video and presentation
- At least one forum per module where all participants are expected to participate at least once
- The development of (at least) one piece of personal work or project from all participants
- The development of (at least) one piece of group work
- One or two conferences where all participants are present. If the group is too large, then various conferences will be organized so that groups of 10 participants are present at each time
- Portfolios: participants presenting a record of their activities throughout the course and in each of the modules
- Closing questions for each module, or other type of feedback
- A section for participants to "meet"
- A library of suggested documents and links

- Room for questions (content and technical service
- Participants completing a course evaluation, giving feedback on the course quality and level of learning.

2. Online tutorials

These present an innovative tool for sharing knowledge which is always available online (figure 3). Different from virtual courses, tutorials are permanently online and users do not need to register or wait for a specific date when the course begins.

A tutorial is designed for self use, and users follow and advance through the contents in their own time and according to their interest. Going through a complete tutorial will normally take a couple of hours.

Tutorials are an excellent way to present subjects and leave directions to follow or deepen knowledge for those interested. Users will normally find a tutorial organized in chapters or sections and contents are completed with diagrams, pictures, messages, facts and "read more" boxes for specific contents. A list of relevant web links and recommended readings completes a typical online tutorial.

Tutorials may also be shared as CD-ROMs or USB pen drives, although with the increasing level of connectivity it is more common to use them directly online. They can be presented in a variety of languages, and since they are online they are fully open for anyone who wants to participate.

Interactive sections may be incorporated. This way feedback from users will be available showing which types of user are benefiting from the tool and also providing suggestions for improvements or for working together in a more profound capacity-building process. Other tools such as online self-evaluations are also common, so that users can measure their understanding of the contents seen.

In addition, the server where the tutorials are hosted also provides valuable information on the number of times the tutorial has been consulted, which pages are visited the most and the country of origin of the users.

Figure 3: Cap-Net's online IWRM tutorial

3. Knowledge sharing websites: www.cap-net.org

Websites designed for knowledge sharing facilitate open access to information on resource centres, courses, tools, references and training materials.

Table 1: Level of access to Cap-Net's developed training materials for IWRM, for the period January-November 2011

	English	Spanish	French	Portuguese	Other	Total
IWRM as a tool for climate change adaptation	832	172	108	129	Chinese 4	1,245
Conflict resolution and negotiation skills for IWRM	1,608	267	49			1,924
Economics in sustainable water management	687	96	55	13		851
IWRM for RBOs	858	661	62	82	Indonesian 831	2,494
IWRM plans	827	209	242	208	Russian 112	1,598
Why gender matters	227	17				244
Hydro-climatic disasters in water resources management	98					98
Water integrity	586					586
Streams of law	465					465
Groundwater in IWRM	1,419					1,419
Water resources Assessment in sub-Saharan Africa	14					14
Total	7,621	1,422	516	432	112	10,938

The figures in table 1 show the level of outreach of the site and how these types of website help to make knowledge accessible on a free basis. With over 10,000 downloads, the resulting number of people benefiting from this manual is significantly higher.

Training materials in English have been downloaded 7,621 times, while for other languages the number of downloads is 3,317. However, if we take into consideration that 5 out of 11 training materials come only in English, we may estimate that the number of downloads for non-English materials may grow if more translations are made available.

Findings from Cap-Net's Monitoring, Evaluation, and Learning Plan (MELP) report (Cap-Net, 2011c) show that the most visited page of the website is the "network members database", showing the significance of openly posting this information for inclusive approaches to capacity development and interdisciplinary thinking.

These types of website, and their valuable information sharing is key for openness, knowledge sharing and demand responsiveness for capacity development aiming for local impact.

F. Capacity-building networks and the Green Economy

Networks constitute innovative and cost-efficient collective strategies to facilitate the achievement of the Millennium Development Goals (MDGs) and to reinforce sustainable development. Through their structure, networks are in accordance with the principle of common but differentiated responsibilities and support local ownership and development by anchoring knowledge and responding to demands.

Being open and inclusive, networks drive participatory decision-making (German Agency for Technical Cooperation, 2006). Networks membership rests on centres of excellence, which provide the base knowledge and specific views to build interdisciplinary thinking and problem-solving. Through the use of innovative ICT tools and web-based knowledge platforms, networks work towards universal access to information and communication technologies to facilitate access and knowledge transfer to multiple target groups.

Through their decision-making and operational frameworks, networks enable capacity development in line with the basic principles of the Green Economy: resources efficiency, social inclusivityand low carbon.

1. Resources efficiency

Experience from capacity-building networks associated with Cap-Net UNDP demonstrates how networks are sustainable and cost effective by generating a significant multiplier effect and co-funding. Networks are an efficient and effective investment in capacity development.

Strategies such as training of trainers (ToTs) put forward a process of replication at the local level which attracts multiple funding and in-kind contributions in a cascade effect for an increased outreach and demand response.

Capacity-building networks are made up of existing institutions responsible for capacity-building. These institutions are sustainable in their own right. When knowledge availability is increased, shared and adapted for local relevance, and transferred into local target groups, sustainability is secured through strengthening locally owned capacities which anchored and available.

Networks are vehicles to enhance cooperation and mutual benefit, and would not exist unless benefit came to members. This is why members bring in funds and are willing to share costs, making the network strategy cost-effective and efficient.

Cost also follows local schemes and as delivery is done through strengthened local institutions, the need for external consultants is diminished, and only applied as part of a knowledge management strategy to cover specific gaps.

2. Social inclusivity

Networks are driven by the principle of working through open partnerships to overcome capacity constraints (Cap-Net, 2002). They are also designed to contribute to sustainable water management and thus recognize multiple water users and a variety of institutions which represent water governance and need to be attended.

Key principles such as equity, gender balance and environmental sustainability are cross-cutting issues included in management structures and knowledge content. Without this inclusive component networks would be unable to operate as limited participation will harm the most important asset and contributors networks have: their membership.

Networks such as the Latin America Water, Education and Training Network (LA-WETnet) have a management structure which functions as a small facilitating organization, supporting and strengthening regional capacity-building institutions in their delivery and linking the network with the global community. The LA-WETnet secretariat is a vehicle to operationalize the network objectives, building capacity at the bottom by means of a regional partnership and shared activities. Network activities are always carried out by network members. The secretariat only acts as a facilitating body in charge of putting forward an active collaborative process, in the form of a knowledge management cycle. Since its formation in 2002, LA-WETnet has delivered 48 training courses, in almost all countries in Latin America, covering more than 10 subjects related to sustainable water resources management, and directly involving more than 120 institutions.[1]

3. Low carbon

Capacity-building networks operating under the principles and strategies described result in low-carbon capacity development initiatives.

Their structures have limited numbers of staff and make the best out of their open membership. Travel is minimized as their geographic spread and connectivity gives networks a level of presence and sharing which does not depend on face-to-face meetings.

In terms of capacity-building strategies, networks enable multiple replications at the local level and the need for travel for 20 or more course participants is part of an old paradigm. Instead, funds are used more efficiently and less is spent on airline tickets and hotels, with a resulting low-carbon scheme.

In terms of capacity-building delivery there are two major settings:

- The training of trainers (ToT) model, where experts from various countries meet for an intensive training course and knowledge updating, and then go back to their countries where further courses are delivered. In this model travel is justified as a means for knowledge sharing to enable replication at the local level.

1 Some have participated in more than one activity.

- For regular courses, the preference is to select participants from various target groups at the local level, keeping attention to multiple water use sectors and gender balance. Additionally, a limited number of participants may be invited from other countries (or zones within the same country). These participants travelling from elsewhere attend the course on the same basis as a ToT, in the sense that they are capacity-builders themselves, who represent an institution with the commitment to put together a similar course at their own location. This strategy has given very good results in Latin America, where the number of courses delivered has been prioritized over spending more funds on fewer courses for which the majority of participants have to fly in, resulting in a high level of carbon emissions. The recommendation is to aim for participants from nearby countries; for example, if a course is held in Bolivia, other participants may be invited from Peru and Ecuador, which are also Andean countries.

4. Water management principles

Capacity-building networks which form the Cap-Net UNDP global network of networks are driven by agreed principles on how water resources should be managed. These include:

- The right to safe and clean drinking water and sanitation as a human right and the critical importance of water resources for sustainable development, including poverty and hunger eradication, public health, food security, hydropower, agriculture and rural development.

- The necessity of setting goals for wastewater management, including reducing water pollution from households, industrial and agricultural sources and promoting water efficiency, wastewater treatment and the use of wastewater as a resource, particularly in expanding urban areas.

- The commitment made in the Johannesburg Plan of Implementation (JPOI) regarding the development and implementation of integrated water resources management and water efficiency plans.

- The need to address the interrelationship between water, energy, food and climate change in order to achieve synergies as well as to minimize conflicts among policy objectives, being particularly sensitive to impacts on vulnerable populations.

G. Conclusions

Integrated water resources management (IWRM), i.e., the "management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems", offers a comprehensive framework to deal with water-related security challenges faced by humankind (UNEP, 2011). IWRM needs to continuously evolve towards partnerships with water-using sectors whose policies and strategies are governed by many factors outside the water sector. There is a need for a

coordinated and harmonized nexus knowledge base and database indicators and metrics that cover all relevant spatial and temporal scales and planning horizons.

The Green Economy concept, much like in the case of IWRM, presents further hurdles to dealing with the increasing level of complexity that comes with higher levels of integration. Implementation of such broader concepts is not straightforward and tensions arise when integrating across sectors, institutions, levels and scales (Hoff, 2011).

Capacity development and social learning – in which development partners can play a role – can help to deal with the increasing complexity of cross-sectoral approaches, and it can help to level the playing field among the sectors. Learning platforms such as the Cap-Net network for professional and social innovation and adaptive management can enable horizontal and vertical policy coherence in this instance. Knowledge generation, sharing, adaptation and transfer have to be put into motion to efficiently feed innovation and problem-solving for the ever-increasing challenges which humankind faces today.

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Chapter 4:

Transfer of environmentally sound technology methodology in Latin American industry: Honduras case study

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Abstract

Between 2008 and 2012, UNIDO introduced its Transfer of Environmentally Sound Technology methodology to a number of industries along a river basin in Honduras. The methodology consists in introducing five management tools at company level with the aim to change management practices in a holistic manner in order to ensure the sustainable introduction of green practices. Relying on local capacity-building and the occasional training by international experts, the project has managed, in three years, to bring about considerable changes to the three participating companies, all reporting a reduced contaminant concentration of their effluents as well as reduced costs, proving that green industrial processes are beneficial to both the environment and the financiers. The companies have introduced most of the cleaner production recommendations (i.e. low cost changes) and they are also investing in the environmentally sound technologies identified during the project to the tune of millions of US$. Finally, the participating companies are now replicating the successes of the methodology in the other branches of their industrial group.

Keywords:
Industrial water
Water efficiency
Capacity-building
Green industry
Zero discharge

A. Introduction

In 2008, the United Nations Industrial Development Organization (UNIDO), along with the Food and Agriculture Organization of the United Nations (FAO), the International Labour Organization (ILO), the Pan American Health Organization (PAHO), the United Nations Development Fund (UNDP) and the United Nations Children's Fund (UNICEF), began the implementation of a Joint Programme for Economic Governance of Water and Sanitation in Honduras to consolidate the pro-

cess of sector modernization in order to support the achievement of the Millennium Development Goals (MDGs) and the targets of the Poverty Reduction Strategy.

This Joint Programme is financed by the Millennium Development Goals Achievement Fund (MDG-f; www.mdgfund.org) set up by the Government of Spain in 2006. The MDG-f currently supports 128 joint programmes, with an average of six United Nations agencies, in 49 countries on eight thematic areas:

1. Environment and climate change
2. Gender equality and women's empowerment
3. Youth, employment and migration
4. Democratic economic governance
5. Children, food security and nutrition
6. Conflict prevention and peacebuilding
7. Culture and development
8. Development and the private sector

According to the Human Development Index, Honduras is the sixth poorest/least developed country in Latin America, after Haiti, Nicaragua, Guatemala, Guyana and Bolivia. Industrial pollution and poor water management are widespread within the country, causing environmental problems and reducing water quality and availability for domestic use, as well as uncompetitive Honduran enterprises.

To address these issues, UNIDO's intervention within the Joint Programme (JP), which falls within the fourth thematic area of the MDG-f above, consisted of implementing the transfer of environmentally sound technology (TEST) methodology for industries on the Rio Blanco, north-west Honduras. High industrial pollution levels on this river have caused environmental problems and losses to local industry.

B. The UNIDO TEST methodology

The Environmentally Sound Technology methodology was developed by UNIDO in 2000 and is aimed at improving environmental management and competitiveness of companies in developing countries and with transition economies (De Palma and Dobes, 2004).

1. The five management tools

The TEST methodology consists of five management tools at company level with the aim of changing management practices in a holistic manner in order to ensure the sustainable introduction of green practices. The management tools introduced concern the whole management pyramid (see figure 1) (De Palma and Dobes,

2004) and, therefore, the whole chain of command in a company is trained and capacitated in the various tools. This ensures true ownership of the changes introduced and the sustainability of their adoption. Moreover, the TEST relies on the application of the double learning cycle, involving continuous movement from "plan" to "do" to "check" and to "act". The concept ensures the proper recording of the changes introduced and the measurement of their effects. Applying the double learning cycle continuously leads to constant improvement of the production process.

Figure 1: Management pyramid of a company

The various tools affect different levels of the management pyramid and it is their coordinated implementation that ensures the success and sustainability of the changes introduced. These tools are technological and managerial (De Palma and Dobes, 2004):

(a) Cleaner production assessment (CPA)

The cleaner production assessment focuses on systematically identifying potential applications of preventive techniques for pollution sources (where pollution is seen as a symptom of process inefficiency). The adopted pollution prevention measures reduce not only pollution but also operational costs. The cleaner production measures identified are classified in two categories: on the one hand, the low-cost measures such as good housekeeping and limited production changes; and on the other hand, the measures which require additional investment. CPA affects mostly the product and production levels of the management pyramid.

(b) Environmental management accounting (EMA)

EMA is defined as the identification, collection, analysis and use of two types of information for internal decision-making: physical information on the use, flow and

destination of energy, water and materials (including wastes) of the company; and monetary information on costs, profits and savings regarding the environment. It focuses on the optimization of production and products by tracking all environmental costs back to their sources, especially costs of pollution that are "hidden" in production costs. The basics of EMA are that everything that the company acquires and that is not part of the final product should be reduced to a minimum. EMA looks into the production level of the management pyramid and is the most helpful tool to ensure buy-in from the manager of a company as it allows for the pinpointing and actual pricing of the inefficiencies in the production process (De Palma and Csutoras, 2003).

(c) Environmental management system (EMS)

ISO 14001 defines EMS, the part of the overall management system that includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving and maintaining the environmental policy. It focuses on identification and management of environmental aspects, and it is widely used as a tool to ensure compliance with environmental standards. However, to operate properly it must be integrated with the other systems of the company. The EMS affects a lower, and therefore more complex, level of the pyramid: the system level.

(d) Environmentally sound technology (EST)

According to Agenda 21, "ESTs encompass technologies that have the potential to significantly improve environmental performance relative to other technologies" (Agenda 21). These technologies protect the environment, are less polluting, use resources in a sustainable manner, recycle more of their wastes and products and handle all residual wastes in a more environmentally sound manner than the technologies they are designed to replace. This tool builds on the concept of best available techniques and can include end-of-pipe solutions after the potential for feasible preventive measures has been explored. The EST typically covers the cleaner production measures which require additional investment. EST affects the production process but needs the endorsement of the managers (hence the stakeholders) to secure the investment. While the TEST projects do not provide funds to support the introduction of the EST, detailed investment packages with a clear payback period based on the EMA analysis are developed with the companies.

(e) Corporate social responsibility (CSR)

CSR is a self-regulation mechanism integrated with a business model that companies use to comply with ethical standards and international regulations. It is based on close cooperation with stakeholders and integrates all sustainability considerations (social, environmental and economic) into business operations. CSR affects the lower portion of the management pyramid and its proper utilization ensures that the changes brought about during the project implementation are properly communicated to the stakeholders of the business.

In the TEST methodology, the sequential introduction and the integration of these five management tools:

1. Gives priority to the preventive approach of cleaner production (systematic preventive actions based on pollution prevention techniques within the production process) and considers the transfer of additional technologies for pollution control (end-of-pipe) only after the cleaner production solutions have been explored. This leads to a transfer of technologies aimed at optimizing environmental and financial elements: a win–win solution for both areas.

2. Links the managerial aspects of environmental management to the technological aspect by introducing tools such as EMS and EMA.

3. Puts environmental management within the broader strategy of environmental and social business responsibilities by leading companies towards the adoption of sustainable enterprise strategies.

2. TEST implementation roadmap

As described in figure 2, the TEST is implemented in three stages.

First, the project needs to select the participating companies. For this, a presentation of the methodology and its past successes is made to a broad range of stakeholders and industrial actors in the region of interest. An initial review of the companies interested is then undertaken in order to identify the best sites for the project implementation. This initial review follows a set of predefined steps in which companies are visited and production and financial data are collected to then allow the project team to select the companies according to a set of objective criteria.

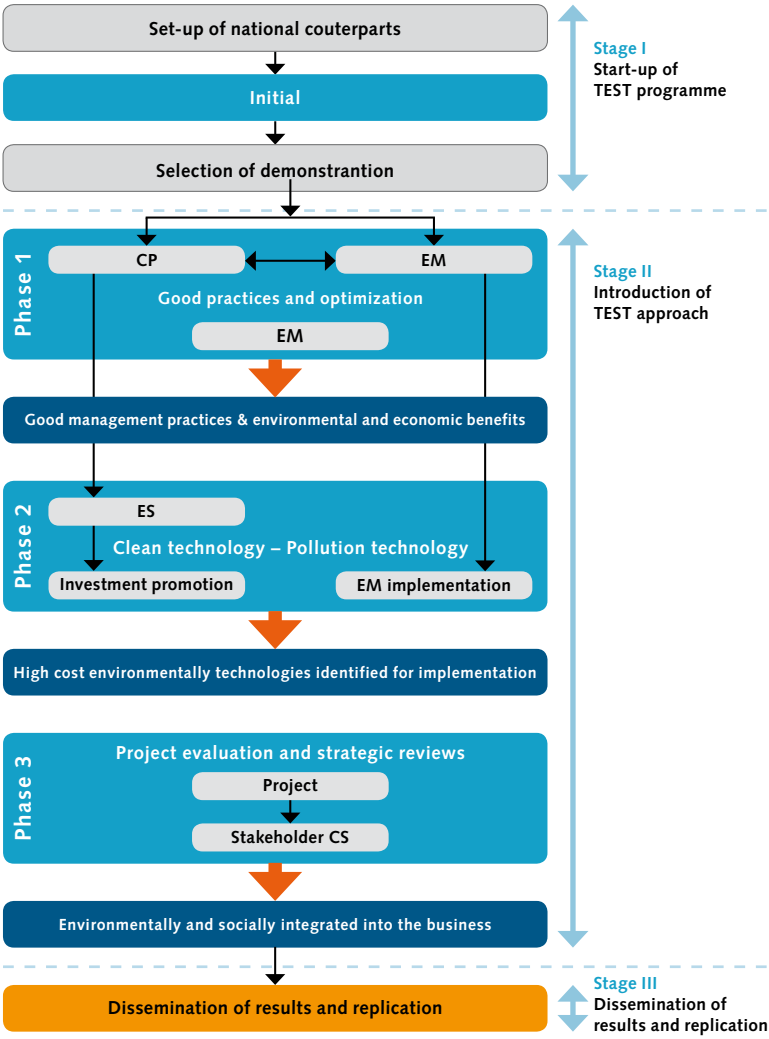
Once the companies have been selected, the second stage is initiated and follows three phases. In the first phase, the CPA and EMA allow the identification of the areas of interest for potential improvement in the industrial process. This also provides the baseline for the environmental and economic performances. Low-costs changes are introduced in the companies where an EMS is already in place. This then is amended to accommodate the new information emanating from the CPA and EMA findings. When there is no EMS, steps are taken for its development.

The second phase starts with a new EMA analysis in order to provide a second baseline, measuring the environmental and economic benefits of the changes introduced. This is an essential step in order to confirm the interest of the management of the company and ensure their willingness to continue with the more investments-intensive changes needed. These are identified in the application of the EST tool, which assesses the best available technologies and the best environmental practices for the industrial process concerned. The project is then implemented in close relation with the management of the company in order to match the investment proposed with the means of the company. Several options can be offered but each with clear financial information on the return on investment. The EMA tool provides the necessary financial data. During this phase, the EMS system is either reinforced or implemented depending on the initial situation.

Finally, in the third phase of the project, a third EMA analysis provides the final environmental and economical performance data and the results are fed into the CSR policy of the company in order to inform the stakeholders of the environmental performance and credential of the operations.

This leads to the last stage of the TEST implementation in which the data from all companies are aggregated into an information brochure and presented to a broad range of stakeholders, including but not limited to the initial group.

Figure 2: TEST implementation road map with individual tools used at each stage of implementation



For it to function successfully, the TEST methodology is based on the following principles:

- It requires a voluntary commitment from the pilot enterprises to proactive environmental management
- It is problem-driven, focusing on the needs of enterprises and/or countries
- It is flexible and open to innovative solutions – the specific tools used in the TEST projects (enterprise-level) are selected and introduced based on the results of the initial review of the needs of the enterprise
- It uses the integrated pollution prevention and control (IPPC) and best available techniques (BAT) approaches
- It optimizes production processes by focusing first on material efficiency strategies, followed by incorporating what are now less onerous, end-of-pipe solutions (if required)
- It ensures that environmental costs are properly allocated to their source, identified measures are implemented and TEST project results are monitored
- It analyses problems in all their economic, social and environmental complexity.

C. TEST implementation in Honduras

From 2005 to 2006 the Honduran Government's Center for the Study and Control of Pollutants carried out a water quality survey along the Rio Blanco, which showed levels of ammonium nitrogen, phosphorus and faecal coliforms higher than the permissible limits for irrigation and human use and lower dissolved oxygen than the recommended limits (Mérida and García, 2005–2006). Based on the findings of this survey, a number of industries were identified as the main source of industrial pollution on this river. Therefore, the initial stage of the TEST methodology was redundant and not implemented. The project went directly into the second stage.

From 2008 to 2011, UNIDO introduced the TEST methodology to three of the major industries still in operation that discharge their residual water into the Rio Blanco – one chicken-processing company and two textile companies – with the aim of reducing water use, industrial pollution and to increase their economic performance.

On-site project implementation relied on local capacity-building through the Honduras National Cleaner Production Centre (HNCPC) and international experts on EMA and EST tools.

1. Capacity development

The director of the HNCPC was trained in the TEST Methodology at UNIDO HQ in Vienna, Austria. This was organized in collaboration with another TEST project implemented by UNIDO in the Mediterranean Region. Following this event, the

staff of the HNCPC was trained in the TEST implementation by its director and the UNIDO project manager. The training consists of a 2.5-day classroom session including the theory behind the TEST methodology, the step-by-step implementation, the analysis of each of the five management tools and their integration with one another. In each case, practical examples using past project experience are used to emphasize the applicability.

Once capacity was built within the national partner agency, a more tailored training was developed for the companies. In each participating industry, a team comprising, at minimum, the company accountant and the head of operations of the site received full TEST training. Then, for each management tool, one responsible member of staff was designated and trained by the HNCPC in this particular method. This ensures consistency in the dialogues between the HNCPC and the company during the whole implementation period as well as ownership of the introduced changes within the company.

Additionally, workshops were organized for the whole company staff and held by the HNCPC on broader aspects of the methods. These include, among others, the necessity to save water and reduce its pollution, and corporate social responsibility. These trainings, while not exactly part of the TEST methodology, are very useful to disseminate the need to consider water as a valuable resource to the broader community.

Therefore, the capacity development was mostly done through classroom training followed by on-site introduction of the technique. The fact that the TEST management tools are still used by the companies shows that the capacity-building exercise was successful. Quality control was done through regular contacts between HNCPC and the companies during the project lifetime (to fine-tune the introduction of the methodology). It is this constant follow-up that gives assurance that the capacity-building was successful and this is an important lesson: it is essential to calculate enough resources to allow regular follow-up visits during the project.

2. Implementation in the chicken-processing company

(a) Situation at project start

At this production site, live chickens are delivered by trucks. They are processed on site producing either whole chicken or chicken parts ready for delivery to wholesalers. In addition to the final product, the process also produces wastes (feathers, blood, skin, fat and bones) which are transformed on site. The blood and feathers are collected at the initial stage of the processing and transformed into flour. The other wastes are generated further down the line and are collected with the processing wastewater. A simple liquid/solid separator allows the processing of the solids into another type of flour and the remaining liquids are then treated through a series of oxidation ponds. Both types of flour are sold as animal feed for other agro-food industries in the vicinity. Because of the poor solid/liquid separation and the under-dimensioning of the ponds, the effluents of the company regularly

largely exceeded national guidelines and meant that heavy fines had to be settled monthly.

(b) Project implementation and results

The introduction of the management tools of TEST at this site allowed the identification of the processing steps inducing environmental degradation and economic losses. Low-cost cleaner production measures were immediately implemented and adopted with over 93 per cent of the recommendations now in place, resulting in a reduction of water use by 21 per cent or about 450 m^3 per day.

One of the main investment recommendations was the remodelling of the effluent treatment, and an international expert was recruited to develop a fully-fledged investment proposal together with the project implementation team of the company. As a result, the oxidation ponds have been totally remodelled according to the best available practices and, consequently, the company's effluents are now well within the national guidelines, representing a saving of more than US$2,160 monthly. In fact, biochemical oxygen demand at the release point has been reduced by 55 per cent following the implementation of the cleaner production measures and the improved wastewater treatment ponds (see figure 3a and b).

Figure 3a: Effluent release: before

Figure 3b: Effluent release: after

(c) Project sustainability

During the last field visit in December 2011, the company confirmed that the various management tools introduced are now embedded in daily operations. The EMA is now routinely updated in order to monitor the continuous improvements generated by the EMS. Following the recommendations from the international expert on wastewater treatment, the company purchased a highly efficient grease separator which will allow it to remove most of the organic material from the

wastewater prior to the pond oxidation treatment. Therefore, it is to be expected that the pollution indicator will further improve. Additionally, the fats collected will be transformed into biofuel and generate much savings on the company's electricity bill.

Finally, the project team was informed that the company had initiated the replication of the TEST introduction at the other production sites of the group, the second largest chicken producer in Honduras.

3. Implementation in the textile companies

(a) Situation at project start

Both textile companies operate on the same site and each has its own wastewater treatment plant. The treatment plants were already ISO 14001 certified at the beginning of the project. This, plus the fact that the plants are of a much larger size than the chicken-processing company, meant that the project team faced initial reluctance from the management of these textile industries. However, after the initial presentations on the project's aim and the assurance of the confidentiality of the collected data, these difficulties were rapidly overcome.

Generally, as the effluent treatment plants were accredited, their operation was already highly efficient, but improvement could be made on the effluent generation from washing and dyeing processes.

(b) Project implementation and results

Low-cost cleaner production measures were immediately implemented and adopted, with over 90 per cent of the recommendations now in place, resulting in a reduction of water use by 7 per cent.

The implementation of EMA in the treatment plants identified a number of processing steps with the potential to generate savings if operated differently. After implementation of the changes, a reduction of energy consumption of 25 per cent was achieved.

Recommendations by regional and national experts in the textile industry resulted in the replacement of a number of dyeing agents by less potent ones and this resulted in a better efficiency of the treatment plants which, ultimately, was reflected in the lower concentration of residual salts in the final release to the river.

(c) Project sustainability

During the last field visit in December 2011, as for the chicken plant, the sustained utilization of the various management tools was observed. The improved economic performance generated by the introduction of the various recommendations meant that the site managers were now fully supportive of the methodology.

As the quality of the effluent had improved, testing is currently under way to assess the use of the treatment plants' effluents as irrigation water for the biofuel

crops grown by the companies as feed for their steam generation boilers. This would totally eliminate the releases to the river and reduce the costs related to pumping irrigation water.

D. Conclusions

Although there sometimes is initial resistance towards the project, the considerable water and economic savings rapidly achieved through the implementation of the TEST methodology means that the changes brought about are sustainable.

In each participating company, a TEST team is now operational and fully capacitated in the methodology. This reinforces the sustainability and ensures that further improvements will be adopted after each EMA exercise. Moreover, before the introduction of each tool, a large number of the companies' staff was trained in the new management method. This ensured full understanding and acceptance of the changes proposed. Therefore, although the core TEST team in each company is relatively small, in fact, most of the staff at these sites have benefited from training in cleaner production, water efficiency, environmental management systems and corporate social responsibility. These workshops were led by experts in their areas.

The main project results include the following:

- Industries have implemented over 90 per cent of cleaner production recommendations
- 7.5 per cent global reduction in water consumption in the three companies through implementation of cleaner production measures, consequently increasing water availability for the riverside communities
- 20 per cent reduction in energy consumption of the treatment plants of the textile companies
- Reduction of 50 per cent of total salt concentration in the effluents to within permissible levels
- Significant reduction of the microbiological contaminants released by the three industries, improving river water quality
- Reduction of 55 per cent of biochemical oxygen demand at the chicken-processing plant
- Treated wastewater reused in irrigation of biomass crops by the two textile companies
- The three companies have invested a total of US$130,000 on water treatment improvements
- Reported financial savings amount to US$90,000 annually for the three companies

- Implemented improvements transferred to another poultry processing company in Tegucigalpa
- Capacity-building:
  - Workshops to train consultants, company experts and local and central government officials:
    - One EMA training workshop held in San Pedro Sula, with more than 25 specialists trained
    - Three TEST concept trainings carried out in La Ceiba, Santa Rosa de Copán and Tegucigalpa. More than 50 experts trained
  - More than 2,200 employees from all three companies trained in sustainable water use, with an impact in at least 25 neighbouring communities (where the staff live)

The programme successfully demonstrated to the companies involved that using environmentally sound technologies has a positive effect not only on the environment but also on economic performance. As a result, one of the companies recently began TEST implementation in another one of its processing plants with positive results.

Given that this methodology has already been successfully implemented in Eastern Europe, parts of Asia, the Mediterranean coast and now Central America, the potential for replication is very high. However, it is to be noted that the TEST methodology works best in small to medium-sized enterprises (SMEs) because the managers are most often also the owners of the company and their interest is, therefore, not only economic but also philanthropic.

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Chapter 5:

Capacity development for safe use of wastewater in agriculture

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Abstract

Wastewater use in agriculture is one of the topics to be addressed in the United Nations Conference on Sustainable Development (Rio+20) as a significant issue for the global Green Economy. It is estimated that 200 million farmers worldwide irrigate at least 20 Mha with treated, partially treated and untreated wastewater. The use of wastewater in agriculture is an effective and economic way of recycling urban wastewater especially as it contains nutrients important for agricultural production. But using it without adequate treatment or practices leads to increased health risks and environmental and economic impacts.

The global understanding of such impacts and mitigation measures has gaps and, therefore, the UN-Water Decade Programme on Capacity Development (UNW-DPC) brought together, in a multi-year project under UN-Water, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the United Nations University Institute on Water, Environment and Health (UNU-INWEH), the International Commission on Irrigation and Drainage (ICID), and the International Water Management Institute (IWMI) to start a global initiative aimed at developing national capacities for the promotion of safe use of wastewater in agriculture in developing countries and countries in transition.

The capacity development approach targets organizations in a vertical direction (individuals, institutions, system) as well as in a horizontal direction (health, water and agriculture sectors). The initiative included capacity needs assessment of individuals and organizations at a national level in many countries and development of their capacities by sharing knowledge at an international level. Different capacity development techniques were followed in this initiative, such as international knowledge-sharing events, hands-on training, development of web-based learning systems and making use of the relevant materials developed by the UN-Water members and partners.

Keywords:
Capacity development
Safe wastewater
Web-based Learning
Green Economy
Knowledge sharing

A. Introduction

The water and agriculture sectors will increasingly be subject to externally driven and man-made changes, yet societies will at the same time expect more reliable services, safe food and less risk. Our understanding of such changes, social phenomena, impacts and mitigation measures has gaps and, therefore, knowledge and capacity development should be a top priority on the local, regional and international agendas.

The gap between water supply and demand is increasing dramatically in some parts of the world. Wastewater is considered a valuable source of irrigation water for farmers in such regions, particularly in urban and peri-urban areas, where large volumes of wastewater are being produced. Urban wastewater can originate from domestic dwellings, institutions, hospitals and industrial effluents. Using (urban) wastewater for irrigation can be considered as both a resource and a risk. On the one hand, wastewater use in irrigation is an effective way of recycling urban wastewater especially as it contains nutrients important for agricultural production. On the other hand, using wastewater without adequate treatment is associated with significant health risks.

Wastewater is used in different forms for irrigation purposes. It is used directly from a sewage outlet as untreated urban wastewater or in diluted form by mixing untreated urban wastewater with clean irrigation water. Treated urban wastewater can also be used directly (Raschid-Sally and Jayakody, 2008). It has to be mentioned that more than 80 per cent of wastewater and faecal sludge generated globally is indiscriminately discharged without treatment (Bos and others, 2004). The total number of farmers irrigating worldwide with treated, partially treated and untreated wastewater is estimated at 200 million, farming on at least 20 Mha (Raschid-Sally and Jayakody, 2008).

Wastewater use in agriculture is getting the attention of the international community as an important issue for the global Green Economy. This can be noticed from the message of the United Nations Secretary-General's Advisory Board on Water and Sanitation (UNSGAB, 2011) to the United Nations Conference on Sustainable Development (Rio+20). UNSGAB believes that the global community must make progress on wastewater management and strengthen the respective actions on pollution of freshwater by adopting a shared vision of urban, industrial and agricultural wastewater management including collection, treatment and water reuse.

This chapter introduces the concept of a global initiative on capacity development for safe wastewater use in agriculture. The chapter illustrates the different impacts of the use of wastewater in agriculture. It also outlines the method followed to carry out a capacity needs assessment in different countries and presents several channels for building the capacities of targeted individuals and organizations.

B. Potential impacts

Hussain and others (2002) developed an overview of the potential impacts of using wastewater in agriculture. Selected potential impacts are summarized as follows:

- **Public health:** Wastewater has the potential to cause diseases as it contains bacteria, viruses and parasites. Also, the inclusion of heavy metals in wastewater can be very dangerous for human health. Wastewater use in agriculture causes risk to the population living within and outside the wastewater irrigation zone
- **Crops:** Wastewater is attractive and economically valuable for farmers because it contains nutrients important for crop growth. However, a high concentration of chemical pollutants in wastewater may be toxic to plants
- **Soil resources:** Accumulation of nitrogen, phosphorus, dissolved solids and other constituents such as heavy metals in the soil affect its productivity and the sustainability of land use for agriculture. Salt accumulation in the root zone has possibly harmful impacts on crop yields
- **Groundwater resources:** Leaching of nutrients and salts included in wastewater has the potential to affect the quality of groundwater. The degree of impact depends on several factors, among them quality of groundwater, depth of water table, soil drainage and the amount of wastewater applied for irrigation
- **Property values:** Using wastewater for irrigation may influence the land property values positively or negatively. Low soil productivity due to the use of wastewater in irrigation may negatively affect the land prices and lease revenues. However, the value of wastewater as a source for irrigation may positively affect the value of land
- **Ecological impacts:** Drainage of wastewater from irrigation schemes into water bodies may indirectly affect the aquatic life and negatively influence overall biodiversity, e.g. the presence of water birds
- **Social impacts:** The use of wastewater in agriculture has different social impacts such as food safety, health and welfare, impaired quality of life, loss of property values and sustainability of land use

C. Capacity development

Capacity development is "the process by which individuals, groups, organizations, institutions and societies increase their abilities to: i) perform core functions, solve problems, define and achieve objectives; and ii) understand and deal with their development needs in a broad context and in a sustainable manner" (UNDP, 1998). This definition has three important aspects, namely, it:

- Indicates that capacity is part of a continuing process

- Ensures that human resources and the way in which they are utilized are central to capacity development
- Recognizes the importance of the overall framework (system) within which individuals and organizations undertake their functions

Following on from this definition, capacity-building in safe wastewater use in agriculture can be defined as the process through which relevant stakeholders, especially from sanitation, agriculture, environment and consumer sectors, improve their abilities to perform their core roles and responsibilities, solve problems, define and achieve objectives, understand and address needs, and effectively work together in order to ensure the safe and productive use of wastewater in agriculture.

1. Levels of capacity

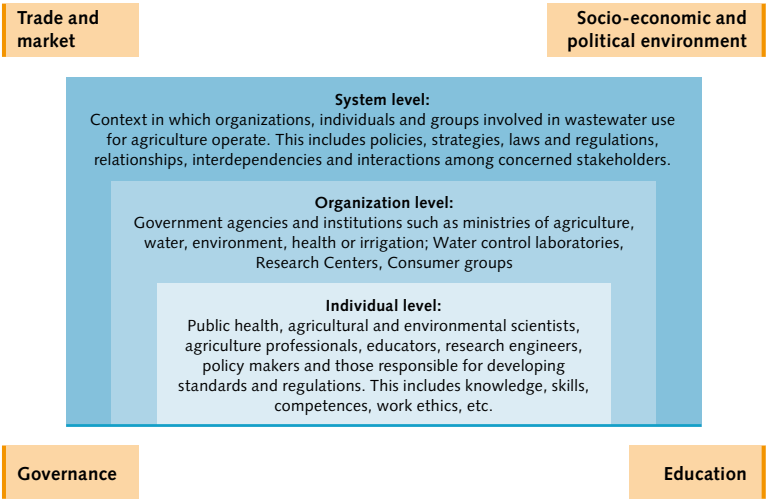
As illustrated in figure 1, capacity for safe wastewater use in agriculture exists at three different but closely related levels:

i. System level or context in which organizations, groups and individuals operate

ii. Organization and group level within the system

iii. Individual level within organizations and groups

Figure 1: Levels and dimensions of capacity with respect to safe wastewater use in agriculture



Source: UNDP (1998)

2. Dimensions of capacity

At each of the different levels described in section C1, there are various dimensions of capacity for safe wastewater use in agriculture (UNDP, 1998):

i. At the system level, dimensions of capacity include the policies, laws, regulations and standards that provide a framework for safe wastewater use in agriculture, as well as the mechanisms for management, communication and coordination among the different organizations involved

ii. At the organizational level, the mission, structure, operational procedures and culture of organizations involved in wastewater use in agriculture are important dimensions of capacity, in addition to their human resources, financial resources, information resources and infrastructure

iii. At the individual level, knowledge, skills, competences, experience and ethics are all part of capacity

These dimensions are the core characteristics or features of capacity. Some of these dimensions are cross-cutting and exist at each of the levels. For instance, the overall human resource capacity of an organization will obviously depend on the number of individuals within the organization, as well as their qualifications and skills, and the external environment in which they operate.

Considering capacity in terms of these different levels and dimensions is useful because it takes account of the relationships between them, and allows for the possibility that the root cause of weak capacity at one level may be found at a different level.

D. Global capacity development initiative

The UN-Water Decade Programme on Capacity Development (UNW-DPC) brought together, in a multi-year project under UN-Water, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), and the United Nations University Institute on Water, Environment and Health (UNU-INWEH) to start a global initiative aimed at developing national capacities for the promotion of safe use of wastewater in agriculture in developing countries and countries in transition. At a later stage, the International Commission on Irrigation and Drainage (ICID) and the International Water Management Institute (IWMI) joined the initiative, contributing significant additional expertise available within the group of UN-Water members and partners.

The initiative is playing a significant role in increasing the understanding of the links between wastewater and health, ecosystem functioning and the potential benefits of wastewater reuse in contributing to development and improved well-being. It also encourages the engagement of stakeholders in all sectors and the improvement of intersectoral collaboration through the development of professional skills and institutional capacities.

1. Development stages

Capacity-building is a continuous process of improvements and can occur at different levels (individuals, organizations or the system in which they operate) and focus on different dimensions of capacity. Similarly, it can be targeted at different types of stakeholder. Given the complexity of a capacity-building process, this initiative is structured in two stages.

(a) Stage I (2011–2013)

The current stage of this project (stage I) targets staff members and individuals from key organizations in the targeted countries which are involved directly or indirectly in the use of wastewater in agriculture. The targeted group is trained in the use of selected materials and methodologies to promote the safe use of wastewater in agriculture, and supported to develop national strategies, and to conceptualize a capacity development action plan for the dissemination of training materials and learning methods in the relevant organizations at country level. Different tools and techniques such as face-to-face training, web-based knowledge sharing and technical publications will be used and discussed and selected to maximize knowledge dissemination in the selected organizations and among related stakeholders. Enhancement of individual capacities will contribute to the improvement of the performance of the organizations as a whole in the safe use of wastewater in agriculture. The institutions and organizations involved in this stage are: ministries of irrigation, agriculture, food, health, water, environment and rural affairs, research centres, consumer groups, water control laboratories, national farmers' unions and others that are linked with wastewater treatment and reuse for agricultural irrigation.

(b) Stage II (2013–2014)

Stage II of this project will start in 2013 and will aim at improving the system performance to enable trained individuals to make best use of their new capacities (acquired in stage I). This will provide the conditions for a comprehensive and effective implementation of projects and programmes related to safe wastewater use in agriculture. Special attention will be given to policies, strategies, laws and regulations and the relationships, interdependencies and interactions among concerned stakeholders. This second stage will focus on the whole system of wastewater production, management and use, and all the organizations and stakeholders involved. The project will address the suitability of working environments, opportunities and incentives, taking into account the organizational/institutional/political level as well as the societal level.

2. Capacity development mechanism

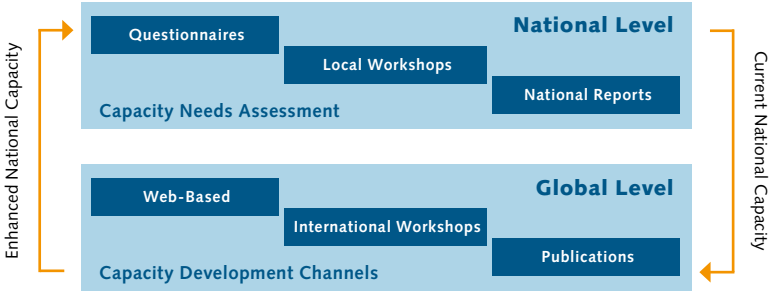
The main idea is based on sharing knowledge between the countries and regions involved. In addition to the different national experiences, expert groups, research institutes and international organizations are involved to provide state-of-the-art expertise, standards, innovations and technologies to enhance the local capacities

and support these in applying and implementing innovative wastewater use technologies in their respective countries.

Cooperative links and a community of practice were established, especially with expert groups of the respective collaboration partners in addition to other UN-Water members and partners, reaching out to the public sector. This enables the participants and beneficiaries to become more active in implementing innovative wastewater use strategies and concepts in developing countries and countries in transition. At the same time, it enables the beneficiaries and participants to learn from experiences of best practice implementation as well as continuing exchange on recent implementation strategies and suitable indicators, respectively, from partners and water organizations, who are active in improving wastewater management and reuse in their respective environments.

This project focuses on two levels: the national and the international level. Figure 2 shows the capacity needs assessment that has been carried out at the national level in the targeted countries. Based on the capacity needs assessment, the capacity development activities have been carried out at an international level to enable knowledge-sharing from different regions using different capacity development channels.

Figure 2: Capacity development mechanism



(a) Capacity needs assessment (national level)

In the first phase of this project, countries representing different regions of the world were selected to be directly invited for participation:

- Iran, Jordan, Lebanon, and Syria from the Middle East
- India and Pakistan from Southern Asia
- Algeria, Egypt, Morocco and Tunisia from North Africa
- Ghana and Senegal from West Africa
- Kenya and South Africa from East and Southern Africa
- Bolivia, Chile, Colombia, Guatemala, Mexico and Peru from Latin America

Key organizations in the selected countries were identified and a national focal point/coordinator was nominated. Country focal points, in collaboration with key national players, have identified the most relevant organizations in the country with competences on safe wastewater use in agriculture. Subsequently, a questionnaire prepared by FAO was used to carry out the capacity needs assessment mainly to identify the needed knowledge and skills. Based on the WHO Guidelines (2006), the questionnaire was designed to assess the following knowledge areas:

- **Health risk assessment:** This includes the capacity to carry out a systematic assessment of the positive and negative health impacts of the use of wastewater in agriculture (microbial and chemical laboratory analysis, epidemiological studies, quantitative microbial risk assessment (QMRA), and health-based targets)
- **Health protection measures:** This includes knowledge of control and protection measures of both treatment and non-treatment options such as crop restriction, wastewater application techniques, pathogen die-off between last irrigation and consumption, food preparation measures (washing, disinfecting, peeling, cooking), human exposure control and wastewater treatment
- **Monitoring and system assessment:** This includes knowledge of institutional arrangements, observing, inspecting and collecting samples for analysis, monitoring of health protection measures and wastewater use system assessment
- **Crop production aspects:** This includes components of wastewater harmful to crop production, agricultural tradeoffs of wastewater irrigation and management strategies to maximize crop production
- **Environmental aspects:** This includes knowledge of components of wastewater harmful to the environment, environmental effects through the agricultural chain and management strategies for reducing environmental impacts
- **Sociocultural aspects:** This includes knowledge of cultural and religious beliefs, as well as public acceptance
- **Economic and financial considerations:** This addresses the economic, financial and market feasibility of wastewater use in agriculture
- **Policy aspects:** This includes institutional roles and responsibilities, laws and regulations, economic instruments, education and social awareness.

In general, the assessment has shown that the health risk and health protection measures should be top priorities on the capacity development agenda. The assessment also illustrated that more capacity development activities are needed in African and Asian countries than in Latin America. An example of the questionnaire results is shown in figure 3. The results were discussed by different stakeholders (relevant ministerial departments, NGOs, local institutions, universities, etc.) in several national meetings. Based on the results of the questionnaires and the national meetings, national reports of the countries involved were developed to cover:

i. Current status and trends for wastewater production, treatment and use in agriculture at national level

ii. Policy framework and national strategy and objectives on safe wastewater use in agriculture

iIi. Description of key organizations working on the safe use of wastewater in the country

Assessment of the knowledge, skills and competences on the safe use of wastewater in irrigation needed by individuals working in these key organizations (e.g., capacities of the extension services of different ministries to promote health protection measures).

Box 1: The case of Ghana

The capacity needs assessment, as indicated in the National Report of Ghana, is based on responses received from 11 organizations involved directly or indirectly in the use of wastewater in agriculture. On average, existing knowledge and skills are mostly basic although a few organizations record good to excellent scores for most of the issues assessed (e.g., IWMI). Others, such as fisheries, scored between low and basic for most of the competences assessed. In terms of importance of the issues assessed, the organizations scored most of the issues as high and very high. There are however significant differences between the scores from various organizations: for example the Women In Agriculture Development Directorate scored the importance of elements of health risk assessment between low and very low while the same elements were scored by Water Research Institute (WRI) and IWMI as high to very high importance.

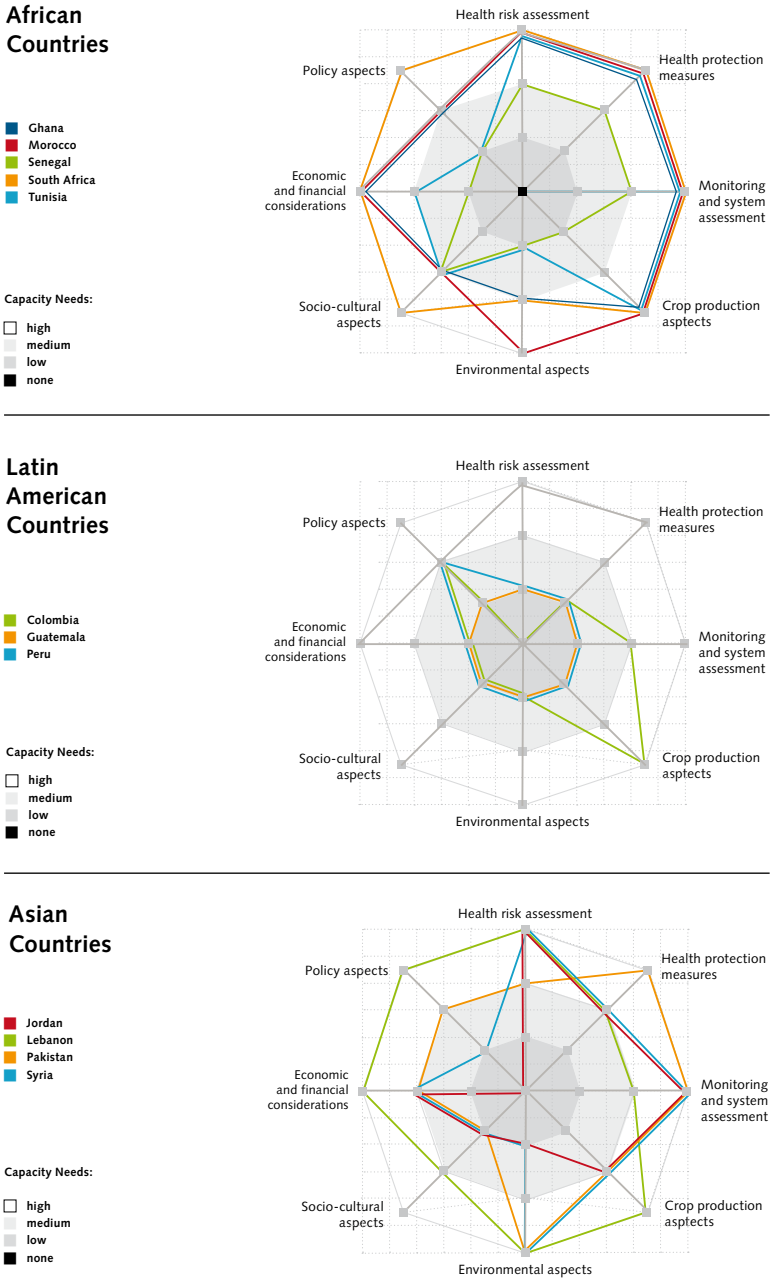
Source: Nutsukpo (2011)

(b) Knowledge-sharing events (international level)

The main outcomes from the National Reports resulting from the capacity needs assessment are used to structure the knowledge-sharing in international workshops. The main country capacity needs are highlighted and common patterns between countries can be identified. The participants receive different information sessions on existing capacity development resources and practices related to safe wastewater use. For example, at the regional workshop for francophone and Northern Africa, held in Marrakech, Morocco:

- The participants were sensitized regarding the safe use of wastewater in agriculture and familiarized with various training materials and guidelines available from UN-Water members and partners (WHO/FAO/UNEP Guidelines)
- Best practices were presented taking into consideration the wide range of differences between the capacity needs of the involved countries
- Discussions were held on various topics during thematic blocks on: "Water reuse planning, economic aspects, crop production aspects and public acceptance",

Figure 3: Results of the capacity needs assessment carried out in the countries involved



"Health risk assessment and mitigation where wastewater treatment does not work", "Health protection measures and policy aspects", "Environmental effects of wastewater in agriculture" and "Awareness raising and national strategies".

Practical sessions were also introduced. One of the hands-on examples was a site visit organized in Morocco to the wastewater treatment plant of Marrakech. This facility treats the wastewaters of Marrakech, which are then used for irrigation of golf courses and, in the near future, of the palm trees of "La Palmeraie". It also generates biogas, which is used to generate a substantial fraction of the power used by the treatment facility.

The knowledge-sharing events enabled the following:

- Clustering and prioritization of the capacity needs of the countries involved
- Identification of the main capacity gaps
- Identification of the necessary materials, expertise and know-how to fill these gaps
- Identification of the exact training and capacity development methodologies and the names of experts to be involved.

These events had other significant impacts such as raising awareness of the topic among the international community, presenting current trends, challenges and activities, exchanging experiences and knowledge and building a community of practice among participants.

(c) Online training management system (international level)

Information and communications technology (ICT) is recognized as a strategic enabler in the process of developing innovative solutions to address problems such as wastewater use in agriculture (Sewilam and Alaerts, 2012). Therefore UNW-DPC has developed the UN-Water Activity Information System Plus (UNW-AIS+) as an integrated online tool for storing, updating and sharing information (web-based content, documents and multimedia) on existing water-related projects, eTraining tools and other activities carried out by UN-Water members, partners and associated programmes.

UNW-AIS+ was used as the official communication and knowledge-sharing platform for this project. A special module for safe wastewater use in agriculture has been developed to enable the involved individuals and organizations to:

- **Share knowledge and best practices** by providing the user with background information on the topic, related materials to the training workshops, relevant publications, guidelines for safe wastewater use, national reports, promotion materials and information about the next events
- Receive **online training** (figure 4) on specific topics through online lectures and video illustration materials of specific processes

- **Communicate online** through forums and other social communication channels
- Access different **projects' databases** which provide the user with information on the project title, location, partner organizations, focus area, contents of the project and project status

Figure 4: Example of the online trainings offered by UNW-AIS+

E. The way forward

In the course of Stage I of this project, a total of five regional training activities will be organized in Africa, Asia and Latin America to focus on, and cater to, the clustered regional capacity needs. Once the regional training activities are completed, the individuals will be given time to make use of the gained knowledge and enhance the management of wastewater use in agriculture in their countries. An international call for success stories for safe wastewater use in agriculture will be published as part of the follow-up, and the best practice teams will be selected to participate in the final international wrap-up conference, which will be held in Iran in May 2013. The selected case studies will also be disseminated at the international level.

The second stage of this project will be devoted to improving system performance by providing the conditions for a comprehensive and effective implementation of projects and programmes related to safe wastewater use in agriculture. An assessment will be carried out to identify the organizational and system barriers that may prevent the trained individuals from making best use of their new capacities. The training for the second stage will focus more on the policies, strategies, laws and regulations, relationships, interdependences and interactions among concerned stakeholders.

It is clear from this discussion that developing the capacities of individuals and organizations on safe wastewater use in agriculture enables the optimum use of wastewater as an economical, valuable source of water, avoids its negative environmental impacts and in turn contributes to the global green economy efforts.

Acknowledgement

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Chapter 6:

The N-Park Negalitres Project: A pilot water-saving initiative using green technology and changing water use behaviour

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The N-Park condominium, a four-block apartment comprising 965 units in Batu Uban, Penang, was the first condominium in the country to carry out a water-saving project. The N-Park Negalitres Project started in August 2009 and ended in December 2010. This was a smart-partnership project jointly implemented by the Drainage and Irrigation Department (DID), Water Watch Penang (WWP), N-Park Management Corporation (NPMC) and Penang Water Supply Corporation Bhd (PBA). The project involved three main components: (i) a rainwater harvesting system comprising six tanks of 10,000 litres capacity each, built on the roof of one of the car-parking blocks adjacent to Block D; (ii) the installation of water-saving equipment in all the common area toilets with dual-flush cisterns, push-flush urinals and automatic push-taps; and (iii) a resident water-saving activity involving 100 apartments. Under that activity the participating apartment residents competed against one another to reduce their water use. Meetings and discussions were held every month to learn from one another and to iron out problems. Two water auditors gave advice and assistance to the participating residents. Results of the project showed that the rainwater harvesting system was most successful as the rainwater harvested was used for gardening, washing common areas and toilets, and for flushing toilets in the common areas. The water-saving equipment also resulted in substantial water savings. Both these items reduced water usage in the common areas of the condominium by 37.38 per cent in May, 36.51 per cent in July and 12.00 per cent in September 2011. This is an average monthly water savings of 28.63 per cent. In terms of monetary savings, this is equivalent to RM1,397.17 per month.[1] Over the six month period, the condominium saved 8,409,400 litres of water or the equivalent of RM8,391.00. However, results from the 100 participating apartments were not as encouraging, proving that changing human behaviour to save water is extremely difficult. This was largely due to cheap water tariffs, apathetic attitude and lack of interest, amongst other reasons. Hardly any water savings were made by the 100 apartments and a general trend of slight decrease in water usage was apparent, but not significant. In conclusion, the project found that integrated water resources management smart-partnership between government, the private sector and NGOs is workable. High density apartments also show great potential as water savings are significant and easily achievable. The rainfall harvesting system showed the most promising results given Penang's high monthly rainfall. This project can be easily replicated in other apartments

1 RM is the Malaysian currency unit. RM1 approximates US$0.31 on 13 February 2012.

throughout the country and the government should seriously consider replicating this project nationwide. Rainfall harvesting and water-saving equipment should be made mandatory for all new apartments, hotels, factories, universities and other institutes of higher learning, and all large water consumers.

The other benefit of this project was the improvement of harmony between neighbours of all ethnicities and nationalities.

Keywords:
Green technology
Water demand management
Water efficiency management
Rainfall harvesting
Water conservation

A. Introduction

Throughout the development of the water industry, technological advancement in the water sector has demonstrated that water behaviour can be changed or controlled for the sake of water conservation to benefit the larger picture of sustainable development (Chuah, 2010). Water flow, pressure, quantity and quality, to a certain extent, can be controlled by appropriate technologies, especially green technology that has emerged in recent decades. In many developed countries, use of technology such as dual-flush cisterns, water regulators and rainfall harvesting systems has substantially reduced water consumption and demand (Chan, 2002, 2010a). Results from many studies have shown that water behaviour can be manipulated and changed to achieve specified targets for water savings. Results of such technical applications to change the behaviour of water users have yielded reductions in water consumption between 20 and 30 per cent of normal water use. Because of this, large water users, such as big hotels, universities, schools, factories and industries, have adopted technical water demand management (WDM) measures to change water use behaviour. Demand management reflects a major paradigm shift from the traditional approach of top-down, government-controlled water supply management (WSM) to a more public-centred, bottom-up WDM approach in water resources management. While WSM over-relies on expensive and technologically advanced construction of physical infrastructures such as dams, reverse osmosis treatment plants, wastewater treatment plants and desalination (the aim is to increase water supply for direct use), WDM is based on an improvement in efficiency of water use, water conservation, water recycling and water reuse, all of which are much easier and cheaper to implement within a shorter period of time. WDM examines the ways water consumers (people, hotels, factories, businesses, etc.) demand and use water, and identifies/innovates new methods/measures aimed at achieving more efficient and cost-effective water use. The main aim of WDM is not to control water use but ideally to encourage wise water use, i.e., to reduce wasteful use of this precious resource. The most important aim of WDM is that it can sometimes obviate or delay the need for new physical or

infrastructure investments (like capital expenditure), as water saved can then be allocated to other users, hence reducing water demands on existing systems. According to the Global Water Partnership (GWP), demand management works best in an integrated water resources management (IWRM) framework which looks across sectors and makes proper links between policy instruments and impacts. [2]

However, technology cannot change human behaviour in relation to water use. Research has shown that human behaviour is extremely complex. Social scientists, especially researchers in the field of environmental humanities, believe that merely adopting a technical solution that only addresses a technical problem does not solve the entire problem of inadequate water supplies. This is because such technical solutions do not address the root causes of inadequate water supplies vis-à-vis water consumption (Chan, 2010b). Hence, it is more important to change water consumption which is closely tied to human behaviour. This paper examines examples of changing human behaviour towards wise water use and conservation via WDM. In many countries where the citizenry are sensitized towards water and environment, the consumption of water is minimized. Therefore, the results are higher water savings to the tune of 40–50 per cent of normal water use. For example, Malaysia's nearest neighbour, Singapore, has managed to reduce water demands amongst its consumers significantly, thereby creating a "water-saving society". Singapore has managed to reduce average monthly household water consumption from 21.7 m^3 in 1995 to 19.3 m^3 in 2004, a decrease of 11 per cent (Tortalajada, 2006). When implemented together, i.e., via changing the behaviour of water and humans, the results can be outstanding. This paper showcases a best management practice (BMP) of WDM in Penang, Malaysia (Chan, 2010c). It is hoped that this BMP will be replicated all over the country to ensure water security for the future. The paper also seeks to show that both WSM and WDM are needed to complement one another towards achieving sustainable future water resources.

B. Background to water resources management in Malaysia

By all standards, Malaysia is considered a "rich" country in terms of water resources. Based on an average annual rainfall of more than 3,000 mm, it has more than 566 billion m^3 of annual renewable surface water (Abdullah, 2002). However, despite being endowed with abundant water resources, it is often plagued by serious water problems that have threatened its current and future water security (Chan, 2002). With per capita renewable water of more than 10 times the international water stress line of 1,700 m^3 per annum, Malaysia does not have any valid reason to blame climate, seasonal variability, the environment or other natural factors for its water woes. In fact, much of Malaysia's water problems are largely human-caused (Chan, 2009). Water resources are depleted by destruction of water catchments (via logging, land clearance for agriculture, highway construction, dam construction, etc.), water pollution, water wastage, high non-revenue water, low tariffs, lack of incentives for water conservation and public apathy (Chan, 2004). The country also lacks strong institutional arrangements owing to the absence

2 See www.gwptoolbox.org/index.php?option=com_tool&cat_id=11. Accessed 12 January 2011.

of a national water policy. Shahrizaila Abdullah (1999) has proposed a water vision to fill this gap. Poor institutional arrangements are manifested in the Federal–State dichotomy, interstate disputes, state–local government disagreements, etc. Hence, human mismanagement is the fundamental cause of most of Malaysia's water problems. Despite this, Malaysia relies heavily on the structural paradigm to solve its water problems by employing top-down engineering and technical solutions such as construction of dams, water treatment plants, interstate water transfers, laying of pipe mains, etc. Such an approach does not tackle the fundamental causes that threaten our water security. It addresses only the technical side of the problems without involving the human side. This is not a sustainable method to ensure the future of Malaysia's water resources. In order to successfully address water problems and ensure future water security, it is imperative that Malaysia tackles both the technical as well as the human contexts that threaten water security (Chan, 2010a).

Malaysia's water woes are manifested in terms of water crises/droughts, floods, poor water quality as discussed above. Combined with other factors, including climate change, the water equation in Malaysia has radically changed from one of relative abundance to one of relative scarcity. Factors such as population explosion (including in-migration from neighbouring countries), rapid urbanization, agricultural expansion, industrialization, tourism and other developments are imposing excessive demands and pressures on Malaysia's water resources. At the same time, water availability is depleted by pollution. All these seriously threaten Malaysia's water security. The authorities have preferred to tackle all these water problems with the WSM approach, which is based solely on technology without addressing the human issues that are really the root causes of these water problems. WDM has been shown to be highly effective in countries such as Singapore, Denmark and Japan. Malaysia can and must adopt WDM. WDM is inevitable and it is imperative that Malaysia embraces this new paradigm as one of its priority strategies to ensure its water security.

C. The N-Park Negalitres water conservation project

The N-Park Negalitres water conservation project is a pilot project and the first of its kind in Malaysia, both in terms of WDM and in terms of its target for condominium/apartment units. This water-saving project is an initiative funded by the Malaysian Government (via EPU), managed by the Department of Irrigation and Drainage (DID), Malaysia, and jointly carried out by DID, Water Watch Penang (WWP), N-Park Management Corporation (NPMC) and Perbadanan Bekalan Air Pulau Pinang Sdn Bhd (PBA). The project consists of three components: (i) installation of a rainfall harvesting system; (ii) installation of water-saving fittings in the common toilets; and (iii) installation of minor water-saving fittings in 100 selected residential units, coupled with increasing awareness and education amongst residents in the entire condominium. Water-saving equipment is installed in the kitchen and toilets of each participating household as the main objective of this project is to reduce the water consumption of the condominium. The target of this pilot project is to reduce piped water usage by 10 per cent annually. Prior to the project

initiation, an assessment of the participants' awareness of water and environmental issues was carried out and it was found that residents had little awareness or did not care since water was cheap and freely available.

Traditionally, government agencies, the private sector and NGOs worked separately in the area of water management. In this project, however, the importance of involving all relevant stakeholders was emphasized so that in this project, besides the residents, the N-Park Management Corporation and its staff were also actively involved. So too was the water company PBAPP Sdn Bhd, as well as the government's Drainage and Irrigation Department Penang. Water Watch Penang, the lead NGO, was also instrumental in facilitating the project.

The project began with the official launch on 21 August 2009 (figure 1). On 31 October 2009, the rainwater harvesting project was launched. This system consists of six sets of rainwater harvesting tanks of 10,000 litres each. The tanks were installed after several months of preparatory survey repairs to existing roofs and gutters, connecting to tanks, and other plumbing works. The official launch was undertaken by the (then) Director of DID Penang, Tuan Haji Hanapi bin Mohamad Noor together with Professor Dr Chan Ngai Weng representing WWP and NPMC (figure 2). The rainwater harvesting project is the first in the nation for condominium units (Yeoh, 2009, August 22).

Figure 1: The N-Park Negalitres pilot water-saving initiative in The Star, 22 August 2009

NEWS

Pilot water-saving initiative

Penang condominium first to kick off campaign

By NONNIE YEOH

Water conservation: Prof Chan (right) showing Hamid (second right) around the N-Park Condominium.

Source: Yeoh, 2009, August 22

Figure 2: Director of DID Penang, Tuan Haji Hanapi bin Mohamad Noor (right) together with Professor Dr Chan Ngai Weng (left) at the launch of the N-Park rainwater harvesting project

Source: Yeoh, 2009

Following the launch, the water conservation project for household units commenced. Initially about 60 residents from Blocks A, B, C and D of N-Park condominium agreed to participate in this project. The participants were visited by the two water auditors, Hong Chern Wern and Chan Men Yen, every Wednesday, Friday and Saturday (night-time on weekdays and daytime at weekends) every week. The auditors also discussed the household water survey questionnaire with residents. The questions included: water usage pattern (total litres per day per capita); water-saving techniques practised at home; willingness to pay for the water-saving equipment; perception of the current water rates in Penang; willingness to pay for an increment in the water rates in Penang; and other water-related issues. Once a month, the participants had a meeting and were briefed about the project, led by a trainer. Volunteers were trained and their performance assessed before they were certified as fit to run the activities. All the volunteers were observed and assessed and then the enthusiastic and committed ones were picked out to facilitate the training sessions. During the sessions, observations continued and changes were made if any trainer was found to be inadequate. The sessions discussed the rainwater harvesting project and the water-efficient fittings in the common area toilets, as well as the effectiveness of the household water-saving fittings and the problems faced. Participants were also constantly being educated about water conservation and the water situation in Penang in order to increase their awareness and to instil a sense of caring for water by creating a water-saving community in N-Park, which is one of the main objectives of this water conservation project. The trainers/teachers were selected from a pool of volunteers. During the sessions, educating the participants involved first giving a talk on the general background

of the topic. The speaker selected was able to keep the participants interested. Lots of stories, pictures, video clips and music were incorporated to make the talk interesting. This was followed by open discussions and a Q&A session. Video documentaries, drama, exhibitions and a water painting competition were also used to increase awareness and education on water. During the training sessions, various topics were discussed.

i. Introduction to global and local water issues

ii. What is happening internationally, nationally and locally?

iii. Water problems in the world and in the local context

iv. What causes water problems?

v. Is water the government's responsibility alone?

vi. How can we solve water problems? What can we do at home and in the office to solve some of our water problems?

vii. What water-saving equipment is available, how much do they cost and how to fix them?

viii. How can you spread the message of the importance of water saving to others and teach others what you know?

D. Discussion and results

1. The rainwater harvesting project

The N-Park rainwater harvesting project showed that a large amount of rainwater can be harvested every month. This is because there is abundant rainfall, averaging between 200 and 500 mm per month. Hence, the lesson learnt is that Malaysia has high rainfall all year round and has great potential for rainwater harvesting. Unfortunately, however, this rich potential is untapped at the moment. Installing a rainwater harvesting system in apartments is fairly easy as most rooftops have built-in gutters and drainpipes trapping rain. The N-Park project showed that the condominium has harvested more rainwater than it could use. To use more of the harvested rainwater, it needs to be diverted to the area where washing activities such as car washing and garbage bin washing take place. During every heavy rainstorm, the 10,000-litre capacity tanks would fill up quickly to the brim (table 1). N-Park is not utilizing all its harvested rainwater for several reasons. First, the PBA taps provide better water pressure and gardeners and cleaners prefer to use the PBA piped water as they can finish their chores faster. Second, there are not that many plants to water in and around the rainfall tanks area in the Block D car-parking block. Third, because of a lack of space, there are no car-washing bays utilizing rainwater in any of the four blocks. Currently, there are two car-washing bays near Block A. Fourth, the rainwater is currently only used for flushing toilets in the badminton court toilets (one male and one female). Fifth, the major landscaped

areas are located on the southern side of all four blocks while the tanks are located on the northern side. It would take extensive piping connections to link the tanks to the southern side.

2. The water-saving fittings in common area toilets

The total number of water-saving fittings installed was 101 units (table 2). The types of water-saving fitting include: dual flush cisterns; automatic push taps; and push urinals. The areas installed with such fittings were the toilets on the ground floor near to the lifts in Block A, Block B, Block C and Block D. Table 3 shows water consumption data for the entire N-Park common area. Before the launch of the rainwater harvesting project (31 October 2009) and water fittings installation (20 April 2010), it was clear that the average water consumption was very high, between 9,000 and 12,000 m^3 per two months. After both systems were installed, the water consumption showed a very significant decrease. This was reflected in the May, July and September 2010 water consumption figures which averaged between about 6,000 and 8,000 m^3. This is a significant decrease of about 33.3 per cent. Figure 3 illustrates the trend of this significant decrease in water consumption. In terms of monetary savings, N-Park Condominium saved RM3,609.1 (table 4), RM3,524.7 (table 5) and RM1,249.2 (table 6) for the billing months of May, July and September, respectively. This gave a total monetary savings of RM8,383.0 over a 6-month period (April to September 2010).

Table 1: Total harvested rainfall from May to October 2010 in N-Park

Date	Tank 1		Tank 1		Tank 1		Tank 1		Tank 1		Tank 1	
	Acc. Cons.	Vol. Rem.	Acc. Cons.	Vol. Rem.	Acc. Cons.	Vol. Rem.	Acc. Cons.	Vol. Rem.		Vol. Rem.	Acc. Cons.	Vol. Rem.
14/5/10	17	nil	124	nil	708	nil	9	nil	20	nil	9	nil
21/5/10	17	5000	367	4000	1257	7000	10	5000	20	4500	16	9000
2/6/10	21	5000	747	4900	1902	6250	11	5000	20	4750	18	9500
9/6/10	22	5000	959	4400	2705	6500	11	5000	21	4750	18	9500
19/6/10	24	5000	1211	4100	3996	2900	12	5000	21	5000	19	9500
1/7/10	30	5000	1347	5000	5083	9200	14	5000	22	5000	20	9500
10/7/10	33	5000	1420	5000	6124	7500	17	5000	23	4800	27	9500
17/7/10	34	5000	1528	5000	6859	4500	17	5000	23	4900	46	9500
18/8/10	50	5000	1992	5000	10270	4700	21	5000	27	5000	80	9500
25/8/10	51	5000	2099	5000	12030	5000	22	5000	27	5000	120	9500
2/9/10	55	5000	2205	5000	15067	5000	23	5000	28	5000	205	9500
9/9/10	58	5000	2290	5000	17023	4000	24	5000	30	5000	301	9500
19/9/10	60	5000	2350	6000	20103	5000	24	5000	31	5000	354	9500
30/9/10	63	5000	2390	5000	23387	5000	26	5000	32	5000	430	9500
6/10/10	70	5000	2439	5000	26300	4500	27	5000	32	5000	520	9500
13/10/10	76	5000	2501	6000	30193	1250	29	5000	34	5000	612	9500
20/10/10	85	5000	2557	5000	33503	500	31	5000	35	5000	741	9500

Table 2: Types and numbers of water-saving fittings installed in the common area toilets in N-Park

Block	A			B			C			D		
	W/C	Basin Trap	Water Trap	W/C	Basin Trap	Water Trap	W/C	Basin Trap	Water Trap	W/C	Basin Trap	Water Trap
Toilet (Gr) Male	1	1	1	1	2	1	1	2	1	1	2	1
Toilet (Gr) Female	1	1	1	2	2	1	2	2	1	2	2	1
Nursery	2	2	1	—	—	—	—	—	—	—	—	—
Surau	—	—	3	—	—	—	—	—	—	—	—	—
Badminton (M&F)	4	6	7	—	—	—	—	—	—	—	—	—
Sauna (m83&F)	2	6	6	—	—	—	—	—	—	—	—	—
Swimming Pool	—	—	5	—	—	—	—	—	—	—	—	—
Car Wash	—	—	2	—	—	—	—	—	—	—	—	—
Garden Tap	—	—	12	—	—	—	—	—	—	—	—	—
Refuse Chute	—	—	1	—	—	—	—	—	—	—	—	—
Car Park E	—	—	2	—	—	—	—	—	—	—	—	—
Car Park F	—	—	2	—	—	—	—	—	—	—	—	—
Guard House	1	1	—	—	—	—	—	—	—	—	—	—
Management Office	—	1	—	—	—	—	—	—	—	—	—	—
RA Club	—	1	—	—	—	—	—	—	—	—	—	—
Total	**11**	**19**	**44**	**3**	**4**	**2**	**3**	**4**	**2**	**3**	**4**	**2**

Table 3: Water consumption at various locations in N-Park

Block	July 2009	Sept 2009	Nov 2009	Jan 2010	Mar 2010	May 2010	Jul 2010	Sept 2010
Block A Main Meter	1201	479	479	883	378	101.1	284	334
Garden Tap A	121	936	936	745	1886	133	169	148
Surau	3	3	2	2	2	2	5	7
Block A Toilet	91	102	70	109	73	36	22	39
Block B Main Meter	0	293	1019	287	1477	538	1358	2531
Block B Tea House	1836	606	219	205	244	179	101	67
Block B Garden Tap	19	16	16	22	23	15	13	12
Block B Toilet	306	364	171	171	132	56	17	15
Block C Main Meter	4996	2547	3096	1814	911	1766	841	857
Block C Car Park	459	862	1058	542	251	62	12	9
Block C Garden Tap	3	1	0	0	0	0	0	0
Swimming Pool Tap	545	497	527	452	507	233	246	249
Swimming Pool	1176	1237	1441	1704	1458	1190	1568	1775
Block C Toilet	435	369	321	383	327	104	93	140
Block D Main Meter	342	447	1329	1352	1307	1463	1176.5	2183
Block D Garden Tap	42	50	42	70	180	39	50	72
Reading Room	28	50	57	51	72	73	66	65
Block D Toilet	256	253	240	265	152	107	69	78
Car Park block E	4	22	15	6	12	34	27	21
Total	**11872**	**9114**	**11036**	**9083**	**9792**	**6132.1**	**6216.5**	**8617**

Table 4: Water savings for May 2010 compared with March 2010 before installation of fittings

Minimum charge	Total litres consumed	Total litres consumed	Total litres consumed
First 20000 litres	20000 litres	0,22 × 20	RM 4.40
20001–40000 litres	20000 litres	0,42 × 20	RM 8.40
40001–60000 litres	20000 litres	0,52 × 20	RM 10.40
60001–200000 litres	140000 litres	0,90 × 140	RM 126.00
More than 20001–40000 litres	3459900 litres	1,00 × 3459.9	RM 3459.90
Total	**3659900 litres**		

Table 5: Water savings for July 2010 compared with March 2010 before installation of fittings

Minimum charge	Total litres consumed	Total litres consumed	Total litres consumed
First 20000 litres	20000 litres	0,22 × 20	RM 4.40
20001–40000 litres	20000 litres	0,42 × 20	RM 8.40
40001–60000 litres	20000 litres	0,52 × 20	RM 10.40
60001–200000 litres	140000 litres	0,90 × 140	RM 126.00
More than 20001–40000 litres	3375500 litres	1,00 × 3375.5	RM 3375.50
Total	**3575500 litres**		

Table 6: Water savings for September 2010 compared with March 2010 before installation of fittings

Minimum charge	Total litres consumed	Total litres consumed	Total litres consumed
First 20000 litres	20000 litres	0,22 × 20	RM 4.40
20001–40000 litres	20000 litres	0,42 × 20	RM 8.40
40001–60000 litres	20000 litres	0,52 × 20	RM 10.40
60001–200000 litres	140000 litres	0,90 × 140	RM 126.00
More than 20001–40000 litres	1100000 litres	1,00 × 1100.0	RM 1100.00
Total	**1174000 litres**		

For the month of May 2010, total water savings was 9,792 m^3 (March consumption) – 6,132.1 m^3 (May consumption) = 3,659.9 m^3. This is equivalent to a saving of 37.38 per cent. For the month of July 2010, total water savings was 9,792 m^3 (March consumption) – 6,216.5 m^3 (July consumption) = 3,575.5 m^3. This is equivalent to a saving of 36.51 per cent. For the month of September 2010, total water savings was 9,792 m^3 (March consumption) – 8,617 m^3 (September consumption) = 1,174 m^3. This is equivalent to a water saving of 12 per cent. The average savings over the period was about 28.63 per cent, which is much higher (2.8 times) than the target of 10 per cent. Combined, over the six month period of April to

September 2010, total water savings amounted to 8,409.4 m^3. Hence, the N-Park Negalitres project can be considered a great success, and can qualify as an exemplary BMP that should be replicated in all apartments in the country. More than that, all large buildings with a high level of water consumption should implement WDM modelled after the N-Park project.

It was interesting to find out whether the water savings were caused by water-saving equipment or by behavioural change, or both. It was deduced that the water savings were mostly caused by water-saving equipment. There are several reasons for this: (i) people are unwilling to make dramatic changes, especially when it comes to water usage; (ii) in the N-Park common areas, there was substantial water saving and this could only be due to changed equipment as the common areas were used mostly by visitors rather than residents; (iii) it was found that even those residents who were unwilling to change their water use patterns recorded water savings, and this could only be due to water equipment; (iv) in terms of residential water use, the 100 participating units registered a slight reduction in water use, attributable to behavioural change.

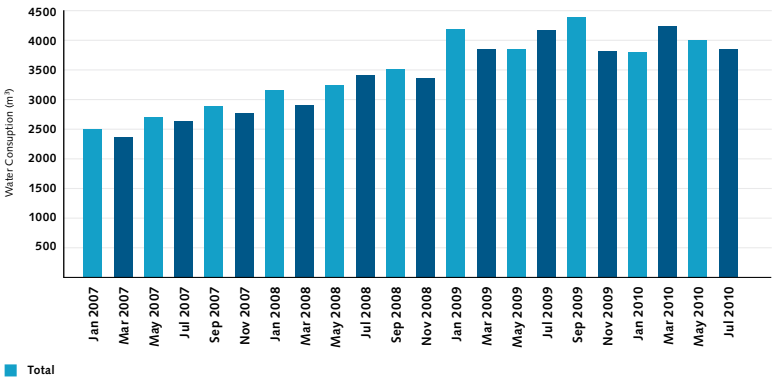
3. Capacity-building aspects of awareness-raising and water conservation

This project started off with the objective of raising residents' awareness of the importance of water and water conservation, but it gained much more than that. Before the project began, residents in the apartment hardly knew each other. It was not uncommon to find hundreds of residents in the apartment who did not know their neighbours' names, let alone socialize with them. During the course of this project, residents taking part (including their many family members) had to interact with one another and in the process not only learnt about the importance of water conservation but also learnt about each other. Many became close friends and, suffice to say, this project succeeded in enhancing neighbourliness and harmonious living amongst people of different ethnic groups, religions and backgrounds. Residents were also more cooperative with one another after they got to know each other in the project.

Initially, the installation of water-saving fittings for the 100 participating apartments in this project began in the month of April 2010. In each apartment, an average of five water-saving fittings were installed. The locations installed with water-saving equipment included the kitchen tap, showers in both bathrooms and taps of both sinks. The types of water fittings installed were the internal water regulator and external water regulator. Economical water fittings rather than high-tech, expensive water equipment were used owing to the large numbers of units involved. These water fittings were given free and installed free of charge by a plumber. The results were also encouraging. Figure 3 shows the total water consumption in 86 participating households (14 households did not have complete data and were excluded) from January 2007 to July 2010. Before the fittings installation in April 2010, water consumption results indicate that household water consumption had steadily increased between 2007 and April 2010. There are probably many reasons for this, such as families getting bigger, lack of awareness, water wasting habits and apartment units being rented out. This gradual increase notwithstanding, after

April 2010, when the installation of water fittings for the participating units began and water awareness and monthly workshops started, the water consumption figures had dropped. The figure for March 2010 was about 3,750 m^3. This dropped to 3,490 m^3 in May 2010 and further dropped to 3,400 m^3 in July 2010. The percentage water consumption decrease was 6.9 per cent in May and 9.3 per cent in July 2010. This is a significant drop in water consumption given the fact that household water consumption patterns are more or less constant because of the difficulties in changing human behaviour. Since April 2010, the water consumption pattern shows a decreasing trend and this can be attributed to this project.

Figure 3: Total water consumption in 86 participating households from January 2007 to July 2010



There are many challenges faced by this project in terms of trying to change people's water-use behaviour. For example, people who are used to having five showers a day would be reluctant to cut it down to just two showers a day. Also, people who are used to washing their cars every day would be unhappy if they are told to wash their cars only once a week. This project faced many of these challenges. Some unhappy participants in fact pulled out from the project when they were asked to make these changes in their water use patterns. Some participants also had very little commitment to the project, and did not bother to inform the secretariat about quitting. Hence, new participants had to be solicited to join the water-saving project late. Another huge challenge was that of different cultural practices (nearly 50 per cent of the 100 participants are university students from foreign countries). It was found that some participants from Middle Eastern countries liked to listen to the dripping of water and would leave the tap dripping all day, while some would shower as many times as they liked (since showering was a luxury in their dry countries). Penang's extremely cheap water tariffs (compared with anywhere in the world) may have been a reason for this extravagance. Hence, Penangites also generally had an apathetic attitude towards water conservation. Penangites would save on energy, petrol, food and clothes, but would not save on water since it is so cheap. It costs only RM0.31 per cubic metre of water for domestic consumers. Another challenge is that many participants are very busy with their work and personal family life, leaving little time to take part in the project seriously.

They did not bother to commit to the project and spent little time or effort to save water. Many participants mentioned that their water bills were already very low, some paying only RM2.50 per month. Hence, they feel that trying to save water is a complete "waste of time". Overall, it was found that apartment residents need attractive incentives before they get involved in water conservation. They did not understand or buy the idea that saving water means saving it for the environment or for their children. Many viewed water conservation as an investment, and found the rewards not attractive at all.

Nevertheless, bringing people together in this project and getting them to talk and mix with one another was a blessing for the project as well as for harmonious living. Results showed that the participants had better awareness and were able to understand and practise water conservation much better than those who were not part of the project. Hence, it can be concluded that participants in the project had built up their capacities as far as water conservation is concerned. Before the project started, they knew little about water conservation. After the project, they are able to figure out what is needed to save water, what equipment or water fittings are required, how to calculate their per capita water bill and water usage, how to run a water-saving campaign, how to organize stakeholders' discussion, public seminars and most of all how to get people to come for meetings and discussions. It was also found that participants in the project are more likely to attend meetings if they are approached personally rather than through phone calls, e-mails or notices in their mailboxes. It was learnt from this project that people cannot be forced to take part. Only those who took part voluntarily stayed on while those who were dragged to the meetings eventually quit. It was also found that it was more effective to get participants to persuade their neighbours or friends to take part rather than going door-to-door.

In retrospect, many lessons have been learned from this project about capacity development and training of the participants, which are difficult aspects to confront. In terms of the content of capacity development, the training sessions were designed with fixed themes: (i) why the need to save water? (ii) water-saving tips; (iii) problems and solutions related to water savings; (iv) water quality issues; and (v) water pressure management. From the results, it was found that this project has successfully increased the water management capacity (in the area of water savings) of a number of actors. First, major players in the water arena, such as the water service provider PBAPP Sdn Bhd, government agencies such as the Drainage and Irrigation Department and Municipal Council of Penang Island, apartment management corporations such as the N-Park Management Corporation and NGOs such as Water Watch Penang, gained experience in the area of working together in smart partnerships. In contrast to the past when each of these organizations worked on the same issue separately, thereby wasting resources and even competing against one another, this project showed that limited resources could be pooled and used effectively. The various expertise of different organizations was employed in a complementary manner to assist one another rather than compete against one another. Second, the capacity of government agencies and private companies in dealing with and working with NGOs and communities was also enhanced. In the past, these organisations viewed NGOs as "anti-government"

and "anti-development", but from this project, they learned that much can be gained working with NGOs and communities. Third, the capacity of NGOs and local communities in dealing with and working with government agencies and private companies was also enhanced. In the past, NGOs merely received grants or donations but from this project, they learned that government departments and private companies have much more to offer in terms of expertise, resources and project implementation than just money. Fourth, the N-Park Management Corporation's capacity in terms of water management was greatly enhanced. This corporation is now well known and other apartments are seeking its help in executing similar water-saving projects. The Penang State Government is also looking at the prospect of replicating the N-Park project state-wide. This shows that the message is spreading fast and once other apartments follow, the capacities of other apartment management corporations will be similarly enhanced. Fifth, residents taking part in the project also experienced enhanced capacities in terms of what they know about water savings. Those taking part can now easily implement water-saving procedures, install simple water-saving equipment and teach others to do the same.

In terms of delivery approach, it was found that participants, whether organizations or people, need to be convinced that a project is important, viable and meaningful to them before they will come on board. Organizations and people cannot be forced to take part in projects. It was found that those who were not interested but were coaxed or forced to participate would eventually drop out. Hence, the main delivery approach is that of stakeholder consultation, open discussion and a friendly approach. Giving lectures was necessary as an approach but people became bored after a while. So, the alternative was to invite the participants to share their experiences. In this project, after the first few talks by invited guests and the project experts, speakers were subsequently selected from the organizations and participants. Hence, we had housewives, engineers, doctors, foreign participants (N-Park has a sizeable community of foreigners as it is located near to Universiti Sains Malaysia) and students sharing their experiences. Open discussion was always followed by food and drinks, and often it was during the break that great ideas and solutions surfaced.

In terms of assessment, the success of capacity development has been demonstrated in several ways. First, all organizations taking part are now capable of executing similar projects with other organizations. Second, NGOs and local communities have enhanced their capacities to save water and manage water consumption. They have also enhanced their capacities to work with government agencies and private companies. Third, participants have increased their understanding of water issues and the importance of saving water, how to save water and how to manage their water demands. Fourth, the best assessment proving that capacity has been developed is that of water consumption of the entire N-Park apartment block, showing a decreasing trend after project implementation. Finally, the participants taking part also showed a decrease in water consumption in their individual household units.

E. Conclusion

In conclusion, it was found that the N-Park Water-Saving Project showed great successes in terms of consumption reduction of about 30 per cent (inclusive of all three components of the project). The rainwater harvesting component showed the greatest promise and saved more water than could be used. The installation of water-saving devices in the common area toilets was also a great success. Not only were water savings significant, but the toilet fittings were a beauty to behold. For the participants of the household water-saving project, many became more aware of the importance of water and enhanced their knowledge about the many advantages of WDM, rainwater harvesting and water-saving devices available on the market. Other benefits of the project include closer ties amongst neighbours, greater sense of Muhibah (ethnic harmony) amongst the different ethnic groups, as well as getting to know new friends from all over the world (Malaysian residents got to mix freely with overseas residents who were taking part in the project). This project can be easily replicated in other apartments across the country, proving that WDM is "workable". The success story of N-Park needs to be publicized and this BMP should be properly documented and replicated in all apartments, flats, hotels and large buildings in the country. This project also proves that IWRM smart partnership between government, the private sector, NGOs and local communities is workable. High-density apartments have great potential as water savings are significant and easily achievable. Finally, it must be mentioned that a reassessment of the participants' knowledge on water and environmental issues underlined that most of them had an increased awareness, showing that the project had had a profound effect on them.

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Chapter 7:

Drinking water and sanitation services: Lessons from relevant experience

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Abstract

On the basis of comparative analysis of reforms in drinking water supply and sewerage services in urban areas of Argentina and Chile and taking into account recent experiences of other Latin American countries (Bolivia, Brazil, Colombia, Mexico, Peru, Uruguay, etc.), the study identifies the factors exogenous and endogenous to the water sector which determine its performance or, in other words, success or failure.

Keywords:
Drinking water supply
Sewerage
Public services
Public policies
Institutional organization
Industrial structure
Privatization
Regulatory framework
Tariff policies
Subsidies
Low income groups
Financing
Investments
International investment
Macroeconomic policies
Policy priorities
Institutional quality
Payment culture

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1 Reprint of Emilio Lentini (2011). "Drinking water and sanitation services: lessons from relevant experience". Circular of the Network for Cooperation in Integrated Water Resource Management for Sustainable Development in Latin America and the Caribbean, No. 34 (October). Santiago, Chile: Economic Commission for Latin America and the Caribbean. Available from www.cepal.org/drni/noticias/circulares/0/43510/carta34in.pdf and Emilio Lentini (2012). "Drinking water and sanitation services: lessons from relevant experience". Circular of the Network for Cooperation in Integrated Water Resource Management for Sustainable Development in Latin America and the Caribbean, No. 35 (January). Santiago, Chile: Economic Commission for Latin America and the Caribbean. Available from www.cepal.org/drni/noticias/circulares/7/45057/carta35in.pdf.

A. Introduction

Over the past 30 years, the drinking water supply and sanitation sector in Latin America and the Caribbean has undergone successive reforms designed to improve its performance (an exhaustive analysis of these reforms is available in Jouravlev, 2004). Most of the countries, however, are far from achieving universal coverage and much remains to be done to provide appropriate levels of service quality. At the same time, there are still problems for the financing of operations and investment in services.

As for the depth of reforms in the region, the most noteworthy have been in Argentina and Chile. Their respective transformation processes have made considerable progress in both the implementation and improvement of new regulatory frameworks and the self-financing of services and private sector participation. Development and results have differed, however.

In the 1970s, services in urban areas in Chile and in the Buenos Aires Metropolitan Area in Argentina showed similar levels of coverage. At present, urban areas in Chile have practically achieved universal drinking water supply (99.8 per cent) and sewerage services (95.9 per cent) and 86.9 per cent of wastewater is treated, but coverage in Buenos Aires Metropolitan Area stands at only 79 per cent, 59 per cent and 8 per cent, respectively.

The Natural Resources and Infrastructure Division of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) has published a study entitled *Servicios de agua potable y saneamiento: lecciones de experiencias relevantes* (Drinking Water and Sanitation Services: Lessons from Relevant Experience) (Project Document Series, LC/W.392, April 2011) by Emilio Lentini.[2]

On the basis of comparative analysis of the two experiences from Chile and Argentina (a detailed analysis of the experience of Chile is available in Valenzuela and Jouravlev, 2007 (see Annex 1), and that of Argentina in Ordoqui Urcelay, 2007 (see Annex 2)) and taking into account references from other countries in the region (Bolivia, Brazil, Colombia, México, Peru, Uruguay, etc.), the author identifies the factors exogenous and endogenous to the drinking water supply and sanitation sector which determine performance or, in other words, success or failure.

2 This study (available in Spanish only) was undertaken within the framework of the Sustainability and Equal Opportunity in Globalization. Component 1, Theme 4: Building Commitment, Efficiency and Equity for Sustainable Water Supply and Sanitation in Latin America and the Caribbean project undertaken jointly by ECLAC and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and financed by the German Federal Ministry for Economic Development and Cooperation (BMZ). The objective of this project was to strengthen the capacity of the governments of the region's countries to design and implement effective public policies with an emphasis on commitment, efficiency, equity and sustainability. The experience accumulated from developing public policy formulation-oriented research and technical assistance activities in its context is summarized – in the form of public policy guidelines for the drinking water supply and sanitation sector – in Hantke-Domas and Jouravlev, 2011.

B. Exogenous factors

1. Macroeconomic policy[3]

Developing drinking water supply and sanitation services entails a major investment process for a prolonged period. The intensity and regularity of this process are subject to the macroeconomic environment. Economic stability and growth in the framework of rational and consistent policies will foster healthy public finances, improvements in the population's ability to pay and an appropriate context for public and private investment. It is therefore understood that a country's macroeconomic situation and public policies have a strong impact on the development of the sector, both when services are provided by public bodies and where the provider is a private company.

Considering the Chilean example, the sector shows substantial, sustained development which has coincided with the period of favourable macroeconomic conditions which began following the serious crisis of the early 1980s, and which has continued to the present. Macroeconomic conditions during that period, together with a stable legal and institutional framework, provided a low-risk environment and encouraged participation by foreign investors in local businesses.

This compatibility of macroeconomic and sectoral policies has been reflected in the fact that increases in tariffs – and their readjustment up to self-financing levels under the model of public service provision – have coincided with periods of growth in household incomes and low unemployment. Political and economic stability, an effective and independent regulatory framework and acceptable tariff levels generated incentives and signals which were suitable for sustained high levels of investment based on reasonable profit margins and acceptable levels of corporate borrowing.

Services in the Buenos Aires Metropolitan Area, however, have developed in a framework which is significantly different from that in Chile. In recent decades, Argentina has been characterized by wide fluctuations in economic growth, alternating boom and bust periods, repeated crises, macroeconomic instability and periods of high inflation, including one of hyperinflation.

The volatility of the Argentine economy has been increasing, and has been so severe that extraordinary measures have been necessary. These have often involved modifications to the legal framework, and uncertainty and weak institutions have influenced decisions on investment: delaying them, guiding them towards assets with relatively short pay-off periods or demanding high yields in comparison with international averages to compensate for possible losses resulting from changes in the "rules of the game".

In the macroeconomic context, the problems of poverty and unemployment should be emphasized. Given the characteristics of the services involved, the poor

3 The implications of macroeconomic policies for water resources management in general, and for the provision of drinking water supply and sanitation services in particular, are developed in Solanes and Jouravlev, 2005 and 2006.

are most strongly affected, either because of lack of access to the service or because they are unable to pay. In the former case, they are affected by levels of investment; in the latter, by the existence or otherwise of subsidies, given the need for levels of tariffs which cover the real cost of providing the service. Concerning trends in poverty levels in the past 20 years, Argentina has experienced fluctuations, particularly during the crisis of 2002, whereas in Chile the poverty index has fallen steadily since the late 1980s.

2. Priority given to the sector

The drinking water and sanitation sector is a permanent and prominent item on governments' agendas, being an important part of public policy. The results achieved in most cases, however, suggest that the sector has often been given low priority among government activities, particularly in respect to budget allocations, probably because the governments tend to emphasize solving short-term problems or those which can yield short-term results, postponing the attainment of long-term strategic targets, which are often vague or even non-existent.

Attempts at sectoral reform, through the strengthening of state-owned service providers or private sector participation, have lacked strategic vision in many countries, focusing more on normative and formal issues rather than on effective policy changes in the sector and the vital elements which could bring about the necessary transformation. This has been the case in Argentina and Bolivia, where new institutions which arose in the 1990s, were developed alongside the involvement of private service provision. Specific contracts were established between the responsible public authorities and the service provider on the basis of a legal framework with general guidelines, and the private service provision was unable to satisfy the resulting expectations and became unstable in the face of political changes and complaints from civil society.

On the other hand, the most recent stages of the transformation strategy in Chile and Colombia were based on a specific legal framework with the characteristics of a state policy. In both of these countries, the process was facilitated by a non-federal political and administrative organization. The legal framework and the institutional organization were not directly linked to private sector participation, and initial contents together with subsequent normative approaches set up regulations and procedures which were essentially technical, with a view to creating sustainable and efficient conditions for service provision regardless of whether the private or public sector was involved.

Priority treatment of the sector should take place through an integrated approach that demands recognition of the considerable externalities involved in the provision of drinking water and sanitation services. Decisions on spending and investment in the sector should take due account of the socio-economic costs incurred when those services are in deficit. This, in turn, would mean that the regulation of the sector should contain explicit targets for universal coverage with binding deadlines as well as mechanisms with suitable incentives to ensure that service management is efficient and economically and environmentally sound.

3. Institutional quality

The effectiveness of the legal framework of the sector depends on the bases and the technical consistency of the instruments it comprises. This would not be enough, however, if it is not implemented by a specialized institutional organization which is experienced, stable, capable, independent and objective. Services should be provided by a diligent, efficient and transparent operator. Bearing in mind the considerable economic resources involved in the sector, the achievement of effectiveness in this context requires efficient anti-corruption measures. The sector's performance, therefore, is heavily dependent on institutional quality. Chile and Uruguay, which are well qualified in indicators of perception of corruption and governance, are also noteworthy for their high levels of coverage and quality in drinking water supply and sanitation services.

4. Urbanization

Growing urbanization in the countries of the region, together with rising levels of exclusion and poverty, have made it more difficult to progress towards the targets of universal service coverage and improved quality. As a result, the countries have been faced with growing unmet demands. In most cases, this has delayed yet further the progress towards the agreed targets.

5. Payment culture

Chile has an outstanding payment culture and, since tariffs fully cover the cost of service provision and consumers are billed on the basis of the quantities used, the economic cost of services is properly valued and there are incentives to use them efficiently. In the Buenos Aires Metropolitan Area, however, tariffs do not cover operating costs. Moreover, payment is in the form of a fixed charge and the micro-metering of consumption is not widespread, leading to bad habits of wasteful water use.

Popular recognition that having drinking water and sanitation services available entails monetary costs which must be paid by service users is an important condition for the sustainability of the system and a clear signal to the responsible authorities that they must act in accordance with that behaviour.

C. Endogenous factors

1. Institutional organization

Over the past three decades, the countries of the region have attempted different strategies to overcome failings in the provision of drinking water supply and sanitation services. Consensus has been reached regarding the need for reforms of the institutional structure, which must be based on a clear separation of the following functions:

- The formulation of sector policies at the ministry level or its equivalent
- Regulation, oversight and control assigned to specialized agencies for which it is imperative to guarantee professional and financial capacity, independence and stability
- Provision and management of services performed in accordance with technical criteria, avoiding their politicization.

2. Industrial structure

The existence of economies of scope and scale, and the need to reduce transaction costs, make it necessary for decisions related to the sector's industrial organization to take into account these conditions in order to avoid affecting efficiency through excessive decentralization, as well as to preclude other negative effects, such as the complexity of regulating and controlling an excessive number of providers and a reduction in the possibilities for cross-subsidization between wealthy and poor areas.[4]

3. Property structure

The property structure of the provider, or the degree of participation of the private sector, does not, on its own, guarantee that successful results will be achieved. In the experience of the countries of the region, performance improvements brought about by private participation depended mainly on:

- Stable public policies for the sector, prioritized by the government, with broad political and social consensus
- An effective financing structure, especially in the long term
- Independent, highly qualified institutions
- Sound regulatory practices
- Efficient tariff structures and a subsidy mechanism for low-income groups
- Competitive bidding processes that are properly organized

4 A detailed discussion of these issues is available in Ferro and Lentini, 2010.

- Institutional quality
- A low level of corruption

and, fundamentally:

- Favourable macroeconomic conditions.

Additionally, a gradual sector reform process and respect for the institutional framework help to shield against risk.

The excessive enthusiasm for private participation that characterized the first half of the 1990s has given way to a more realistic view on the part of both governments and investors. Therefore, one can expect that the private participation processes seen from now on will be based on more detailed and specialized studies, on regulatory and institutional frameworks that are adapted to local conditions.

4. Regulatory frameworks

The importance of the public interests involved, especially the impact on the socially vulnerable population, along with the need to mobilize significant economic resources in order to correct deficits and the obligation to use those resources efficiently, make it essential to adopt regulatory frameworks that:

- Anticipate sector issues and conflicts in a technical and specialized manner
- Contain sufficient incentives and signals for regulating and guiding the conduct of intervening parties
- Are sufficiently sound from a legal standpoint.

Regional experience has shown that there are advantages to adopting a regulatory framework on the basis of higher level laws or regulations and, in the case of private sector participation, to define this framework and organizing regulatory, control and oversight agencies prior to the privatization process itself. The experience of Chile in the region gives an example of a country that has followed these guidelines.

5. Tariff policies

As a result of financing problems experienced by the sector in most Latin American countries, gradually and increasingly there is more attention being given to tariff policies (Fernández and others, 2009). The earlier practice of basing sector development almost exclusively on financing through public funding separate from service provision has been abandoned. The current focus is based on a belief in the importance of the tariff levels for the rational use of resources and for self-financing, which are essential requirements if service provision is to be efficient and sustainable. This does not mean that tariff revenue should be the only way to finance service delivery, but rather a means of achieving an appropriate balance between tariff resources and public sector funds, and that the latter should be allocated to investments and subsidies that maximize the social profitability of public spending.

6. Policies for low-income groups

Latin America is a region with high levels of poverty and extreme poverty, and the worst income distribution in the world. Of greatest concern is the fact that in recent years it has virtually not shown any significant signs of positive change. For this reason, the sector policy must contain specific mechanisms for effective subsidies to address this issue. This requirement is even more pressing if tariff adjustments are planned in order to approach self-financing levels, and, additionally, access to services needs to be expanded since in both situations there is a conflict with the low ability to pay of major groups of the population. Here, once again, the Chilean experience is worth noting because a subsidy system has been in place since 1990 to help pay the drinking water and sanitation bills of the low-income population. It is a direct subsidy, financed with national budget resources, and it is granted in a targeted manner through a formal survey, the bases and guidelines of which are established by the national government.

7. Financing policies

One of the main characteristics of the drinking water supply and sanitation industry is that it is very capital intensive. This feature of the sector's assets, along with the size of investments required in most of the region's countries, shows the importance of having an adequate, long-term financing structure in place that will make the sector strategy sustainable.

In this sense, the experience of Chile and of some companies in Brazil has lessons to offer in terms of using the capital market to secure long-term, low-cost financing. The experience of services in Argentina, on the other hand, shows that certain excessive external borrowing practices are best avoided because they carry high risks, especially in very volatile economies with recurring crises and macroeconomic instability.

8. Contractual arrangements and guarantees

One aspect that is extremely important to keep in mind when designing legal frameworks is to avoid granting excessive guarantees in order to attract the participation of private companies. These guarantees, which do not appear as direct expenditures at the time they are taken, can generate significant contingent liabilities further down the road (Solanes and Jouravlev, 2007). Unlike other countries in the region, especially Argentina, the privatization process in Chile did not include deliberate measures on the part of the state to reduce the exchange rate risk for foreign investors, and yet the lack of exchange guarantees did not hinder the incorporation of foreign capital and the development of the sector.

9. International investment protection treaties

In some cases, for example in Argentina, the economic crisis, which was accompanied by a devaluation and financial collapse, aggravated regulatory conflicts and led to contract renegotiations, which, because they were not settled amicably,

ended up as demands in international arbitral tribunals.[5] This experience illustrates the importance of structuring the legal framework to include avenues for local conflict resolution, thus avoiding the need for international arbitration. Furthermore, regulation is better governed by a general legal framework, as opposed to specific contracts, since this provides greater protection to the authority awarding the contract in the case of disputes arising as a result of possible modifications or events affecting the contract's environment.

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Annex 1

Urban drinking water supply and sewerage services in Chile: Determining factors of performance

Soledad Valenzuela and Andrei Jouravlev[6]

The provision of drinking water supply and sewerage services in Santiago, and in the other urban areas in Chile, is of interest for two main reasons:

- The high levels of service coverage, operational efficiency, service quality and complete self-financing (and even profitability, in the sense of contributing to, rather than being financed from, the governmental budget) achieved in the public sector provision of those services
- The scale of investment and the lack of significant regulatory conflict or the ability to settle them quickly and pragmatically under the private service provision model.

The analysis of this case gives rise to various conclusions about what determined the high level of performance and development of drinking water supply and sewerage services in Santiago and the country's other urban areas.

The first and possibly most important conclusion is that the drinking water supply and sanitation sector "is not an island" (and of course neither is any particular service provider, no matter how large and significant). In other words, any problems of service coverage or quality do not originate solely in the sector's institutions (policies, laws, traditions, organization, etc.), nor can they be solved by these institutions alone.

As a result, any analysis of sectoral reforms (successful or otherwise) cannot ignore or be separated from their socio-economic, political and cultural context. One of the implications of this is that public policies cannot be directly transplanted into other realities. Ignoring this has sometimes led to the formulation of oversimplified, uniform and generalized recommendations that turned out to be mainly ideological and even counterproductive. This study therefore analyses factors that are both exogenous and endogenous to the sector, with special emphasis on the impact of macroeconomic policies on patterns of service sustainability and with a long-term vision spanning over several decades.

Factors explaining the success of the reforms include:

- Professional capacity and a vision of national development within the country and the creation of solid institutions with a long-term vision that were able to re-

6 Reprint of Valenzuela, S., and A. Jouravlev (2008). "Urban drinking water supply and sewerage services in Chile: determining factors of performance". Circular of the Network for Cooperation in Integrated Water Resource Management for Sustainable Development in Latin America and the Caribbean, No. 27 (August). Santiago, Chile: Economic Commission for Latin America and the Caribbean. Available from www.cepal.org/drni/noticias/circulares/8/32078/carta27in.pdf.

cruit the best professionals, as well as the high quality of the state apparatus that could take on the implementation of complex public policies (such as regulation and the provision of targeted subsidies) requiring a certain level of confidence in the state on the part of corporate management, investors and the public.

- Government discipline concerning criteria for investing fiscal resources, with an insistence on minimum returns, prioritizing investment based on economic and social evaluations and its contribution to national development, as approval criteria.

- In Chile, governments of various political orientations have always managed this sector responsibly and given it priority, even in terms of allocating funds during periods of crisis. The public authorities have therefore never allowed the situation to deteriorate to the point of needing urgent and radical reforms in response to a deep crisis (as has been the case in several of the region's countries where service providers have become so discredited that a social consensus is generated around the need for far-reaching and radical change). In Chile, the process has been one of long-term improvement, where what is learned in one stage is built upon in the next. This is extremely important, as the experiences of several other countries in the region suggest that the drain of human resources and the general deterioration at the organizational level have a prolonged effect over time. After any such crisis, it takes a long time to recover certain standards of management efficiency.

- In terms of the origin of reforms, rather than an externally promoted process against a backdrop of weak and poor-quality institutions, limited government bargaining power in interactions with third parties (investors, multilateral banks, etc.) and structural problems in state finances, Chile has seen a process of reflection and broad consensus built up at the political level and within the professional sector, which has laid the foundations for its consolidation in the long term.

- As for the pace of reforms, rather than sweeping and radical changes of the "big bang" variety, the strategy has been one of gradual change governed by realistic and pragmatic judgement and a particular concern for ensuring overall coherence and keeping sight of the country's actual capacities. These steps are as follows: to prioritize the state-financed expansion of coverage through an integrated organization which makes use of economies of scale; to improve the efficiency of public providers, which are transformed into corporations subject to the same rules as the private sector; to move over to self-financing charges along with an effective subsidy system for low-income groups; to adopt a regulatory framework and set up the regulatory body; and to use the experience accumulated over all these years to fine-tune the subsidy system and the regulatory framework. Only once all this had been done was the decision made to promote private-sector participation. The original regulatory framework was defined and enhanced using general legislation formulated with a high level of participation of relevant stakeholders, and avoiding the rigid approach of contract-based regulation.

In contrast to the public policies implemented in the overwhelming majority of Latin American countries, where drinking water supply and sanitation services are provided mainly by municipalities as a result of decentralization reforms of the

1980s and 1990s, the central government of Chile began to strengthen its presence in the sector in the 1930s, as part of a process that culminated in the creation of the National Service of Sanitary Works (SENDOS), the Metropolitan Sanitary Works Company (EMOS) and the Valparaiso Sanitary Works Company (ESVAL), which all went on to become corporations organized by administrative region. Chile has thus opted for an industrial structure based on the vertical integration of all stages of service provision, as well as on regional companies covering large geographical areas. In addition to taking advantage of the significant economies of scale and scope that exist in the drinking water supply and sewerage sector, this model has the following advantages:

- Facilitates regulatory and control activities, compared with a system of numerous municipal systems
- Avoids subjecting service provision to a relationship with local governments which in many countries has quite often resulted in the politicization of essentially technical decisions and a misuse of public resources
- Gives clear signals to companies in terms of watershed protection, optimization of water abstraction and water pollution control. Water law has also had a positive effect in this regard by making water allocation more flexible and enabling a relatively smooth reallocation of water rights to urban uses in river basins that are in principle saturated by agricultural use, thereby achieving a more efficient use of scarce water resources

Unlike most other countries in the region, where chronic underfunding of water supply and sanitation services remains a serious ongoing problem, Chile has managed to consolidate a tariff system that not only recovers all the costs of service provision (operation, maintenance, investment, acquisition of water rights), but also generates significant profits for owners, whether private investors or the state. This process has not been completely free of conflict, and has taken over a decade to become fully consolidated. It has been made possible by a combination of factors, some endogenous and some exogenous to the sector. The main endogenous factors include:

- The creation of an effective subsidy system for low-income groups. In Argentina, for instance, when drinking water supply and sewerage services in the Buenos Aires Metropolitan Area were privatized in 1993, the financial policy applied to the concession was initially based on long-term self-financing exclusively through tariffs, with the state rejecting all financial responsibility. It was only in a context of growing economic crisis in January 2001 that the authorities decided to create what was known as the "social tariff" to subsidize demand and put an end to disconnections. In any case, this measure in Argentina has more limited scope and coverage than the subsidy system that has been operating in all urban areas of Chile since the early 1990s.
- A gradual readjustment of tariffs until self-financing was achieved over a transition period lasting several years, with a view to easing the impact of change on the population

- An intelligent and proactive commercial policy on the part of service providers, which not only were firm in applying charges, like supply cuts, and disconnection and reconnection charges, etc., but also adopted various measures to help customers adapt to higher tariffs, e.g. educational campaigns on the true cost of the service and how to rationalize consumption, assistance in applying for subsidies, payment facilities to settle debts, etc.

- Self-financing tariffs were only introduced following an intense efficiency drive in public companies in order to avoid passing on any cost of inefficiency to customers

- The creation of a regulatory system that – although not without shortcomings – avoids an indiscriminate and unjustified rise in tariffs, offers companies incentives to reduce costs and reassures consumers that their interests are being protected.

The most significant exogenous factors are as follows:

- The strong payment culture among the population, thanks to general and sectoral public policies (such as early emphasis on improving collection even with low tariffs)

- The fact that tariff-adjustment coincided with a period of rapid economic growth, major political and social consensus, low unemployment and considerable increases in real wages helped reduce the impact on the population, given that the same process would have been received very differently had the economic situation been worse

Another major factor in sector sustainability that sets the reforms in Chile apart from those undertaken in other countries in the region was the fact that, hand in hand with tariff adjustments towards self-financing, an effective subsidy system using resources from the national budget was introduced to target low-income groups. This measure had the following positive effects on service sustainability patterns:

- It has been possible to significantly raise tariffs without triggering massive opposition among users or generating payment-collection problems, simultaneously protecting the most vulnerable groups

- Unlike in many of the region's countries, where cross-subsidy systems have weakened the finances of service providers, the subsidies in the Chilean system are paid directly by the state to the companies providing the service, so that the latter have the income stability to be able to invest, offer services, recover their investment and make a profit

- Subsidies targeting the lowest income groups made it possible to optimize the use of public funds available for sectoral objectives

It should be borne in mind that it has been possible to implement a targeted demand subsidy thanks not only to the sector's decision makers and the active collaboration of companies and regulators, but also to the following favourable conditions exogenous to the sector:

- Prior existence of a nationwide system that makes it possible to identify and classify low-income groups and target social-welfare programmes accordingly
- Efficient and relatively incorrupt public administration at the central and municipal government levels
- Low levels of poverty and indigence by Latin American standards
- Orderly public finances and an efficient tax system capable of generating sufficient resources, even in times of crisis.

Lastly, the effects of adequate macroeconomic policies have been clearly apparent in the case of Chile. The country's development model is based on macroeconomic balances and exports that make use of comparative advantages. From the mid-1980s, this strategy has generated buoyant export development and considerable economic growth, which have in turn brought down unemployment, poverty and indigence, while significantly improving wages. As the country's macroeconomic balances and realistic exchange rates keep debt under control, the credit systems and interest rates are relatively moderate and do not deter investment. Furthermore, public policies, in addition to promoting an environment favourable to investment, have been changing in pace with social and environmental goals, while sound macroeconomic policies have helped generate the resources needed to achieve them.

Annex 2

Drinking water supply and sewerage services in the city of Buenos Aires, Argentina: Determining factors of sustainability and performance

María Begoña Ordoqui Urcelay[7], ECLAC

The analysis of the experience of providing drinking water supply and sewerage services in the Buenos Aires Metropolitan Area, Argentina, is interesting because it offers lessons for the following two reasons:

- Deficient management of service provision by the state-owned enterprise made it easier to justify the process of sectoral transformation and privatization, which was characterized by its rapid pace and large scale
- The performance of the private company was marked by breaches of contract, constant renegotiations, tariff increases and regulatory disputes, which eventually resulted in termination of the concession contract.

The case is therefore an illustrative example of sustainability problems of drinking water supply and sewerage services, when provided both by public-sector agencies and private companies.

The analysis of the conditions in which the drinking water supply and sewerage services were provided in the metropolitan area of Buenos Aires over the last 25 years makes it possible to identify the main factors that have affected the performance of service providers. The period under consideration covers two models that differ mainly in the ownership of the service providers. Between 1980 and 1992, services were provided by the state-owned enterprise, National Sanitation Works (OSN), while between 1993 and 2005 they were provided by a private company, Aguas Argentinas. The results have not always been the direct responsibility of the service providers, and the aim of the study has been to identify endogenous and exogenous factors that have affected their performance.

In March 2006, the Government of Argentina terminated the contract of Aguas Argentinas and transferred the operation to a state-controlled corporation. This heralded a new phase in how drinking water supply and sewerage services are organized in the metropolitan area of Buenos Aires, and a new regulatory and insti-

7 Reprint of Ordoqui Urcelay, M.B. (2008). "Drinking water supply and sewerage services in the city of Buenos Aires, Argentina: determining factors of sustainability and performance". Circular of the Network for Cooperation in Integrated Water Resource Management for Sustainable Development in Latin America and the Caribbean, No. 28 (November). Santiago, Chile: Economic Commission for Latin America and the Caribbean. Available from www.cepal.org/drni/noticias/circulares/6/33216/carta28in.pdf and Ordoqui Urcelay, M.B. (2009). "Drinking water supply and sewerage services in the city of Buenos Aires, Argentina: determining factors of sustainability and performance". Circular of the Network for Cooperation in Integrated Water Resource Management for Sustainable Development in Latin America and the Caribbean, No. 29 (March). Santiago, Chile: Economic Commission for Latin America and the Caribbean. Available from www.cepal.org/drni/noticias/circulares/2/34862/carta29in.pdf.

tutional framework will be created for that purpose. All those concerned, and particularly the populations of areas with no coverage or low-quality services, hope that the lessons of the past ensure that the problems of providing drinking water supply and sewerage services in the Buenos Aires Metropolitan Area can be solved equitably and efficiently.

This experience should also be examined to extract lessons on improving public policies in countries seeking solutions to deficient services. In this context, the analysis carried out has led to the conclusions and recommendations detailed below. It focuses separately on factors exogenous and endogenous to the drinking water supply and sanitation sector and considers the determining factors of economic, social and environmental unsustainability (and sustainability) of providing services in the metropolitan area of Buenos Aires, in a way that can be applied to other countries of the region.

A. Exogenous factors

As part of the analysis, the following exogenous factors were identified as having an impact on the provision of drinking water supply and sewerage services in the metropolitan area of Buenos Aires:

- The macroeconomic context
- The national investment policy for that sector
- Poverty and ability to pay
- The quality of institutions
- International arbitration
- The change of corporate strategy by the Suez Group.[8]

Exogenous factors are, by their very nature, impossible to control directly, and the actors of the drinking water supply and sanitation sector are passively subjected to the conditions and decisions of the wider context. However, in the areas of policy-making and institutions, as well as in service management and business decisions, it is possible to take preventive measures to mitigate the impact of exogenous factors.

As stated in an ECLAC study[9]:

> "It must be recognized … that many factors which impinge on operations are external to any reasonable definition of the area of direct responsibility of water system management. Nevertheless, the impact of many of these

8 See, for example, in from www.psiru.org/sites/default/files/2003-01-W-Suez.doc

9 ECLAC (1989), *La gestión de los recursos hídricos en América Latina y el Caribe* (Management of water resources in Latin America and the Caribbean). Estudios e Informes de la CEPAL, No. 71, LC/G.1523-P, Santiago, Chile.

> 'external factors' can be mitigated or magnified by management action. Only too commonly, management actions, or the lack thereof, have exacerbated rather than reduced the influence of unfavourable external conditions… While management may be no more responsible for inflation than it is for wet or dry years, it nonetheless does have a responsibility to protect the water system from negative external impacts. All too often, however, water managers remain passive … in the face of the threats posed by external forces to the effective operation of the water systems for which they are responsible… The existence of factors over which water managers have no direct control does not mean that management should be passive towards them. It appears to be true that the managers of water systems are rarely passive in response to the impact of natural events on water systems, although the damage caused is not always repaired. In the same way, management must not be passive in the face of disinterested or short-sighted government policies and decisions."

1. Macroeconomic context, investment policy and poverty

Throughout the period in question, the macroeconomic context did not contribute to the development of services. Recurrent crises, high economic volatility, a lack of economic growth, inflation, financial problems in the public sector and their impact on the social situation of the population were all conditions that had a negative effect both on the behaviour of political authorities and on the population's ability to solve the problem by its own means.

During the public provision of services, repeated rises in inflation meant that, on many occasions, the state used utility tariffs as nominal price anchors, which affected the self-generation of resources. Furthermore, the financial crisis of the state meant that it could not contribute through treasury funds or borrowing. Quite the opposite in fact: as public enterprises (and OSN in particular) were used as a source of external financing, this not only compromised the financial situation of such companies to an even greater extent, but also removed the transparency of their financial accounts. In the case of OSN, this lack of resources was reflected in a low level of maintenance expenses and the delay of works intended to improve levels of quality and coverage.

During the period of private-sector service provision, especially in the first few years, several factors combined to produce significant improvements in the management and results of service delivery. However, a fresh macroeconomic crisis gave rise to new complications in addition to the existing problems of the contract.

In order to overcome the limitations of the macroeconomic context and the policy on investment, the drinking water supply and sanitation sector would have to be made into a real priority (rather than simply declared a priority) within public policy, along with national and provincial legislation to validate the targets to be achieved by the sector. In the past, high-level political and economic authorities could be said to have ignored the impact of their decisions on the sector, and sectoral authorities arguably failed to assess those impacts and were not firm enough to draw attention to the consequences, which required a certain level of independ-

ent judgement. This lesson should be taken into account for changing attitudes in the future.

Obviously, this attitude will not be sufficient if it remains a formality. It is vital for the relevant actions to be backed up by a participatory process with a high level of civil society involvement. This is viable to the extent that there is significant dissemination and awareness-raising for the public and social organizations about how important drinking water supply and sewerage services are in terms of quality of life and a country's economic and social development. If this was validated by the community concerned, the authorities would have to meet the unsatisfied demand. In other words, if and when targeted surveys are carried out in areas of poverty and indigence, and drinking water supply and sewerage services are cited in the top three problems to be solved, they are more likely to be considered as a priority by the authorities and in the public budget.

The effects of poverty and "ability to pay" on service performance are closely linked to the aspects described above. However, one specific way of tackling the problem is through targeted subsidy mechanisms for low-income groups, both to facilitate or guarantee access and to provide help with payment of bills. It would be preferable for the subsidy to be financed with resources from the central government's budget, although the second option could be to use a cross-subsidy awarded in a targeted way by selecting beneficiaries using a specially designed survey.

2. Quality of institutions

In terms of the quality of institutions, one way of mitigating its impact is to implement and improve social oversight systems, on the basis of transparency and the dissemination of performance information on service provision and aspects of service management, including the following: the business plan; any works and their progress; financial results; level and breakdown of borrowing; efficiency of costs and activities; and details of procurement and contracts, like bids, information on tenders and acquisitions, prices and suppliers. It would also be important to include information on the assets of the company's board members and employees linked to management, as well as a sworn declaration on links between directors or employees and suppliers, contractors and subcontractors of the company concerned. All such information should be available online and a summary periodically published in the mass media, i.e. press, radio and television, including reference to more information being available on the relevant website. The system should probably be run by one or more non-governmental organizations selected by public tender based on institutional background, the team responsible for the system, proposed methodology and plan for tasks and equipment.

3. International arbitration and change of corporate strategy by the Suez Group

These exogenous factors, international arbitration and the change of corporate strategy by the Suez Group are linked to the participation of the private sector as a service provider. Although the provision of services in the metropolitan area of Buenos Aires will not immediately be faced with this situation, past experience recommends that the legal framework of the contract should provide for local

dispute settlement bodies, in order to avoid recourse to international arbitration. Furthermore, it is important to point out that regulation governed by a general legal framework, rather than by a specific contract, provides more protection to the concessioning authority in the face of disagreements that arise from changes to the legal framework. In terms of changes in the business strategies of the operating companies, it is essential to create mechanisms to discourage, prevent and penalize opportunistic conduct on the part of private companies seeking to generate conflicts that could result in a termination of the contract.

B. Endogenous factors

The main conclusion that can be drawn from this analysis, as well as from other experiences on both the local and international level, is that problems of efficiency, transparency and infringement of the rights of actual and potential users are largely common to both public and private water utilities. This conclusion leads to the main recommendation which is the need for a specific legal framework to regulate service providers, as well as an institutional set-up that includes a specialized oversight body endowed with a certain degree of independence. The principal objectives of the regulation and control of service provision should be:

- To ensure that the service is socially, environmentally, technically and financially sustainable
- To establish appropriate incentives for efficient service provision, understood as minimization of long-term service costs
- To ensure that efficiency gains are justified in terms of social equity goals, making sure that the savings generated will be passed on to the community through lower tariffs, improved service quality and greater access for populations not covered by the service previously
- To establish incentives and make the service provider and its management accountable for the fulfilment of agreed goals and objectives, in accordance with the principles of due diligence, good faith and the duty of efficiency
- To offer incentives for rational service use.

Within this general framework, it is important to consider those problems and lessons learned for the control and regulation of private, state-owned or mixed water supply and sanitation companies. The problems involved in conducting economic activities under a monopoly are widely recognized in economic theory. Attempts to mitigate these problems through a competitive bidding process designed to attain water tariffs that reflect efficient costs are quickly diluted once the contract is under way and the whole process is reduced to a bilateral relationship with opportunistic behaviour by firms and weaknesses on the part of political and concessioning authorities and regulatory and oversight bodies, when these exist at all.

The "principal–agent" approach focuses on this bilateral relationship, in which the principal delegates the task of service provision to an agent and sets the required objectives and mechanisms, but in a context where the agent is better in-

formed about the business being managed. Here theory and practice coincide: the theory warns of information asymmetries, the possible capture of the principal by the agent and difficulties in creating incentives for efficient service provision; the practice shows that the principal concessioning or regulatory body does indeed lack sufficient information to regulate the service provider's conduct, as well as the institutional capacity and strength to stand up to a large monopoly, and that regulatory instruments are insufficient to induce service providers to conduct themselves in a socially desirable manner.

Interestingly enough, both theory and practice agree that the bilateral relationship of principal–agent and its problems, mainly inefficiency and capture, are also detrimental to users when the agent or water supply and sanitation company is state-owned. The challenge for sectoral public policies, then, is to create *ex ante* mechanisms (regulatory framework) or *ex post*, in the case of a contract or operating licence, to mitigate the problems inherent in a monopolistic market or a principal–agent relationship in which the principal is, usually, in the weaker position. The following are the main recommendations, by topic.

1. Limiting capture of the concessioning authority and the regulator

- Implement a system for user participation and supervision covering all areas of the utility company's management, such as the evaluation of annual reports and opinions on investments or the settlement of complaints
- Ensure that decision making by supervisory bodies is transparent, to avoid their capture by the regulated company to the detriment of users.

2. Implementing and strengthening regulation and supervision

- Specify the types of decision to be taken by regulators, the means and procedures to be used, the information to be requested and the reports to be submitted by the utility company
- Define a precise scheme of penalties for non-compliance, which must be dissuasive in their frequency, impact and magnitude
- Define the capacity of the regulatory body to impose penalties, as a key element in motivating or correcting the conduct of the utility company, limiting its scope for finding administrative loopholes
- Take steps to ensure that the regulatory body's internal organization includes the definition of roles and assessment of specific tasks, providing for the formulation of a long-term strategic plan and the calculation of a budget with secure funding
- Use competitive processes to select management and technical staff, requiring appropriate experience and expertise and establishing responsibilities and roles and a system of remuneration and promotions.

3. Enforcing compliance with the investment plan and guaranteeing access to services for low-income groups

- Prepare a consistent and sustainable development plan for services, with a priority on meeting social needs
- Define *ex ante* the economic and financial structure of the service provision including, where appropriate, return on private capital invested in accordance with the risks assumed, reconciling tariffs levied on low-income groups with their capacity to pay
- In order to achieve universal service coverage in the shortest time possible and avoid disputes arising from the consequent rise in tariffs, the state should be actively involved in the funding of investment plans, either by contributing with budget funds or by assuming long-term loans.
- Put in place mechanisms to protect funds earmarked for investment (whether derived from tariffs or from state contributions), in order to ensure that investment goes ahead as planned; a trust fund may be one good mechanism
- Establish subsidy systems targeting low-income groups, both to expand service coverage and to help pay bills. Although it would be preferable to provide subsidies directly through external contributions, another alternative would be to set up funds using contributions from users with a greater ability to pay. This would then fund cross-subsidies through a focused procedure using a survey structured to minimize inclusion and exclusion errors.

4. Dealing with conflicts over water tariffs and the effects of macroeconomic shocks

- Design a tariff scheme based on micro-metering of consumption, to encourage rational use of water and simplify the billing base. This ensures clarity for users and facilitates control and regulation of the providers' income.
- Determine whether service delivery costs will be recovered partially or in total from tariff income. If only partially, it will be necessary to establish how the necessary funds will be provided and what institutional and financial arrangements will be made to secure the financing to ensure the service's sustainability.
- Define beforehand how service provision risks will be shared between the state and the company, and ensure that such risks are fully reflected in the terms of the contract and in the business's financial structure, providing contractual mitigation and adjustment mechanisms in order to deal rationally and equitably with any contingencies that might disturb the equilibrium. This would avert opportunistic behaviour by either the concessioning authority or the utility company.
- Establish specific regulations on debt levels in order to avoid negative impacts from macroeconomic shocks and opportunistic behaviour by the company in "offsetting" costs, which should be done consistently with the risk allocation set forth in the contract.

5. Improving access to information on service provision

- Define the content and frequency of reports to be submitted by the company: business and investment plans, service provision report and annual inventory, quarterly statements, monthly budget execution and reports prepared for regular tariff reviews
- Set standards for the plan of regulatory accounts to be used by the company, specifying the type of plan, accounts to be included, breakdowns and cost centres to be used, along with instructions for submission, i.e. regulatory accounting
- Create and implement instruments for the regulator to develop its own information, so that it can define a set of efficient costs by which the utility company's behaviour should be guided. These instruments should be developed using an integrated approach incorporating elements of technical design, such as demand, assets and investments, operation of networks and plants, operating costs, process innovation and technological change, and financial considerations, e.g. demand and consumption factors, operating costs and investments, general and industry-specific efficiency indicators, the cost of capital and optimum levels of debt.
- Make arrangements for technical and accounting information provided by the company to be reviewed by certifiers or auditors who should be hired by the concessioning authority or regulator, in order to avoid their capture by the utility.
- Develop benchmarking systems, defining indicators, markets and companies to compare with utilities in Argentina and abroad.

6. Improving the competitiveness, transparency and efficiency of the utility company

- Establish a procurement and contracting regime for technical consultants, inputs and work, defining the types of action to be regulated, sums, procedures, registration of suppliers, bidding conditions, external audits, obligations regarding attendance and information, and proper dissemination
- Impose management efficiency obligations on the company, with penalties for non-compliance, creating mechanisms to transfer the benefits of efficiency gains to users
- Implement regulatory procedures to improve the capacity to impose service delivery efficiency targets and induce companies to meet them
- Without disregarding the benefits of economies of scale, analyse the technical and financial viability of separating metropolitan services by region or function, which could even facilitate participation by other service providers through build, operate and transfer (BOT) contracts, particularly for investments in wastewater treatment plants

- Look at the possibility of opening up the utility's capital to investors, or set this as a goal, with the dual aim of securing voluntary financing for investments and improving the management information system
- Establish a staff remuneration system for the utility company that rewards good performance achievement or results.

Chapter 8:

The role of water technology in development: A case study in Gujarat, India

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Abstract

This article traces the historical water problem in Gujarat for both drinking and irrigation that has affected the development of the State, caused regional imbalances and increased incidence of rural poverty. Technological initiatives such as a 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.

Keywords:
Water technology
Water infrastructure
Water supply
Governance
Water in agriculture

A. Background of water problem in Gujarat

Gujarat has just 2.28 per cent of India's water resources and 6.39 per cent of the country's geographical area. This is again constrained by imbalances in intra-state distribution. The State has an average annual rainfall of 80 cm^3 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 per cent of the State's surface water resources are concentrated in central and southern Gujarat, whereas the remaining three-quarters of the State has only 20 per cent. On average, three years in a cycle of 10 have been drought years. Since Indian independence in 1947, the drought 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 (Gupta, 2004).

Before 2001 drinking water scarcity had posed a serious threat to the human and cattle population in Gujarat. Successive governments had to spend billions of rupees on temporary measures to supply drinking water by road tankers and sometimes even by special water trains. The State, which generally had a track record of peace and a harmonious social ethos, even witnessed "water riots" due to severe water scarcity compounded by poor water resources management.

Over extraction of groundwater (as compared with annual recharge) has caused serious water quality problems due to excessive fluoride, nitrate and salinity. The number of fluoride-affected habitations increased from 2,826 in 1992 to 4,187 by 2003. The fluoride concentration in these villages ranged from 1.5 mg/litre to as high as 18.9 mg/litre. Fluoride has been the cause of extensive health damage in many parts of Gujarat. Dental fluorosis causes permanent pigmentation of teeth in children and bone deformities are caused by skeletal fluorosis even in adults. Other serious problems experienced as a result of high concentrations of fluoride include anaemia, loss of appetite, nausea and thyroid malfunction, which sometimes results in brain impairment of children and an adverse impact on the foetus, in some cases causing abortion or stillbirth in expectant mothers.

The water problems have also led to intra-state migration from drought-prone regions such as Saurashtra and Kutch (western and south-western Gujarat) to the central and southern regions of the State. Often, this migration occurred alongside the movement of the livestock population and also caused a shift in the primary workforce of hundreds of thousands of people, dislocating them economically, socially and culturally. Therefore, the regional imbalances in Gujarat have been accentuated because of increasing water scarcity (Gupta, 2003).

Historically, most of the drinking water supply was based on groundwater from deep tube wells; high-capacity pumping machinery was utilized in the State, leading to tremendous electricity consumption and a high carbon footprint for water supply.

B. 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 such as elevated storage reservoirs with a total capacity of 1,164 million litres and 10,683 storage sumps and high-level reservoirs with a capacity of 2,504.8 million litres have also been constructed in the State. Along with this, 151 water filtration and treatment plants with a total capacity of 2,750 million litres per day (MLD) have been constructed. About 2,250 MLD of treated water is delivered to more than 10,501 villages and 127 towns in the State, ensuring safe and reliable water supply to about 65 per cent of the State's population in drought-prone and water quality-affected areas through the water supply grid.

C. Impacts

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

1. Reduction in fluoride

All these efforts have resulted in considerable relief from the problem of excessive fluoride contamination. According to a recent survey (table 1), only 987 habitations have been found to be affected and the range of fluoride content has also shrunk considerably.

Table 1: Status of fluoride-affected habitations

District	Total number of habitations	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

2. Reduced expenditure

This has also resulted in a sharp decline in expenditure on tanker water supply in the State from 2003/04 onwards (table 2), which is another indicator of creation of water security in the State.

Table 2: Annual expenditure on tanker supply, 1990 to 2009

Year	Number of villages	Cost (Rs. millions)[a]
1990–1991	896	23.40
1991–1992	1943	92.90
1992–1993	700	14.00
1993–1994	1803	83.00
1994–1995	724	24.96
1995–1996	1619	96.30
1996–1997	1642	123.95
1997–1998	1447	62.19
1998–1999	1215	41.02
1999–2000	2987	346.20
2000–2001	4054	436.94
2001–2002	2959	348.11
2002–2003	3961	475.36
Subtotal		**2168.06**
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
Subtotal		261.95
Total		**2430.01**

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

3. Reduction in carbon footprint in water supply

In several villages, the tube wells are now utilized as a dual source and the operational hours have been reduced. Based on a random survey, it has been observed that a significant saving has been achieved in electricity consumption which is now available for alternative uses, proving to be an eco-friendly achievement. Solar pumps have also been commissioned in 260 villages in the State and about 200 more solar pumping systems will be installed in the near future. In various parts of the State, including coastal and tribal areas, rooftop rainwater harvesting structures have been installed in public buildings, schools and individual households, which is resulting in substantial electricity savings. Comprehensive energy audits for various group water supply schemes have also resulted in energy savings (table 3).

Table 3: Emission savings in drinking water supply

Sr. No.	Particulars	Energy saving (MWh per annum)	Equivalent carbon dioxide emission (tons per annum)
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 rainwater harvesting	386.74	86.24
	Total	**72 087.68**	**16 076.14**

Source: Gujarat Water Supply and Sewerage Board, 2009

4. Paradigm shift

With a paradigm shift from dependence on drinking water supply by tankers, trains and deep tube wells to safe surface water, much of the fluoride-affected habitations have been covered by piped water supply.

Technological interventions, such as 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 with 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.

D. New water governance model

The creation of the Water and Sanitation Management Organisation (WASMO) was a significant shift in the role of governance from provider to facilitator by empowering village-level institutions through extensive capacity-building and proactive facilitation. Since its inception, WASMO has been able to bring in effective citizens' engagement through its innovative governance model for facilitating the successful community-led water supply programme throughout the State of Gujarat. Now more than 16,740 Village Water and Sanitation Committees have been formed in the State that are ready to take on the responsibility for management of service delivery and water resources management at the decentralized level. More than 6,500 villages have already commissioned the 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 the community being fully empowered to take ownership of their water service delivery wherein operation and maintenance is done through a tariff mechanism devised by consensus in the village assembly. It has also been able to institutionalize the rural water quality monitoring and surveillance programme. The majority of villages are now able to monitor their water quality teams which are duly trained. WASMO's innovation in Gujarat has emerged as a model for learning and exchange, influencing policy initiatives in the water sector at the country level. WASMO has also been given the United Nations Public Service Award in the category of fostering participation in policymaking decisions through innovative mechanisms (Modi, 2010).

1. Inter-basin water transfer through the Sardar Sarovar Project

The Sardar Sarovar Project on the River Narmada is a multi-state, multi-purpose river valley project, borne out of deliberations of a constitutional body, following the principles of "equality of right" and "equitable utilization" of the whole course of an interstate river. This unique project is planned to irrigate 1.905 million ha of land, increase agricultural production by 8.7 million tons per annum (worth US$430 million), generate environmentally friendly hydropower with installed capacity of 1,450 MW, supply drinking water to 8,215 villages and 135 urban centres of Gujarat (around 20 million population), generate 1 million jobs – mostly in rural areas, and prevent rapid processes of desertification, salinity ingress and rural-to-urban migration being experienced in many parts of Gujarat. The command area and drinking water supply areas of the project are exactly the worst water scarcity-hit areas of the State (Gupta, 2003).

Table 4. Sardar Sarovar dam height and storage increase in Sardar Sarovar Project

Stage	2003	2004	2006	Ultimate
Height (m)	100	110.64	121.92	183.68
Gross storage (millions m^3)	2,602.6 (3.00MAF)	3,700 (3.00 MAF)	5,265.8 (4.27 MAF)	9,460 (7.7 MAF)
Live (usable) storage (millions m^3)	—	—	1,565.8 (1.27 MAF)	5,800 (4.77 MAF)

Source: Sardar Sarovar Narmada Nigam Limited, 2009
Abbreviations: MAF = million acre feet

2. Increased dam height and storage

With a concerted strategy and satisfactory compliance with 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 (table 4). 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 which were awaited for almost 15 years have now started flowing. Diversion of Narmada water to the main canal of the project (world's largest lined irrigation canal) was just 705 million cubic metres (MCM) in 2001, but it spectacularly increased to 5,195 in 2003 and to 6,194 MCM in 2004. Although the water flow decreased in subsequent years because of consecutive good 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 2008 and water supply to the neighbouring State, Rajasthan, began in March 2008, fulfilling the real objective of this project as an interstate river project.

What's more, with the command area covering around 500,000 ha, significant interlinking has been achieved in many rivers by the interbasin transfer of Narmada waters using the Sardar Sarovar Canal Network.

3. Hydropower

Another outstanding issue was that of operationalizing the 250 MW Canal Head Power House (for want of required water head in the reservoir). This power house started operating in August 2004, and thereafter a river bed power house of 1,200 MW capacity was also put into operation in a phased manner starting from February 2005 to June 2006. The hydropower generation that commenced in Sardar Sarovar Project in August 2004 has resulted in the generation of 15,070 million kWh of electricity to March 2010.

E. Micro water harvesting

The miseries of millions of small and marginal farmers caused by the vagaries of nature and difficult terrain have been reduced through rainwater harvesting by micro-irrigation structures implemented through people's participation.

1. Sardar Patel Participatory Conservation Project (SPPWCP)

This scheme stipulated that check dams, village tanks or ponds could be taken up for construction by a beneficiary group or any non-governmental organization (NGO) with technical and financial assistance from the District Panchayat (local representative body). They were initially required to contribute 40 per cent of the estimated costs (later reduced to 10 per cent) and the rest was to be funded by the government depending upon the progress of the work. In 2007 they were also given the option of contributing their 10 per cent by way of physical labour and, therefore, increasing their sense of belonging to 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 to their own design if necessary and feasible. The technical scrutiny and work supervision would be done by the engineers of the local body. The entire responsibility for the quality of construction, however, would 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 would be carried out by the beneficiary group at their own expense. A total of 353,937 check dams and village ponds or tanks have been created in the last eight years providing direct benefit to over 13 million people in rural Gujarat.

F. Drip irrigation: Gujarat Green Revolution Company Limited

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 per cent of the cost initially; GGRC provides a 50 per cent subsidy and helps arrange a loan for the balance of 45 per cent. Around 100,000 ha are covered by drip irrigation, and most of these have been moved to high-value crops (Gulati, Shah and Shreedhar, 2009). It has been estimated that around 74.1 million kWh of energy has been saved in just one year through the adoption of drip irrigation by Gujarat Green Revolution Company – a body specially created for the purpose.

G. Jyotigram Scheme (technological initiative in the power sector for irrigation needs)

Like elsewhere in India, unreliable farm power supply in Gujarat had been anathema for farmers as well as rural society as a whole. Uncontrolled farm power subsidies led to unsustainable increases in groundwater 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 tube well owners while providing 24 hours of 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 metering of tube wells 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 tube wells. 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. Jyotigram'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 2002–2006 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; that is, continuous and full voltage power especially for agriculture at predictable timings for villages across Gujarat. By 2007/08, all the 18,066 villages were covered under JGS. With this, Gujarat has become the first State in the country where villages get three-phase power supply 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 also happy that they were spared the very high repair and maintenance cost that the 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. Groundwater and power rationing through the Jyotigram scheme not only increased efficiency of water and power utilization for agriculture, but also freed up these resources for the rural non-farm economy to grow.

Greater access to water not only had a land augmenting effect, but also allowed for multi-cropping and growth of high value fruits and vegetables such as mango and banana (that require much water). More water has also been made available for livestock, animal husbandry and fisheries, which are significant sectors in Gujarat's economy.

H. Impacts

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

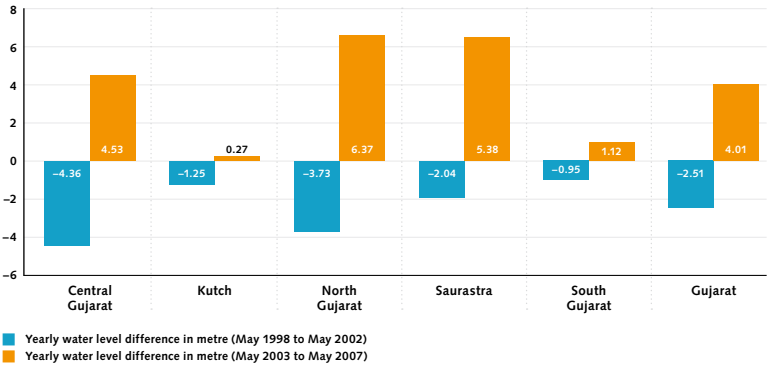
1. Greening of other rivers

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 improved dramatically over the last few years. In addition to minor rivers, around 700 village tanks have also been filled up with Narmada water as part of drought management measures, which has substantially improved the water availability for irrigation purpose in these villages.

2. Increasing water tables

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

Figure 1: Ground water level fall/rise (Metres)



Source: Narmada, Water Resources, Water Supply and Kalpsar Department, 2009

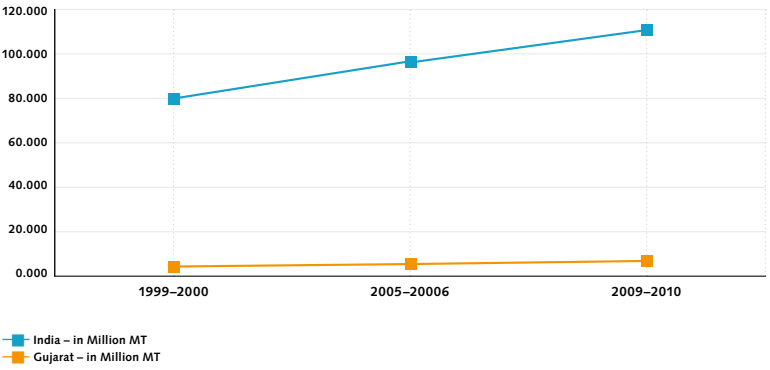
3. Boost to rural economy

Myriads of micro water harvesting structures dotting the landscape of Gujarat have led to a reduction in soil moisture evaporation in the surrounding agricultural fields and have facilitated the creation of orchards in places which barely used to produce

single rain fed crops. Employment opportunities have been created for local residents, agricultural production has been enhanced, leading to a rise in household incomes. The living standards and the average productivity of dairy cattle has also gone up owing to year-round availability of fodder.

The average annual growth rate of milk production in the State during the last decade has been recorded as 6.83 per cent whereas that of the entire country was 4.38 per cent (figure 2).

Figure 2: Comparative growth of milk production,1999–2009



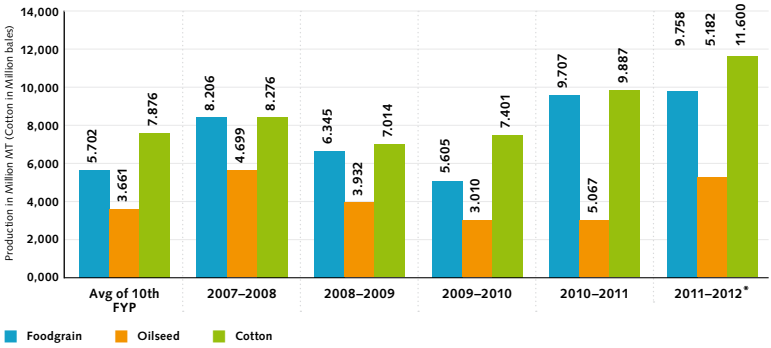
Source: Directorate of Animal Husbandry, 2010
Abbreviations: MT = million tonnes

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

4. Outstanding performance in agriculture

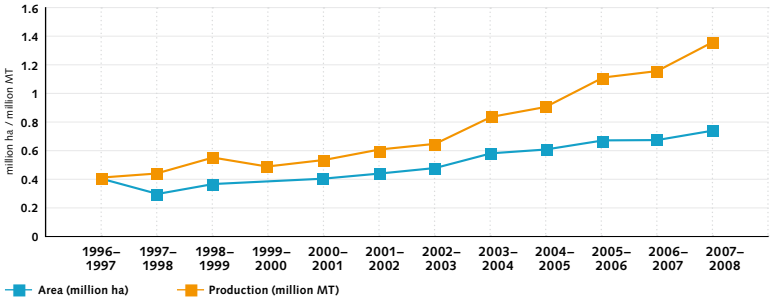
The cumulative effect of all these innovative technological and participatory water management initiatives has been an increase in productivity of the major crops of the State, despite the 0.1° to 0.9° C average increase in temperatures recorded at various locations during the last couple of years. Compared with other states in India, Gujarat is an outstanding performer in agriculture, growing at the rate of 9.6 per cent per annum. Though there is high volatility in agricultural growth rates for almost all states in India, Gujarat's agricultural growth rate is more than three times that for all of India. The International Food Policy Research Institute, in a 2009 document, has specially commended Gujarat's recent growth in cotton, fruits and vegetables, and wheat production (figures 3, 4 and 5).

Figure 3: Agricultural production scenario



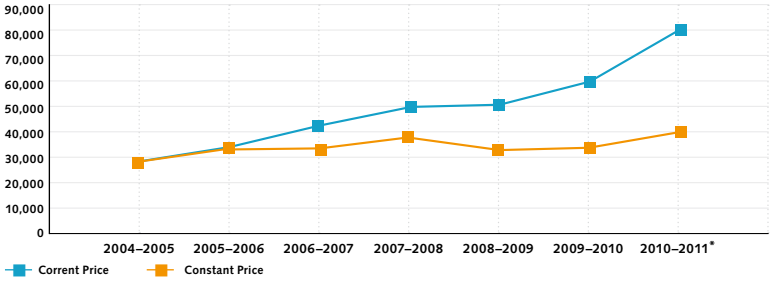
Source: Agriculture and Cooperation Department, 2011 **Note: Data for 2011–12 is provisional*

Figure 4: Area and production of total fruits and vegetables in Gujarat by area and production (Area in million ha, production in million tonnes)



Source: Directorate of Horticulture, 2011

Figure 5: Growth in agricultural income (Millions Rs)



Source: Agriculture and Cooperation Department, 2011 **Note: Data for 2010–11 proposed*

I. Conclusion

The most important lesson that emerges from the foregoing discussion is that technological initiatives to improve the drinking and irrigation water supply have to be complemented by grass-roots participation in management of water distribution. The decentralized, community-managed water supply programme in Gujarat has proved to be an exemplary model for the entire country. Another very significant fact is the balanced importance given to both micro water harvesting and large water resources development projects which has led to unprecedented agricultural growth in the State. Increased availability of water and reduction in consumption of conventional power has also led to a reduction in the carbon footprint of water supply and has promoted further development of a low carbon economy in the State.

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Chapter 9:

Eco-Tanks for Asian Cities: Lessons learned in sustainable transfer of green technologies for localized capacity-building

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Abstract

In recognition of the urgent need for greater awareness and action on sanitation, the United Nations General Assembly declared 2008 as the International Year of Sanitation. [1] In accordance with the declaration, in 2008, UNITAR began formulating a pilot project to research how an enabling environment is practically created for the transfer of greener technologies, in this case focusing on improving local wastewater management and sanitation through decentralized wastewater treatment. The UNITAR project took place in partnership with CITYNET and other stakeholders from 2008 to 2011 with the objective of researching the sustainable transfer of Ecological technologies for wastewater treatment or ecological sanitation (Eco-San) to three different communities in Sri Lanka, Indonesia and the Philippines.

The project showed that once Eco-Tank technology was transferred successfully, local governments, such as San Fernando, manifested their willingness to replicate the project and procure Eco-Tanks for other city locations. As the process for procuring, installing and maintaining Eco-Tanks or similar technologies becomes more commonplace for these and neighboring cities, the possibility of acquiring new and innovative green technologies will ensure developing country cities can make informed and concrete steps towards becoming greener cities. The case study herein outlines the project's findings and lessons learned in working with local governments for green technology transfer.

[1] International Year of Sanitation, 2008. Online at: http://esa.un.org/iys/

Keywords
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A. Introduction

Today, 2.5 billion people still lack improved sanitation. The March 2012 United Nations Report, Progress on Drinking Water and Sanitation, showed that the world is still far from meeting the Millennium Development Goal target for sanitation and is unlikely to meet it by 2015 (WHO/UNICEF Joint Monitoring Programme, 2012). The same report conveys a stark outlook for many communities across the developing world where only 63 per cent of the world population has access to improved sanitation, a figure projected to increase to just 67 per cent by 2015.

In parallel to this need to fulfil the human right to water and sanitation in developing countries, the international community is also pushing for a greener development paradigm. The United Nations recently published its system-wide perspective on what characterizes a "Green Economy" at the operational level. In this practical context, the publication defines a Green Economy as "one whose growth in income and employment is driven by investments that: reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the lost of biodiversity and ecosystem services" (United Nations Environment Management Group, 2011b). By this more practical concept then, to achieve a Green Economy, communities must ensure their investments in human capital, or soft technology, and hard technologies are oriented along low-carbon and eco-efficiency principles.

Eco-efficient processes and technologies do more with less negative impact than traditional technologies and are, by default, low carbon. As defined by the World Business Council for Sustainable Development (WBCSD), eco-efficiency is essentially a management philosophy "achieved by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle" (World Business Council for Sustainable Development, 2000).

While countries are now beginning to develop Green Economy road maps in accordance with the tenets that govern eco-efficiency at the national level, practical application of these requires a localized and community-driven approach. These "investments" and advancements towards eco-efficiency are, as an end-game, implemented and sustained at the local level. Equally, the progress made towards a national Green Economy can most easily be measured by how extensively new green technologies, services and practices are executed locally (at the state, municipal or even town levels), to ensure that there is observable bottom-up change towards a greener model overall.

Under the framework of the 2008 International Year of Sanitation and as an outcome of a training workshop on sanitation for local governments, the United Nations Institute for Training and Research (UNITAR) applied Agenda 21 and other frameworks within a technology transfer project between Asian cities, utilizing the technological expertise from a regional private enterprise. The UNITAR project took place in partnership with CITYNET and other stakeholders from 2008 to 2011 with the objective of researching the sustainable transfer of ecological technologies for wastewater treatment or ecological sanitation (Eco-San) to three different communities in Sri Lanka, Indonesia and the Philippines. The project showed that once Eco-Tank technology* was transferred successfully, local governments, such as San Fernando, manifested their willingness to replicate the project and procure Eco-Tanks for other city locations. As the process for procuring, installing and maintaining Eco-Tanks or similar technologies becomes more commonplace for these and neighbouring cities, the possibility of acquiring new and innovative green technologies will ensure developing country cities can make informed and concrete steps towards becoming greener cities. Based on project documents from UNITAR and CITYNET, the case study herein outlines the project's findings and lessons learned in developing a practical checklist for local green technology transfer in developing country communities.

B. Transferring eco-efficiency and the challenge of "greening" developing countries

After enjoying a high-polluting and high-energy consumption stage, developed countries are now entering a less-polluting production-consumption stage thanks to the growing awareness, application and use of cleaner or "eco-efficient" technologies, resulting in a green paradigm shift (box 1). Yet, in this new stage developed countries still face other challenges (e.g. chemical waste management, threats to ecosystems and unsustainable growth).

Box 1: Environmentally sound technologies

The United Nations Environment Programme defines environmentally sound technologies (EST) as "technologies that have the potential for significantly improved environmental performance, relative to other technologies, and specifically i) protect the environment, ii) are less polluting, iii) use resources in a sustainable manner, iv) recycle more of their wastes and products and v) handle all residual wastes in a more environmentally acceptable way than the technologies for which they are substitutes".

Source: International Environmental Technology Centre, United Nations Environment Programme (2003)

Developing and/or emerging economies still rely, to a large degree, on heavy industries for their economic growth. This is further compounded by the absence of accessible eco-efficient or "environmentally sound" technologies for mainstream use in communities across developing countries. Clearly, these same supply constraints, coupled with the global push for a green paradigm shift, inversely create a higher and more urgent demand for both high- and low-tech eco-efficient technologies to be made available for use in developing countries.

A ground-breaking study released in January 2011 by the United Nations Economic Commission for Africa (UNECA) tracks flows of North-South investment and knowledge, looking specifically at technology transfer trends. The study stresses the need to prioritize technology development and transfer through four core areas, including the promotion of university-industry-government partnerships, where existing research centres can be used to acquire, adapt and diffuse new technologies and emerging green solutions to a wider user-base, thereby attaining greater economies of scale.

In spite of such suggestions, greener technologies, such as eco-efficient transport, eco-sanitation technologies or low-carbon fuels, continue to be viewed as expensive and inaccessible technologies by low-income populations. However, in recent years countries such as Brazil and Costa Rica among others have pioneered a low-carbon growth agenda at the national level.[1] Many of today's most innovative low-tech, low-cost and eco-efficient technologies are being generated in emerging economies, enabling leapfrogging towards greener growth. There is considerable market potential for greater South–South/North–South technology transfer and foreign direct investment (FDI) as these green infant industries evolve, achieve economies of scale and become more cost-efficient. Equally, for low-income communities, with the leadership of local governments, private sector and other actors, accessing these more eco-efficient technologies can also become a reality.

1 Since 2008, under the leadership of then President Oscar Arias, Costa Rica became the first nation to pledge carbon neutrality by 2021, spurring a top-down generation of policy, financing, an entrepreneurial test bed and various incentives to go low carbon and carbon neutral. See www.npr.org/player/v2/mediaPlayer.html?action=1&t=1&islist=false&id=19141333&m=19141278

To fully integrate this green growth agenda within current government planning models and policies, it is of the utmost importance to decentralize green growth knowledge and practices, by providing local governments and local private sector with the know-how and access to new technologies. Communities across emerging markets are already seeking, adopting and even hosting indigenous, imported and innovative green solutions to improve urban services. These green solutions will need to achieve a critical mass if a global low-carbon and resource-efficient future is to be sustainably secured among emerging markets, however.

For decades now, the focus has been placed on the need for an enabling environment, including building knowledge, skills and capacities for sustainable technology transfer. The 1992 United Nations Earth Summit Programme of Action is commonly known as Agenda 21. Agenda 21's Chapter 34 specifically focuses on the "Transfer of environmentally sound technology, cooperation, & capacity-building stating that there is a need for favorable access to and transfer of environmentally sound technologies" through a focus on "building up economic, technical, and managerial capabilities for the efficient use and further development of transferred technology," and "systematic training and capacity-building at all levels". The chapter provides a comprehensive definition of the enabling environment for sustainable technology transfer, with a focus on ensuring ESTs are accessible, appropriate, affordable and eventually sustainable (United Nations, 1992). In 2003, UNEP published a series of papers, including one report encompassing Chapter 34 of Agenda 21 into a more comprehensive guideline for technology transfer called the Seven "C"s (see box 2). The Seven "C"s guidelines take the concept of technology transfer into a more practical approach, that also proposes focusing on the technology transfer process through a more contextualized or "community specific" approach.

Recently, multilateral environmental agreements have also developed provisions for stimulating and guiding sustainable green technology transfer. The UN Framework Convention on Climate Change (UNFCCC) now promotes the transfer of renewable and clean energy technologies from developed to developing countries through the Clean Development Mechanism and established a Technology Mechanism under the Convention "to enhance endogenous capacities and technologies of developing countries" and ensure the diffusion of "environmentally sound technologies and know-how to developing countries" (United Nations Environment Management Group, 2011a). The World Trade Organization has equally echoed similar diffusion and transfer of technologies from developed country governments and companies to least developed country counterparts. UNCTAD notes in its 2012 Technology and Innovation Report (for energy) that "accumulation of technological know-how and learning capabilities is not an automatic process. Learning accompanies the acquisition of production and industrial equipment, including how to use and adapt it to local conditions" (United Nations Conference on Trade and Development, 2011). While the transfer of green technologies often focuses on basic services, such as energy, other basic services, such as sanitation and water, are equally in need of similar attention. In short, local public and private stakeholders alike need knowledge of green technologies across sectors – it is not enough to centralize Green Economy knowledge and planning at national levels.

Box 2: UNEP Seven "C"s guidelines for technology transfer

In 2003, the United Nations Environment Programme (UNEP) published a framework report building on the Agenda 21 approach to technology transfer, promoting various methodologies, tools and guidelines following the "Seven 'C's" for sustainable technology transfer. The paper is targeted to high level and national stakeholders, highlighting that national governments are charged with setting the enabling framework for technology transfer. It also emphasizes that "there is no ubiquitous approach to enhancing technology transfer – the suite of measures for addressing barriers, and facilitating successful technology transfer, is typically community specific".

The Seven "C"s framework rests on the following concepts:

1. Context: Recipients and users choose an environmentally sound, economically viable and socially acceptable technology that is compatible with the national sustainable development agenda, local needs, culture and capacities
2. Challenges: Barriers to successful technology transfers are context-specific, but can generally include shortfalls in technology creation, innovation and sourcing, underdeveloped enabling environments and lack of verified information. Small and medium enterprises are affected
3. Choice: Decision-support tools that facilitate informed choice and provide several technology alternatives that characterize environmental and economic performance and potential social impact
4. Certainty: Removing barriers and decreasing risks for key stakeholders and reducing uncertainties that may affect investment. Certainty is increased by ensuring macroeconomic policies maximize potential for technology transfer and protect property rights
5. Communication: Effective two-way communication and cooperation between key stakeholders is essential. It allows synergizing contributions made by diverse players (from formal and informal networks) to the processes of technology transfer
6. Capacity: Key players, within the public and private sectors and in civil society, must possess adequate skills to perform tasks assigned to them. Innovation must be encouraged and markets must support ESTs. Legal systems must also be strengthened
7. Commitment: Commit to overcoming challenges and furthering capacity for technology transfer. Monitor and evaluate policies that affect the enabling environment, and develop a strategic framework to promote the adoption and use of ESTs.

In the framework of this case study, UNITAR also suggests that the framework include an eighth term: "Collateral". Collateral refers to assets required for financing the actual technology transfer process, including acquisition of technologies, to ensure long-term local market viability, access and overall sustainability of the EST.

Source: International Environmental Technology Centre, United Nations Environment Programme (2003)

C. Transferring technology for improved sanitation in Asian communities: UNITAR's city-to-city cooperation projects for Eco-San

In Asia, one such key opportunity to apply Agenda 21 or UNFCCC provisions is by addressing the gap in sanitation services and investing in the transfer of sanitation technologies that are environmentally sound, while delivering much needed sanitation services for communities (eco-efficient sanitation technologies). Sanitation is generally defined as the provision of facilities and services for the safe disposal of human excreta, and also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2010).

World Health Organization (WHO) has reported that inadequate sanitation is a major cause of disease worldwide and improving sanitation is known to have a significant beneficial impact on health, both in households and across communities. "Globally, an estimated 2.6 billion people lack access to adequate sanitation …Rapid urbanization and population growth, expansion of piped water services, and increased per capita water use all lead to greater volumes of wastewater discharge. Untreated, this discharge can harm biodiversity in rivers, pollute lakes and coastal waters, and affect public health" (World Bank, 2012). The urgency for better sanitation certainly ranks high for cities and local governments, especially in developing countries. The disparity in access between North and South is clear, and an even wider gap exists between urban and rural or low-income communities within developing countries.

According to a 2008 World Bank study on the economic impacts of sanitation in South-East Asia, "Cambodia, Indonesia, The Philippines, and Vietnam lose an estimated US$9 billion a year due to of poor sanitation …The associated economic costs of polluted water attributed to poor sanitation exceed US$2.3 billion per year" (World Bank, 2008). The study denotes, like many others, that poor sanitation access, hygiene and infrastructure cause at least 180 million disease episodes and 100,000 premature deaths annually, while significantly contributing to water pollution. The economic cost of this, especially on quality of life, productivity and local economic outputs across low-income communities hardest hit by the effects of poor sanitation is surely an impetus for improving local infrastructure and access through the acquisition of new technologies.

In recognition of the urgent need for greater awareness and action on sanitation, the United Nations General Assembly declared 2008 as the International Year of Sanitation (United Nations, 2007). In accordance with the declaration, UNITAR then began formulating a pilot project to research how an enabling environment is practically created for the transfer of greener technologies, in this case focusing on improving local wastewater management and sanitation through decentralized wastewater treatment. Decentralized wastewater treatment can have enormous potential in contributing to the development of environmentally sustainable sanitation services and water quality in developing country communities, in line with the Bellagio Principles (EAWAG Aquatic Research, 2010). UNITAR worked in partnership with several stakeholders to research the sustainable transfer of ecological technologies for wastewater treatment to three different communities in Indonesia, Sri Lanka and the Philippines.

In the case of the UNITAR project, the three beneficiary cities were all non-capital cities meeting a series of selection criteria and participation requirements for the project. Palembang, Indonesia, has the highest population, with about 1.5 million inhabitants and data also commonly shows that Indonesia, given its population size, is the worst-ranked nation in sanitation access among the three project countries. Negombo, Sri Lanka, and San Fernando, Philippines, have no more than 160,000 inhabitants each and, in the case of San Fernando, there were various successful pre-existing experiences in working with improved sanitation technologies.

Negombo is approximately 37 km north of Colombo, Sri Lanka. The 100 km long canal network running through the town is still used, and outrigger canoes and modern water-craft use this route daily for trade and tourism purposes. Currently, the city's population is estimated at 160,000, 20 per cent of which are from the fishing and low-income communities. Likewise, there is an increasing number in settlements from remote areas, mostly located in the urban fringe, causing the sprawl of illegal settlements and traffic congestion in the city. The city targeted the city Fish Market, the Monocogama Housing Project Site, which caters for about a hundred low-income families, and a planned new public bus terminal as ideal sites for Eco-Tank installation. The projected amount of daily users would be an estimated 700 people.

As the capital of South Sumatra Province, Palembang has 1.5 million inhabitants. Its territorial area is 400.61 km^2 distributed into 14 sub-district territories. Palembang is divided into two by the Musi River, which is also known as the Palembang River. This stream forms the heart of the city and is a major transport waterway including the small creeks especially on the Ulu side (upstream). The creeks are only navigable at high tide; as the river ebbs they are dry. Owing to its orientation towards the river, the city has an elongated profile along both sides and does not stretch far inland. The riverbanks of the Musi used to be home to moored raft-dwellings, called rakit (in the local language), some of which served as vendors. These are widely recognized as slum areas and were targeted, along with one public housing complex, for Eco-Tank installation. At the moment, these are mainly found upstream from the main city centre. The houses along the banks face the water and are built on piles, as the Musi is a tidal river, which means that the banks are covered with water at regular intervals.

The City of San Fernando is situated in the mountainous area at almost the mid-section of La Union province along the Philippines' China Sea coast. The City of San Fernando is the seat of national government agencies in Region I and centre of trade, commerce, financial and educational institutions, among others. With a population of 115,000, the city currently does not have a wastewater treatment plant and wastewater is directly released into the nearby rivers, ponds or coastal areas. Septic tanks are common in many places and the city has taken the initiative to improve its sanitation using eco-san toilets in some areas. Two low-income riverside slums were initially targeted as sites for the Eco-Tank project. These low-income riverside communities discharged wastewater directly into the San Fernando City River.

Along with Agenda 21 recommendations, the project also integrated the UNEP Seven "C"s Framework, as stated above, conducting a variety of pre-project feasibility studies, baseline research, study visits to Bangkok, Thailand, for the beneficiary cities and other measures to maximize the sustainability of the technology through a community-specific approach. The following section details the actual implementation phases and final outcomes from the project.

D. UNITAR and CITYNET's Eco-Tank Project for Negombo, Palembang and San Fernando

Although the Asia-Pacific region is contributing to poverty reduction, it is still home to more than 504 million slum dwellers. The State of Asian Cities 2010/11 notes that: "Over the coming decade, two-thirds of demographic expansion in the world's cities will take place in Asia, which is already home to 50 per cent of the global urban population" (United Nations Human Settlements Programme and United Nations Economic and Social Commission for Asia and the Pacific, 2010).

There are a series of key dynamics confronting local authorities in developing countries today: increasing decentralization and growing urbanization, now coupled with pressures for greener growth. A transversal theme that can address the

challenges is the strengthening of governance through effective capacity development for local authorities and local actors.

Based on identified capacity gaps, UNITAR's local development activities integrate innovative training methodologies, develop contextualized learning content and deliver training to enhance the capacity of local actors for a measurable impact on sustainable urban development. The vision is that "Every local actor has the knowledge, skills, and capabilities to effectively plan, finance, implement and manage urban services, while leveraging local expertise to achieve the MDGs and sustainable development at local level." UNITAR's local development activities target local actors (public and private sectors and civil society) with a goal of multi-stakeholder cooperation and city-to-city exchange. Capacity-building is carried out through four key methodologies: e-learning courses, short-term training workshops and events, specialized face-to-face courses and longer-term, tailor-made capacity development programmes, such as the Eco-Tank project herein.

Box 3: Eco-Tank technology

An Eco-Tank is an innovative, small-scale sewage treatment system composed of a disposal tank that receives and purifies wastewater before discharging it into the environment. The compact, ready-made septic tank works independently and without power supply, using anaerobic bacteria to biochemically transform wastewater into a safe, non-contaminated effluent. It is capable of treating all kinds of wastewater from buildings, including toilets, sinks and kitchens as well as treating sewage from up to 750 persons a day. It can also be used to treat organic waste and turn it into compost. The Eco-Tank implemented in this case is a modification of the jokaso (purification tank) used in Yokohama City, Japan.

As an added benefit, this specific project targeted Eco-Tank installation for communities with tropical climates, which meant that using anaerobic bacteria would be an even more effective method to process wastewater (as anaerobic digestion occurs more efficiently at higher temperatures).

UNITAR implemented the Eco-Tank City-to-City (C2C) Cooperation Project in partnership with CITYNET, the Asia-Pacific Network of Local Authorities for the Management of Human Settlements. The pilot was titled "City-To-City Cooperation for Decentralized Sewerage Treatment Using Eco-Tanks" and was an outcome of a 2008 training workshop on urban sanitation improvement held by the International Training Center for Local Actors in Kuala Lumpur – CIFAL Kuala Lumpur (a regional training centre for local governments under the umbrella of UNITAR and CITYNET).[2] The growing CIFAL Network[3] is currently composed of nine centres

2 UNITAR ultimately seeks to stimulate city-to-city (C2C) cooperation through training implemented through the CIFAL Network of nine regional training centres for local actors, for measurable transfer of best practices in sustainable local development.

3 For more information and a map of the global CIFAL Network as well as UNITAR's other face-to-face and e-learning activities, see: www.unitar.org/ldp/cifal-network/cifal-centres and www.unitar.org/ldp/e-learning

worldwide. Each CIFAL is a regional hub for capacity development bringing together local governments, the public and private sectors and civil society. Through this training, the CIFAL Network builds regional communities of practice and public–private partnerships, leading to C2C cooperation to implement best practices and innovative approaches to sustainable local development.

During a CIFAL Kuala Lumpur workshop in 2008, the City of Bangkok, Thailand, showcased its experience using Eco-Tanks for community sanitation, procured from a Thai enterprise, which adapted the tanks from the Jokaso Japanese model. Various cities were interested in pursuing C2C cooperation with the City of Bangkok and the Eco-Tank enterprise (Premier Products, Ltd[4]), to explore how to implement replicable eco-sanitation for their communities and potentially even identify how to start-up Eco-Tank production with national manufacturers for sustainable technology transfer. In this case, the project pre-selected the type of technology to be tested for community uptake, but this was based on expressed demand from local governments and the successful experience of Bangkok in using the technology for improved decentralized sewerage treatment.

UNITAR and the Prince Albert II of Monaco Foundation, which supports effective water resources management as one of its main tenets, co-funded the project, including the purchase and transport of Eco-Tanks from Thailand. Without these two partners committing financially, the actual project could not have been implemented in the beneficiary cities. As such, a key "C" to add to the Seven "C"s model in this case is "Collateral", or assets required for obtaining financing for infrastructure and technology acquisition. Sustainable financing is a key barrier to access, as this is needed to implement any sustainable step towards building local knowledge, skills, attitudes and capacities, for any private, public or community stakeholders involved in transferring technologies.

The Eco-Tank C2C Cooperation Project's overall goal was to improve urban sanitation in Asia, particularly in low-income settlements, transfer Eco-Tank technology and related expertise from Bangkok to other Asian cities, and offer an inexpensive yet efficient effluent treatment system adapted to local conditions. The C2C cooperation project aimed at reducing water pollution from domestic sources and raising awareness on sanitation issues using the technology and advantages of Eco-Tanks. UNITAR and CITYNET ensured research, coordination and facilitation in the knowledge and technology transfer process, as the actual expertise and technology came from Bangkok. As such, the project helped promote partnership between local governments and community towards sanitation improvement. To realize the above-mentioned goal, the operational objectives of the project were as follows:

4 Thailand-based Eco-Tanks producer and project partner Premier Products, Ltd. See www.premier-products.in.th/

- To assess the city's current sanitation situation with sanitation usage matrices and needs assessments for the project's initiation
- To create a database from selected cities on sanitation, identifying their needs and resources
- To transfer the technical expertise and technology from resource city/company (Bangkok/Premier Products, Ltd) to selected cities for the installation and operation of Eco-Tanks
- To develop the pilot projects showcasing the installation and use of Eco-Tank systems in the beneficiary cities
- To ensure the enabling framework (including soft technology skills) is present to sustain the technology after the project's end.

The first year of implementation of the project was mainly focused on assessing the institutional framework, including the development of baseline assessments regarding the Bangkok Eco-Tank model and the potential feasibility of the Eco-Tanks installation for beneficiary cities. UNITAR and CITYNET disseminated a call for applications among regional local governments, members of CITYNET, together with a survey to identify potential beneficiary cities and a Terms of Reference (TORs) to guide qualifying applicant cities.

In order to participate in the project, UNITAR and CITYNET requested applicant cities to meet the following criteria that included the willingness to:

- Complete a sanitation usage matrix and needs assessment
- Participate in a study visit to Bangkok, Thailand
- Finance local transportation costs for the Eco-Tanks (from arrival of Eco-Tanks in country to installation sites)
- Provide the required data during the project timeline
- Commit human resources to learn about the usage of Eco-Tanks through study trips and carry out the project over the three year time frame
- Commit resources to organize awareness-raising and information sessions to target audiences
- Prepare necessary documentation for the project
- Participate in events and to report to outsiders
- Eventually upscale the project from pilot status, with potential private sector partnerships

While a variety of applications were received for the C2C Cooperation Project, three cities were selected as suitable host cities, with each city receiving two Eco-Tanks for the pilot project. The three cities selected were: Negombo (Sri Lanka), Palembang (Indonesia) and San Fernando (the Philippines), accepted as a later entry candidate in 2009 following delays in finalizing baseline research and participation agreements. Initial groundwork began immediately upon selection of the cities to assess potential sites and land plots, negotiate with key landowners, conduct public awareness campaigns, outline budgeting plans with local governments for any on-site costs and develop work plans. As a prerequisite upon selection, two delegates from each of the beneficiary cities participated in a study visit to Bangkok enabling city delegates to learn how Eco-Tanks were designed, proper installation and technical functions, and assess overall uptake possibilities and benefits in their local contexts, while developing action plans for transferring the model locally.

The project was the first of its kind in all three cities, especially as external financing would support knowledge and technology transfer to test greener local infrastructure and services. Mayors from all cities expressed their keen interest in implementing the pilot project and this in turn confirmed that there would be strong political and administrative leadership in supporting the project, at least initially.

During the second and third year of activities, the project faced a variety of obstacles owing to unforeseen circumstances. This phase, from 2009 to 2010, particularly lent many of the lessons learned overall. The core part of the project for the second year was the actual transfer of the Eco-Tanks to Negombo and Palembang, as well as "soft technology" or "knowledge transfer" in the form of IEC (information, education and communication) campaigns and project demonstrations.

Figure 1: Eco-Tank being installed in Negombo in 2011

Owing to political, logistical and manpower challenges in the **City of Negombo,** the project was put on hold for months, but work resumed in mid-2009 (see figure 1). UNITAR, CITYNET and the City of Negombo held a series of workshops to sensitize community members about the project goals and Eco-Tanks, with 20 to 30 community leaders and other stakeholders attending each time. There were mixed reactions from the community members, as some expressed concerns that the cost–benefit ratio was too high. Other concerns expressed revolved around behavioural changes that would have to be made by older citizens in using new designated toilets.

As months passed and delays in transporting the tanks mounted, alternative solutions to expedite the installation of the tanks were sought through a variety of methods. This was unsuccessful, mainly because of the poor transport infrastructure to move the Eco-Tanks and because completion of the final target site (a new bus terminal, see figure 2) was delayed. Negombo also indicated that the delay was due to political developments, since transporting the tanks to the project site would have to take place after the presidential election in late January 2010.

Figure 2: New bus terminal (target site) under construction in Negombo with Eco-Tank installation completed

Source: Photo courtesy of Municipal Council, Negombo

The tanks arrived in Negombo in February and were transferred to the bus terminal site through a lagoon, since the bridges were not designed to withstand the weight of the tanks. However, because of unexpected political disturbances, the construction process did not proceed as planned, since approval for construction was delayed from another local government office. This challenge of local political coordination, limited contact with the local government and absent leadership and political will for the project for almost one year, delayed any progress on the project until the following year. The project did not progress much for Negombo until installations began in early 2011. The Eco-Tanks were functional by June 2011 and evaluations to attest to the success of the project were completed in July the same year. The experience of these challenges and the lessons learned from Negombo, as well as other cities, are detailed below.

Despite facing the worst floods in five years, by the end of 2010, the **City of Palembang** had successfully completed its on-site delivery of the tanks (see figure 3), community participation sessions, awareness-raising campaigns and installation with limited delays. In early 2009, the Eco-Tanks were shipped from Thailand and arrived at the destination on schedule. Work for laying pipes and other material began as soon as the tanks arrived. By the end of 2009, the Eco-Tank project neared its second phase and tank installation began in a specially constructed underground compartment near a low-income housing complex. Palembang's progress continued in 2010, with the installation of the tanks completed by the end of the year.

Figure 3: Eco-Tanks being transferred to the project site in Palembang, Indonesia

Figure 4: Low-income housing complex owned by the City of Palembang, target site for Eco-Tank installation

Figure 5: Dr. Ksemsan (Chief Advisor, Premier Products), the expert who modified the Jokaso system from Yokohama to Eco-Tanks, visits Palembang and inspects the project site in November 2010

Figure 6: Local engineers from Palembang receive advice from senior sanitation advisers from CITYNET, representatives from San Fernando and WTO (World Toilet Organization, member of CITYNET) in November 2010, Palembang

As indicated in the original 2008 plan of action, Palembang installed the two tanks at a public low-income housing complex and also conducted orientation sessions for the residents of the building (see figure 4). Regular communication between CITYNET and the city project officers in Palembang allowed for close monitoring of the project, with a strong commitment from the Mayor. As of November 2010, technical officials from CITYNET and Premier Products (the Eco-Tank manufacturer) were able to visit the project site for inspection and had advisory sessions with local engineers and supervisors to transfer technical knowledge, remedy installation flaws and provide solutions for other key challenges, such as odour contamination from the tanks (see figures 5 and 6). In 2011, engineers from Palembang were able to apply all the recommendations and changes.

In November 2010, the City of Palembang also hosted an international sanitation workshop to bring further knowledge and discussion on sanitation practices

and technologies to the city.[5] With the objective of creating clean and comfortable cities in terms of sanitation standards and public health, the workshop provided the platform for various stakeholders to develop ideas and methods which can help reduce sanitation-related challenges in more applicable and sustainable ways in developing cities in Asia. The event, supported by various international partners including UNITAR, CITYNET, the Asian Development Bank and UN-HABITAT, represented collaborative engagement at its best and presented a chance to share new knowledge on sanitation issues and consider lessons learned and best practices for wastewater management in low-income communities. The workshop also resulted in expressions of interest and commitments from eight new beneficiary cities across Asia to develop similar Eco-Tank pilots, as well as commitments from local governments to prepare greener sanitation plans and strategies for their own cities. Palembang is now replicating and expanding the project by partnering with qualified local manufacturers if their technical conditions are deemed suitable for manufacturing.

The **City of San Fernando** started its pilot 15 months later than Negombo and Palembang following delays in completing the initial needs assessment phase and finalizing participation agreements. In February 2010, the Mayor of San Fernando and his team paid a technical visit to the resource city of Bangkok, Thailand, and Premier Products (the manufacturer of Eco-Tanks) to study Eco-Tank technology, learn first-hand how tanks were designed, view installation procedures and learn about the broader science behind wastewater treatment. After the visit to Bangkok, the San Fernando delegation began the preparatory phase by conducting initial site surveys for potential Eco-Tank sites, with additional support from USAID's technical sanitation officials in the Philippines. From March to April, San Fernando municipality also conducted meetings with various community officials and stakeholders including health workers, resort owners and other local inhabitants, to ensure community participation and support for the project.

Figure 7: Low-income riverside communities discharge wastewater directly into the San Fernando City River

5 www.citynet-ap.org/media-room/events/s/Sanitation-Workshop-in-Palembang/

Figure 8: Eco-Tank installation completed in low-income riverside community

The foundation for successful implementation was further enhanced by additional data gathering and promotional plans for the city's new project, which included a regional symposium on "Septage, Sewerage and Sanitation" held in March 2010. The city took this opportunity to unveil the newly arrived Eco-Tanks to the public and showcase the planned project. Technical officials participating in the symposium were also able to offer advisory services prior to the Eco-Tank installation. Through similar technical cooperation visits for Palembang, Premier Products sent engineers to San Fernando to assess the situation prior to installing the tanks. With the support of the city, Premier Products is also exploring opportunities to manufacture the tanks locally in San Fernando. The city completed installation of the tanks in the low-income communities along the San Fernando River in March 2011 (see figure 7 and 8) and has even engaged in cost-sharing to purchase more Eco-Tanks and expand the project's outreach to other local sites such as San Francisco Beach.

E. Challenges and key lessons learned

There are a variety of barriers and prerequisites when implementing a cooperation project for knowledge or technology transfer with a local government, as in this case. However, the project confirmed that involving local governments and building their capacities and ownership of such projects is a key factor for the sustainability of locally-led investments in greening municipalities. The project also managed to avoid a series of typical barriers stalling the transfer of greener technologies for communities in developing countries, such as financing and private sector partnerships. As such, the project especially showcases what can be done with two key success factors in place: (i) committed financing; and (ii) a regional private sector partner as a committed provider of the targeted technology for transfer.

Financing for this four-year project was guaranteed upon selection of the beneficiary cities. Through a multilateral partnership, costs for the project were shared, but shouldered mainly by the Prince Albert II of Monaco Foundation, and by UNITAR, with the local governments and Premier Products contributing in-kind costs as well. Without these committed funding sources, the feasibility of Eco-Tank transfer to any of these cities remains uncertain. However, once transferred, local governments such as San Fernando and others have shown financial commitment to replicate the project and procure Eco-Tanks for other city locations. As the process for procuring, installing and maintaining similar technologies becomes more commonplace for these and neighbouring cities, the possibility of acquiring new and innovative ESTs will ensure that these cities take concrete steps towards becoming green cities.

The second key success factor and lesson learned for this project was the active participation of Premier Products as a partner throughout the project. Often-observed barriers to technology transfer are the reluctance from the private sector to export new technologies and the high cost of patent licensing fees and intellectual property restrictions. In the case of Premier Products, it did not oppose local modifications of the technology or local replication. The company was also heavily involved through technical visits to and from the project sites, transferring knowledge and expertise on the technology and did not charge any additional fees for the Eco-Tanks. This was largely because of a variety of benefits. First, participation in the project meant region-wide promotion of the Premier Products brand and products, as well as its new Eco-Tank model. Second, Premier Products could act as the tried and tested supplier for any further demands for Eco-Tanks in any of the three countries herein. The project also allowed Premier Products to test its operation model and technology at a low-cost in new potential markets. Finally, the project allowed Eco-Tank to extend its potential manufacturing base with new national partners and distributors, as in the case of San Fernando.

There were a variety of shared challenges and lessons learned for all three Eco-Tank project cities. Some of these were especially related to the need for greater understanding of technical aspects related to the Eco-Tanks. While city delegations did take part in study visits to see the original Bangkok Eco-Tank sites, it seemed that upon arrival of Eco-Tanks in beneficiary cities none of them had envisioned the

large weight and size of the Eco-Tanks. This meant that all the cities had difficulty transporting and managing the tanks from arrival at the ports to the destination sites. More could have been done to prepare recipients of the tanks for their actual weight and size and the procedures for unloading tanks safely. The three cities each reported issues related to receiving the tanks at the port, off-loading and customs, which in each case ended up costing the city greater local transport expenses and delayed the project, especially in the case of Negombo. Further logistical research for all officials involved in the process would possibly help to alleviate these issues for future projects. It is also interesting to note that all three Eco-Tank cities also experienced problems with groundwater and tank flotation. In the future, providing installation instructions for dealing with this site condition would be useful.

Overall, the project experienced a variety of shared challenges for technology transfer across the cities, which led to lessons learned and the development of a checklist suitable for guiding the implementation of similar projects for and with local governments (table 1). UNITAR will use the checklist to asses a parallel project for the transfer of biogas technology to local governments and planned future knowledge transfer projects on green technologies, services and practices between cities and private sector partners.

Table 1: UNITAR Checklist for Future C2C Green Technology Transfer Training Projects

Checklist item	Checklist output
1. Is available financing ensured for the entire process from beginning to end?	• Final agreed budget between project partners (including local government and community stakeholders) • Disbursement schedule for delivery of funds is set
2. Have the needs assessments and feasibility studies been performed on the local government's key stakeholders' institutional capacities and the technology's target audience?	• Results of needs assessment and feasibility study from community • Decision tree assessing next steps for the potential technology transfer project
3. Is there a formal partnership with a private sector partner (provider of the technology) committed to a process of cooperation, technical assistance and long-term transfer of technology to the developing country community and with a national partner manufacturer or distributor?	• Private sector partner has undergone due diligence and been selected by project partners as ideal provider of the technology needed • Private sector partner formally commits to the process (long-term) • Private sector partner and project partners identify potential national manufacturers or distribution partners to ensure sustainable access to the technology for replication and servicing
4. Have the local government leadership (mayor) and municipal staff expressed formal commitment to the project long-term?	• Confirmed agreement with mayor or local government leadership and key staff • Leadership is publicly and substantively involved during key points of process
5. Has the interest/cooperation from community stakeholders and the ultimate beneficiaries/end-users been confirmed?	• Number of and results from meetings with community stakeholder and local leaders • Number of and results from community awareness-raising sessions, sensitization meetings with the targeted end-users
6. a) Has the city developed a project team to lead the project implementation from beginning to end and has this project team's skill set been assessed? 6. b) Does the project team include contingency members, understudies or alternatives in case of dropouts?	• Composition of project team (technical capabilities, skill sets assessments) • Contingency team set in place • Commitments confirmed and project team validated by local government leadership and project partners
7. Has there been an overall workplan and timeline developed and agreed upon by project partners?	• Workplan is shared among project partners • Workplan schedule of deliverables is monitored with intermediate evaluations • Partners participate in opportunities for communicating promoting project's ongoing results (e.g., international conferences, seminars, online media, etc.) • A final external evaluation has been completed and shared
8. Is there a plan in place to train and address knowledge gaps among the target audience throughout the process?	• City's project team, including technical staff, has participated in a knowledge gap analysis and results are shared • Complementary trainings are held and knowledge acquired by participants is assessed and results are shared
9. Is there a transport and delivery plan in place for the technology, from point of origin to point of delivery?	• Plan is shared, especially with expert stakeholders to avoid potential transport-related delays, and transport is monitored

Checklist item	Checklist output
10. Has there been a thorough review of customs and tax procedures for the importation of new technologies and products from a local government perspective?	• Excerpts noted from customs/fiscal regulations regarding importation of technology • Confirmation from customs authorities obtained or contacts developed to assist in expediting the process within tax authorities
11. Is there a disaster risk management and contingency plan in place to ensure sustainability of the project in case of common natural disasters?	• Project plan is linked within city's disaster risk management plan • Project workplan integrates risk of natural disasters into planning prior to start of project to mitigate risk and project delay
12. Are there constant communication channels and progress updates to/from project partners and beneficiaries?	• Progress reports shared and monitored by project partners according to an agreed schedule and workplan

1. Contextualized challenges according to project city

(a) Negombo

Among the three beneficiary cities, Negombo faced the most challenges throughout the project. The project ultimately suffered from a variety of setbacks as a result of commonplace challenges that stall the implementation of new technological solutions in many of South-East Asia's cities: namely, dependence on limited local technical expertise, limited transport infrastructure to support technology transfer and logistics, bureaucratic barriers and weather-related delays. However, with many of these challenges addressed, the project continues to move forward. There appears to be a great opportunity for Premier Products to take part in the development and proliferation of new wastewater treatment technologies in Negombo and elsewhere in Sri Lanka.

Logistical: Unfortunately, those cities and areas that most need sanitation services also often suffer from poor infrastructure in general. After receiving the tanks, Negombo was unable to transport the tanks to the project site since the road leading to the area (Monacogama) had a bridge that was incapable of withstanding the weight of the tanks and the trucks carrying them. The alternative was to transport the tanks across the lagoon. However, the city was not able to find a boat big enough to transport the tanks safely. After changing the project site twice, they finally agreed to install it at a planned new bus terminal, which was yet to be fully completed but easier for delivery of the tanks.

Bureaucratic: This factor has been the major drawback for Negombo's progress in installing the tanks. The city's unresponsiveness in updating all project partners such as CITYNET and UNITAR caused delays from the very beginning. There were a variety of long communication lapses with the city, despite repeated contact attempts, throughout the project. In addition, the city faced political disturbances after presidential elections and further delays in processing construction permits from relevant municipal departments. In early 2011, partners from the City of

Galle, Sri Lanka, visited Negombo and re-confirmed the mayor's willingness to complete the project.

Supply and quality of local technical personnel: The city did not have a substitute engineer who was capable of handling the project. The main engineer responsible for the Eco-Tank Project had a cardiac problem soon after being assigned to the task. The city was not able to find a replacement and waited for his recovery to resume work. This was revealed only after various requests from CITYNET for progress updates. Negombo decided to continue working with the same engineer. Availability of additional skilled workers could have prevented the loss of time.

Weather: Sri Lanka suffers from many seasonal typhoons and Negombo is one of the most vulnerable cities as it is surrounded by a lagoon and is situated at sea level. Floods are common even with regular rain, which disrupts transportation badly in the city. Therefore, the window for conducting the groundwork is very limited. There is no solution for this. However, better contingency plans could be implemented by the city.

(b) Palembang

Palembang suffered from similar challenges as Negombo but was still able to complete the project in October 2010. The key difference may have been the stronger political will and leadership, particularly exhibited by the City's mayor throughout the project. The mayor informed UNITAR and CITYNET of the key challenges faced, which were additionally confirmed via external evaluation reports, as follows:

Customs/tax regulations: Since the tank was imported from Thailand, the procedures to obtain the correct documents for tax purposes for customs took longer than expected as they had to be filed in Jakarta. Time could have been saved if the city had done prior research on the required paperwork for imports and had better coordination with customs and tax authorities.

Weather: This was a major issue in Palembang as well. Since the country receives rain throughout the year, it was very difficult for the engineers to fix the date to start digging the ground. Soon after the city installed the tanks into the ground, the compartment holding the tanks was flooded by rainwater causing the tanks to float, as they had not been filled with wastewater yet. This caused the Eco-Tank to crack. The rainwater mixed with wastewater also had filled the hole dug to install the tanks. However, the city completed Eco-Tank repairs using public funds. Time management and efficient planning would be the solution.

Supply and quality of local technical personnel: Similar to Negombo, the city did not have a skilled engineer who was able to supervise the installation. This caused the smell from the wastewater to leak into the surrounding area resulting in complaints from the residents. This was particularly the case when the wastewater and rainwater filled the tank and the compartment thus making it inevitable for the engineer to pump the water out before proceeding with the repairs. However, this problem was solved with the support of an engineer from Bangkok.

(c) San Fernando

The procurement of the tanks in San Fernando was relatively easy compared with the other two cities. The main obstacle was the paperwork required for releasing the tanks from customs. With the introduction of Eco-Tanks, the city has been able to promote decentralized, efficient and relatively easy-to-install wastewater treatment. As a pilot project, two low-income communities were chosen for the Eco-Tank installation. The specific challenges and lessons learned from San Fernando are as follows.

Customs/tax regulations: This was a major setback when the city faced paperwork which it had not been aware of in order to import the tanks from overseas. Since the Eco-Tank was the first of its kind to be imported in the Philippines, the authorities were not able to identify it to put it under one of their tax codes. As a result, the city had to cover extra charges for storage at customs. They were also not able to produce the necessary paperwork since the local council regulating the approvals had not been properly briefed on the project. Prior research on import procedures could have prevented the time loss.

Logistical: Soon after San Fernando cleared the tanks from the port, it found out that the road leading to the proposed site was not wide enough for the trucks carrying the tanks. The same challenge was faced by Negombo City. The city eventually managed to take it to the site but not without having to go through extra work to put the tanks in the proposed site. This could also have been prevented if the city had done a proper survey on construction.

Supply and quality of local technical personnel: San Fernando also lacks the technical skills necessary for the installation and long-term maintenance of the tanks. Premier Products and other partners have provided technical advice on how they should proceed with the implementation, but more needs to be done.

F. Conclusion

The project was designed to offer selected cities the opportunity to gain sustainable knowledge and expertise in Eco-Tank technology while improving overall sanitation conditions in each city. The cooperation aimed to eventually transform the pilot projects into replicable projects in other parts of the city or other country towns. UNITAR originally intended to complete the project in three years, starting in April 2008, but owing to a variety of challenges, the project was not completed in the cities until late 2011.

Despite the challenges of the past four years, the beneficiary cities were confident that Eco-Tanks can be scaled-up to other sites across their cities. Ultimately, though, sustainability of this and similar projects is contingent on overcoming the shared challenges these and other similar cities face – especially the limited supply of capable technical personnel available locally to lead and support similar projects. Potentially, through future partnerships with national engineering schools and national commitment, local towns and municipalities can enjoy access to capable per-

sonnel for more green technology transfer projects. Finally, across all communities there is still a greater need for continued community awareness-raising sessions to ensure behavioural change among the users and recipients in project areas. Through partnerships with local schools and media, as well as continuing partnerships with community leaders, the city can continue including users and involving them in awareness-raising campaigns.

Sustainability of the project can also be ensured with continued local government leadership as the cities have begun investing in the project's replication themselves. For example, San Fernando purchased an additional tank using its own resources to be installed at San Francisco Beach, which receives thousands of tourists during the summer and wastewater from the toilets runs directly into the sea. Palembang has also taken a keen interest in expanding its sanitation programmes throughout the city after the International Sanitation Seminar in November 2010. Sustainability will be ensured through further partnerships with local manufacturing companies for localized Eco-Tank suppliers. The City of San Fernando, with Premier Products, has been searching for partner corporations who may be interested in Eco-Tank production in the Philippines. Furthermore, activities such as monitoring of discharged water quality continue in the three cities for data collection, reference purposes and further improvements.

Following on the heels of UNITAR's fruitful partnership with CITYNET, lessons learned from the Eco-Tank C2C pilots in these first beneficiary cities and the continued support of implementing partners, UNITAR will seek to continue developing replicable, hands-on capacity development projects to assist interested local governments to decentralize green technologies. In 2012, UNITAR, CITYNET and other partners will focus not only on increased C2C on Eco-San technologies, but also on other waste management solutions for local development, such as biogas, while integrating the lessons learned. Additionally, to build on the key challenges observed and the local capacity gaps to absorb new technological solutions for basic services, UNITAR will also focus its local development training programmes in Asia to address capacity challenges in sustainable project cycle management and financing for eco-efficient technology transfer and for increased South–South and North–South cooperation in greening local economies.

As urban populations continue to grow in Asia and the gap between the privileged and the underprivileged widens, health and sanitation issues will continue to be one of the biggest challenges for local governments. Local governments in the region are not yet well enough equipped to tackle simultaneous pressures of a growing population, upgrading to greener cities and implementing large-scale investments. Cities can, however, share experiences and practices through facilitated training programmes that enable local governments to lead their development agendas, while accumulating the knowledge, skills and technologies to develop as greener cities.

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Chapter 10:

Watershed management of Sereng River Basin: Part of the Brantas River Basin System, East Java, Indonesia

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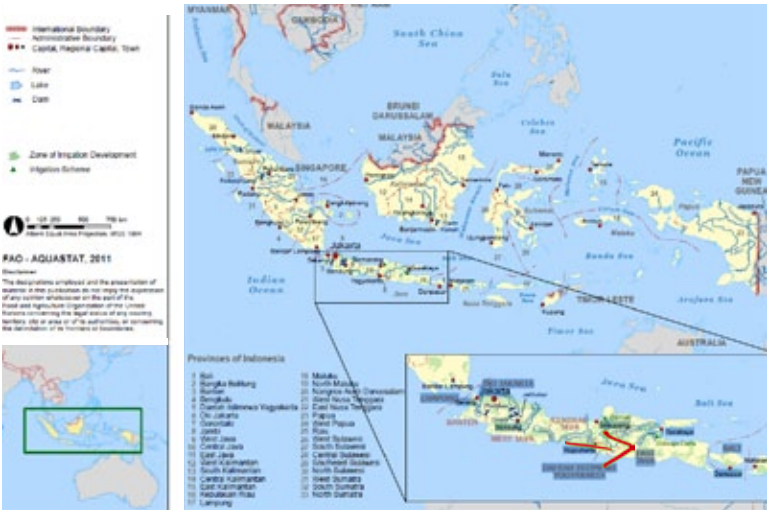
This project focused on small watershed management of the Sereng River Basin, in an area of high agricultural productivity from fertile soil but with degraded hill slopes and acute pollution of the streams from animal waste and soil erosion. With the support of public agencies, the committed local communities have turned these challenges into opportunities. They learned how to manage their rural watershed through a combination of terracing, reforestation, constructing gully plugs, riverbank protection and check dams, thus reducing erosion of the hill slopes. They learned to harness small hydropower for their street lights and recycle their animal waste into biogas for cooking, providing them with alternative energy sources. These activities have the added effect of reducing pollution of streams and rivers.

Keywords:
Small watershed management
Community commitment and ownership
Alternative energy

A. Introduction

The Sereng River Basin Watershed Management is co-funded by Jasa Tirta 1 (JT1) and United Nations Economic and Social Commission for Asia and Pacific (ESCAP) through its Eco-efficient Water Infrastructure Project. ESCAP's Eco-efficient Water Infrastructure Project is in turn funded by Korea International Cooperation Agency (KOICA). JT1 is the river basin management agency for the Brantas River Basin and Bengawan Solo River Basin in East Java. JT1 is a state-owned company of the Indonesian Government. The location of the project area is shown in figure 1.

Figure 1: Location of Sereng/Konto River



The Sereng River is a tributary of the Konto River, which in turn is a tributary of the Brantas River. The Konto River Basin is divided into the upper and lower reaches by the Selorejo Reservoir, which formed in 1972 after completion of the dam. The upper watershed of the Konto River covers an area of 236 km^2 between four volcanic complexes which determine its natural setting. The altitute ranges from 2,800 m at the summit of Mt Butak to 600 m above sea level (a.s.l.) at the Selorejo Dam.

The Jasa Tirta 1 choice of the Sereng River Basin, with a focus on Bendosari Village, was appropriate for the following reasons:

- This is a highly productive highland agricultural area, producing fruits and vegetables for the markets of the surrounding urban areas and further afield. Dairy farming has been added to supplement household income. Each farm family was provided with 2–3 cows.
- The hillside has been severely deforested, for agriculture as well as firewood, resulting in hillside erosion and river sedimentation.
- The dairy waste product is very polluting, affecting residents downstream of the study location.
- The villages have also been devastated by recent unprecedented flooding.
- The local communities, especially in Bendosari Village, are committed to move forward to make their village better and to improve their agricultural outputs.

In January–February 2010, there were several flooding episodes in the Konto River: on 14 January, 5–6 February and the last on 24 February 2010. The flood discharge on 24 February 2010 resulted in casualties and damage: two people died

(swept away by the floodwater), a bridge was damaged in Bendosari Village, there was cliff erosion, eight check dams collapsed in Konto River, three houses were damaged and paddy and agricultural fields were inundated. This flood also caused a traffic jam on the Malang–Kediri route for approximately two hours.

The Sereng River is a small tributary in the upper reaches of Konto River. The river has an approximate length of 7.3 km. Flood occurrences in the Konto River indicate the degradation of the watershed in the upper reaches of Konto River. An effort has been made to improve the management of the watershed area by encouraging public participation and initiatives.

The catchment management proposed for the Sereng River Basin included implementing structural and non-structural measures, comprising: (1) implementation of non-structural measures, to prevent further catchment degradation (soil conservation) based on local community participation (e.g., bio-pores, land terracing, gully plugs, regreening and/or reforestation); (2) construction or installation of at least one eco-efficient modular/in situ structure to reduce pollution flow into the stream and to improve water quality; and (3) construction of at least one eco-efficient river protection structure to prevent riverbed or riverbank erosion.

B. The proposal

The catchment area of Sereng River Basin is mostly located in Bendosari Village, Pujon District, Malang Regency. Bendosari Village lies in a mountainous and highland area. The village area is approximately 269 ha, of which there are 31 ha of settlement area with the rest dryland and rain-fed rice fields. The village is divided into five *Dusun* (sub-villages), namely: *Dusun* Cukal, *Dusun* Dadapan Wetan, *Dusun* Dadapan Kulon, *Dusun* Ngeprih and *Dusun* Tretes.

Bendosari Village has a population of approximately 3,858 people and most of their occupations are mainly related to the agriculture sector. The life philosophy of the people of Bendosari is reflected in their slogan stated in the Javanese language: "Rumangsa Melu Handarbeni, Rumangsa Melu Hangrukebi, Mulat Sariro Hangrasa Wani" which means "thinking about how the village can be developed, advanced and be independent to become self-sufficient villages" (see http://bendosari.wordpress.com/).

Jasa Tirta I Public Corporation, in cooperation with the Bendosari Village Government, has conducted many previous activities in order to promote people's awareness of a healthy and sustainable environment in Bendosari Village under the initiative of promoting a "Green Village". The basic concept of a Green Village here is to increase environmental sustainability through a master plan, consisting of watershed conservation through reforestation, development of erosion control structures and environmental improvement by developing healthy animal husbandry that include recycling the solid waste from dairy farming to biogas production.

Owing to the flooding that occurred in early 2010, the watershed improvement activities were conducted more intensively by conducting regreening activi-

ties and building check dams and gully plugs. These structures are intended to prevent the deposition of sediment carried by the river directly into the Selorejo Reservoir. Other activities were also conducted such as community-based bio-monitoring (participatory water quality monitoring using water insects) to increase community awareness of environmental conditions. This activity was conducted in cooperation with the non-governmental organization (NGO) ECOTON (Ecological Observation and Wetlands Conservation).

The Bendosari Green Village Concept is expected to be the pilot project for other areas in the Brantas River Basin, especially in the upstream reach of the basin. The National Development Planning Agency (BAPPENAS) has shown interest in expanding the Bendosari Green Village Concept to other areas within the Republic of Indonesia but with adaptations to suit the specific needs of the other areas.

C. Non-structural measures

The non-structural measures are expected to prevent further catchment degradation (soil conservation) and include local community participation (e.g., bio-pores, land terracing, gully plugs, regreening and/or reforestation)

1. Bio-pores (*biopori)*

Bio-pores *(biopori)* is a water absorption method which is used to reduce the surface run-off and inundation effect by increasing the water infiltration capacity into the ground. Bio-pores are an appropriate and environmentally friendly technology to deal with flooding and reduce inundation problems by increasing water absorption, converting organic waste to compost, utilizing soil organisms and roots and overcoming the health problems caused by inundation such as dengue and malaria. This method was chosen because it is easy and cheap, so in future the local people can implement it by themselves. The recommended numbers of bio-pore holes were calculated using the equation (http://biopori.com/jumlah.php):

Total bio-pore holes = rainfall intensity (mm/hour) x impervious area (m^2)/ volume of water flowing per hole (litres/hour)

Location of the boreholes: *Dusun* Cukal, , Dadapan Wetan and *Dusun* Dadapan Kulon; each sub-village (or *dusun*) had 50 holes each.

2. Land terracing

The land terracing activity is aimed at rehabilitation of the terraces. A terrace is a levelled section of a steep cultivated area, designed as a method of soil conservation to slow or prevent rapid surface run-off. A terrace is a soil conservation structure constructed by digging and filling to form a tillable surface, end bund and drainage ditch which follows the contour line. It is complemented with other structures such as waterways and drop structures perpendicular to the contour line. Once the terracing is complete, it is further strengthened by the planting of

elephant grass. The terracing is in two locations in *Dusun* Cukal with a total area of 10 ha.

3. Gully plug

A gully plug is a civil enginering technique of soil conservation for controlling surface water run-off by plugging the gully, at a specific location, with stones wrapped with wood and/or bamboo. The gully plug is also a soil conservation technique that serves to control a gully or valley by constructing a small, water-permeable dam across the gully made of rock gabions, wood/bamboo riprap or concrete structure. The gully plugs in this case were made from bamboo, as it is easy to find in the local area and is not expensive. Eight gully plugs were constructed in two gullies, each consisting of four gully plugs in series.

4. Regreening (afforestation) and reforestation

The purposes of afforestation and reforestation are to rehabilitate and to improve critical land conditions outside the forest area in order to improve water management, to maintain and to improve land use. Regreening rehabilitates critical land outside the forest area by planting trees and establishing soil conservation structures so that the land is productive and at the same time serves as a hydrological control to maintain and improve land carrying-capacity in accordance with its function. The determination of critical land refers to the definition of a piece of land as severely damaged and as a result has reduced or lost its function beyond a tolerable limit. The locations of the afforestation and reforestation were in the *dusuns* of Cukal, Dadapan Wetan and Dadapan Kulon involving the planting of 8,000 trees on 20 ha.

D. Structural measures

Structural measures proposed are the construction or installation of eco-efficient modular/in situ structures to reduce pollution flow into the stream and to improve water quality. Eco-efficient development of sustainable infrastructure also aims to improve the quantity and quality of the river flow, with minimal waste of natural resources and within the stability and capacity of the environment's carrying capacity. The structures built were:

- Riverbank protection (revetment): a structure placed on the surface of the slope of riverbanks or levees in order to improve their stability and prevent landslides which can lead to the collapse of riverbanks and/or leeves into the river. Riverbank protection (revetment) can be made from woven bamboo that is placed on both sides of the riverbanks.

- Drop structure: an in-stream structure constructed from stone, bamboo or wood and compacted grass *(gebalan rumput)* to reduce the energy of the water surface flow in an area with sufficient gravity drop. A drop structure is needed if the slope of the bottom surface of the river is too steep. It is usually necessary to build a series of drop structures to maintain the river slope.

- Check dams: another structure that can provide riverbed or riverbank protection. Check dams were built across the river to reduce the flow velocity and capture sediments carried by the flow, so that the flow depth and slope of the riverbed can be reduced. These structures are usually made from locally available materials, such as wood, soil or stone. This structure has a high failure risk, but may provide temporary stabilization and can be combined with agronomic systems (using organic material).

A check dam, riverbank protection and a small drop structure were constructed in *Dusun* Cukal of Bendosari Village.

E. Capacity-building

Part of the programme included developing a "capacity-building module" with educational and advocacy materials on promoting healthy rivers and eco-efficient water infrastructure development including the organization of a training workshop on the development of the educational and advocacy materials.

The module was developed in the Indonesian language and titled "Pengembangan Kapasitas untuk Peningkatan Kapasitas Lingkungan" (Capacity-building for Environment Improvement). This module was used for the Community Training Programme for Sereng River Catchment Management that was held at Bendosari Village community hall on 21 and 22 September 2010.

The training was attended by approximately 80 participants from Bendosari Village. The first day of the training was focused on teaching and explanation of the components of the project. The second day was practical training on installing bio-pore holes in Bendosari Village.

The participants in the training consisted of village officials, youth and women who joined in the "empowerment of the family welfare movement" (Pemberdayaan Kesejahteraan Keluarga, PKK) and the farmers' groups. The village headman, advised, assisted and coordinated with JT1 in the selection of the participants. All critical stakeholders were included in the training as many of the participants are members of the group for the "empowerment of the family welfare movement" and the local farmers' groups.

The programme was designed and delivered by JT1 officers with the active participation of the village headman). Although no formal evaluation/assessment of the participants was carried out immediately after the training, later training programmes on watershed conservation in this project location, including similar activities introduced in the earlier training, were carried out successfully by the local communities themselves. JT1 also conducted on-site training on development and maintenance of small biogas plants and water treatment construction facilities for the villagers in order to empower them to build and maintain their own future facilities.

F. Other activities of the villagers

The villagers, through the initiative of the headman and with the support of Jasa Tirta 1, other government agencies and a university, have also developed the following activities:

Piloted biogas production for cooking, utilizing the animal waste from dairy cattle. This can help to overcome the waste problem from the husbandry as well as to reduce pollution flow into the stream and to improve water quality.

Harness small hydropower to provide 8 hours of night lighting to the village. This was carried out by harnessing a 2-metre drop of a 20-metre waterfall. The waterfall area is a recreational spot for the villagers. The decision to use only a 2-metre drop, channelled to the side, is to maintain this recreational area for the villagers, and especially the youth and children.

G. Requests from the villagers

While some of the villagers who can afford it have built smaller, individual biogas facilities, the village has also submitted requests for the following activities, for which funds are still being identified. Constructing these biogas plants will reduce pollution from the dairy cattle activities and minimize cutting of forest trees for firewood needed for cooking. This will reduce pollution of the streams from both the solid waste and hillside erosion thus improving water quality. Concurrently, less cutting of trees and reforestation will ensure that the forest land is maintained to ensure reduced emission of greenhouse gases.

1. Biogas plant and water treatment

To overcome the waste problem associated with animal husbandry, there is a need for construction or installation of at least one eco-efficient modular/in situ structure to reduce pollution flow into the stream and to improve water quality. The proposed structure is biogas plant equipped with wastewater treatment. Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic material and is a type of biofuel.

In Indonesia, the common type of biogas plant is "fixed dome", which is an immobile fixed dome type. This type of biogas plant comes in various sizes (4, 6, 8, 10 and 12 m^3) and categories (see table 1) to earn subsidies from the Indonesia Domestic Biogas Programme (IDBP/BIRU, biogas rumah).

Table 1: Bio-Gas plant sizes subsidized by the Indonesian Biogas Programme

Type	Processing capacity[a] (m^3)	Gas production per day (m^3)	Required cattle waste per day[b] (kg)	Required water per day (litres)	Required number of cattle
1	4	0.8–1.6	20–40	20–40	3–4
2	6	1.6–2.4	40–60	40–60	5–6
3	8	2.4–3.2	60–80	60–80	7–8
4	10	3.2–4.2	80–100	80–100	9–10
5	12	4.2–4.8	100–120	100–120	11–12

a Processing capacity is the volume of biogas plant and the dome for the gas storage
b Average storage time: 50 days

(a) Biogas plant 6 m^3 with water treatment

Cattle waste treatment was achieved without regard to environmental sustainability, causing degradation of the water quality of the river. The selected construction of the biogas plant is type 2 with a processing capacity of 6 m^3.

Location: *Dusun* Cukal
Number: one site

(b) Biogas plant 12 m^3 with water treatment

Cattle waste treatment was achieved without regard to environmental sustainability, causing degradation of the water quality of the river. The selected construction of the biogas plant is type 5 with a processing capacity of 12 m^3.

Location: *Dusun* Cukal
Number: one site

(c) Healthy cage

The condition of the cattle stall/byre had not considered cleanliness, health, aesthetics and animal welfare During the rain, the rainwater mixed with the cattle waste which spread everywhere. The construction of a healthy byre was needed to provide a clean and healthy environment for the cattle and residents.

Location: *Dusun* Cukal
Number: one site

H. Conclusion

Many lessons were learned from the project, which indicated huge potential achievements when working with communities and stakeholders who are committed to improving their environment. The project also has the potential of being cascaded not only to other watersheds within the Brantas River Basin but also to other river basins in the different parts of the Indonesian archipelago.

Currently ESCAP is not able to support the additional requests of the villagers from Bendosari as the initial eco-efficient project has been completed. If there are any interested donors, this is a project that should be supported as the villagers themselves are so committed and willing to provide their own labour.

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Chapter 11:

Natural infrastructure solutions for water security

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A. What is natural infrastructure and why manage it?

The availability of water at any place and time, and its quality, is determined by the water cycle. The water cycle is a biophysical process that involves precipitation falling on a physical landscape in which the functioning of ecosystems in part determines the flow, storage and quality of water. Figure 1 provides a simplified illustration of this cycle.

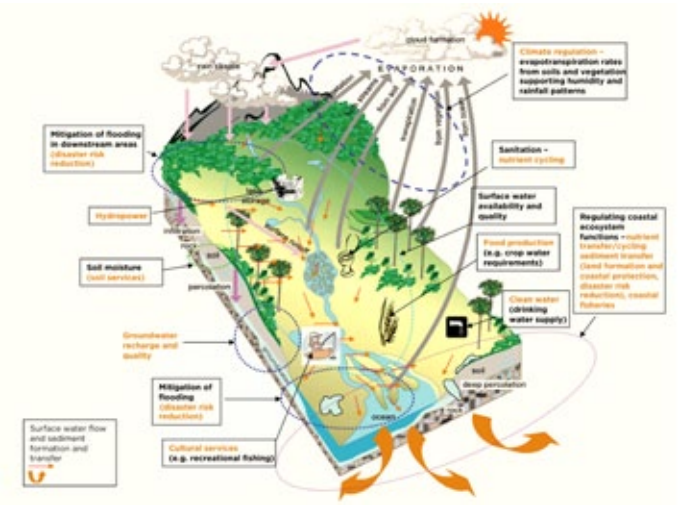
It is well known that land- and water-use activities impact ecosystems or "the environment" through, for example, the impacts of dams and irrigation on river flows or through land erosion or chemical use leading to water pollution. Capacity-building to address such impacts remains an important need and this subject centres broadly on the concept of managing "environmental impacts". This chapter, however, introduces a different and more positive way of looking at ecosystems by considering the opportunities that improved ecosystem management offers to help us achieve our water-management goals. The approach is founded on the fact that ecosystems are not just the victims of water use or diversion for human needs, but are also responsible for making water available in the first place. Proactive ecosystem management, therefore, offers opportunities to manage ecosystems as a "natural infrastructure" alongside, and complementary to, physical or built infrastructure. Natural infrastructure can also offer considerable advantages, including improved sustainability and often cost-effective solutions, and in particular the delivery of co-benefits, in addition to sustaining water for direct human use: for example, the recreational and cultural benefits of an improved landscape, regulating and maintaining soil formation, soil transfer and the health of estuaries, and supporting fisheries.

Climate change provides an additional reason to pay more attention to natural infrastructure solutions. Most commentators recognize that we already have pressing water challenges, even without factoring in climate change. Climate change will, however, make this situation significantly worse. The main impacts of climate change on people are through changes in the water cycle, which are mostly mediated through ecosystem changes. Given that climate change is about ecosystem change, the logical conclusion is that the adaptation responses required, as a priority but not exclusively, need to consider how to manage ecosystem change. This means that managing natural infrastructure has a key role to play to help us cope with such change (Smith and Barchiesi, 2009). Additionally, climate change

in particular is about the changing frequency and magnitude in extremes of water (droughts and floods) – essentially this is about managing risks under increasing uncertainty. One implication of this is that the original design parameters for much of our existing physical infrastructure are becoming increasingly invalid. Without an effective strategy to respond to changing risks we can reasonably expect more systems to fail, including with catastrophic consequences. Natural infrastructure solutions are, therefore, not just about the design and operation of new water management approaches, but also about retrofitting increased risk reduction into highly managed landscapes and river basins.

Using "natural infrastructure" to manage water is by no means a new idea. Examples of it, although not necessarily using this terminology, span at least several decades (and probably millennia). A number of case studies in this book are either based largely on, or contain elements of, such approaches. What is emerging is an increasing willingness to consider such approaches and increasingly by a more diversified range of stakeholders, such as by agriculture, business, drinking-water supply engineers and urban authorities. What stimulates this interest is the increasing evidence base for the approach and, in part, shrinking options for traditional, exclusively hard engineering solutions. There are, however, significant capacity constraints to mainstreaming the approach fully.

Figure 1: A simplified conceptual framework illustrating the role of ecosystems in the water cycle. The ecosystem components of this cycle, including land cover (e.g., forests), wetlands and soils, function as the "natural infrastructure" that supports the water cycle. The figure lists in blue some of the water-related benefits to people (ecosystem services) that this ecosystem functioning provides. In reality, the various services illustrated, and others, are more dispersed, interconnected and impacted by land and water-use activities (not shown in full).



Source: MRC (2003) Mekong River Awareness Kit: interactive self-study CD-Rom. Mekong River Commission. P.O. Box 6101,Unit 18 Ban Sithane Neua, Sikhottabong District, Vientiane 01000, Lao PDR. Secretariat

B. Key components of natural water infrastructure

The following are illustrations of some components of ecosystems with key functions as water-related infrastructure. However, the interconnected nature of the water cycle means that identifying manageable elements of the ecosystem is, in fact, a matter of scale. Most considerations for natural infrastructure are at the ecosystem, that is landscape, level.

1. Plants as land-cover

Plants covering the land surface perform numerous functions, including contributing (through their roots) to soil water infiltration and stabilizing soils, and thereby regulating soil erosion, and through water transpired through their leaves, etc., contributing to humidity levels and thereby regulating local and regional climates. In many areas, particularly the humid tropics, the bulk of rainfall actually arises (or is being recycled) locally through plants. Forests are often the most widely recognized land cover (infrastructure) type and are widely used to protect water supplies. Other land-cover types, such as grasslands, however, can perform similar functions. Depending on the objectives, the land cover does not necessarily need to be "natural". Agricultural crops should also be considered, and managed better, as potential infrastructure. The agriculture–water dialogue is currently dominated by the irrigation debate, in itself an important topic, but there is a great need to focus also on how better management of crops as land cover can be part of the solutions to better water management in the broader landscape.

The majority of the water recycled by plants is recharged (one way or another, and as for most water) through precipitation. There are, however, examples of ecosystems in which plants are directly the original source of recharge of water, including in some cases being the only source: an example is some coastal desert areas that depend almost entirely on plants capturing water from humidity (via condensation), which would otherwise not fall in that area via precipitation; tropical "cloud forests" function similarly, but in this case condensation in the tree canopy is not the major source of water.

It is important to note that because it is widely (mis)understood that plants "use" water (through transpiration) it can often be assumed that removing them increases water availability for other purposes. The evidence, in fact, strongly discredits this notion (although this is very much case specific). Removing land cover can reduce soil water infiltration and accelerate evaporation from land: desertification, for example, is a phenomenon driven in part by the degradation of land cover through, for example, overgrazing of livestock.

2. Soils

What happens in the below-ground part of the water cycle, in terms of management, is very often a case of "out of sight out of mind". Groundwater usually refers to water stored deeper underground, for example in aquifers, whereas "soils" refers to the thin and biologically active surface layer of the land. Soils play a very significant, and often underestimated, role in the water cycle and should be man-

aged as such. The life associated with soils (soil biodiversity) is usually naturally extremely diverse, even in natural deserts, ranging from larger animals such as mammals (moles) and earthworms, through to microscopic bacteria and fungi. These function collectively to support soil health, including regulating (together with land cover) how water enters and stays in the soil (soil moisture) and thereby enables soils to function properly as aquatic systems, and so underpinning other soil ecosystem services, such as erosion regulation, nutrient cycling and carbon storage. Among other things, soil functions underpin the entire world agricultural (and forestry) production and therefore food security. Sustaining soil functionality is therefore a major aspect of water security for food security.

The actual amount of water stored in soils, or rather recycled slowly through soils, is globally and locally significant. Soil is also partly, together with other sources, responsible for recharging groundwater. Degrading soils by, for example, over disturbing them, removing land cover or over applying chemicals essentially results in the loss of these functions and benefits. However, maintaining or restoring this natural infrastructure of soils offers significant opportunities to manage water better, not just for crops, but also for other benefits in the landscape setting.

3. Wetlands

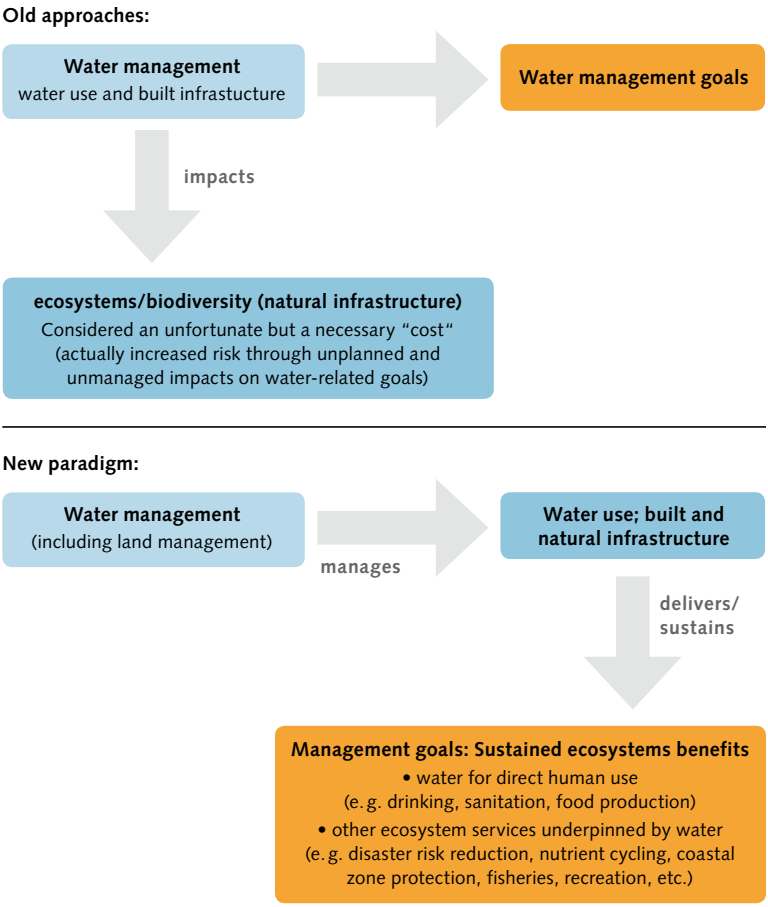
Wetlands, including river and lake floodplains, bogs, mires, permanent and temporary lakes of varying sizes, saturated or high water-content soils (such as peatlands), flowing surface waters (rivers), mangroves and estuaries, are among the most conspicuous components of natural water infrastructure. Wetlands perform significant hydrological functions; for example, as regulators of surface water flows, including in particular flood events, and, in many cases, regulating groundwater recharge. They also perform significant roles in nutrient cycling, including recycling wastes, and in soil regulation, including influencing land formation and stability, particularly in estuaries and along coastal systems. "Wetlands" also includes vegetation associated with them, such as mangroves, which can contribute to wetlands services, such as coastal protection against storms and nutrient cycling.

C. Changing paradigms for water management

There has been a shift towards more proactive approaches to using the environment as an asset to solve water problems. This centres on a better understanding of how the ecosystem functions as natural water infrastructure. Historical approaches tended to be aware that water management impacts ecosystems, but proceeded on the assumption that water use (for humans) was more important than the ecosystem (environment). The values and benefits of the full suite of services provided by the ecosystem were therefore not included in decision-making. The result is an increased overall risk, with the ecosystem and its needs perceived as in conflict with human needs. In the "new paradigm", ecosystems are managed (together with built infrastructure) to achieve a water-management goal of delivery of the full suite of required ecosystem services (including water quantity and quality), and

thereby reduce overall system risks. The ecosystem is seen not as a problem, but as a solution (Figure 2).

Figure 2: Evolving approaches to the water–ecosystem nexus



D. Examples of natural infrastructure solutions to meet water-related challenges

Sustaining, or restoring, natural infrastructure offers solutions to help us manage a multitude of water-related problems. These centre on the interrelated needs to manage water quantity and quality and sustain broader ecosystem-wide, water-related ecosystem services.

Examples of the pitfalls of ecosystem-blind approaches abound and make a convincing case to pay more attention to better ecosystem management. But ecosystem solutions for dealing with uncertainty and risk are best demonstrated through practice, and there is currently a wholesale shift towards this approach. Some stakeholders in the business sector are leading by example. For example, the World Resources Institute (WRI), working in conjunction with the World Business Council for Sustainable Development (WBCSD), has developed the "Corporate Ecosystem Services Review", which helps companies to identify and measure the risks and opportunities that arise from their impact and dependence on ecosystem services (WRI, and others, 2008), within which water plays a prominent role. WBCSD (2011) also makes the case for ecosystem valuation as an integral part of business planning and corporate decision-making. There is a need to upscale such approaches across all relevant business activities.

1. Using natural infrastructure to manage water quality

The basic principle of water-quality management should be that healthy ecosystems, with some exceptions, deliver clean water in the first place. Water quality becomes subsequently degraded through human activity. Poor water quality is, therefore, essentially a problem caused by poor ecosystem management. There are two broad solutions. Firstly, deal with the symptom of the problem by treating water to rehabilitate its quality to the desired level. Mainly this is done using physical water-treatment facilities (water-treatment plants). This can be expensive and such costs are essentially incurred because of the loss of a prior ecosystem service (clean water) previously received for free. The costs of water treatment, therefore, give us an indication of the monetary value of this ecosystem service. But natural infrastructure can often also be used to the same effect, either instead of or alongside artificial approaches (Box 1). Secondly, deal with the cause of the problem by managing the ecosystem better so that water of undesirable quality does not arise at source. This, obviously, and where feasible, involves removing sources of pollution in the catchment. However, alongside this there is often the opportunity to use natural infrastructure to remove or mitigate the impacts of land-use activities on water quality. Examples include at the small scale by restoring vegetation in riparian (river margin) zones to capture sediments and pollutants before they enter rivers, to catchment-scale approaches (Box 2).

Box 1: Constructed wetlands deal effectively with pollution in Lake Manzala in Egypt

Lake Manzala in Egypt is a long, shallow lake on the north-eastern edge of the Nile delta between the two port cities of Dormietta and Port Said. Much of the heavily polluted drain water crossing the delta enters large coastal lakes, such as Lake Manzala, before flowing into the Mediterranean Sea. Contaminated water and tainted fish stocks in the lake represent huge risks to the ecosystem and the region's food security. In response, 0.24 km^2 of constructed wetland were established. These imitate the role of natural wetlands by working as a biofilter to remove nutrients, heavy metals and toxins from wastewater; they treat up to 50,000 m^3 of water per day, removing 90% of traditional pollutants and 75% of toxins. The cleaner water is then used in ponds for local farmers to produce fish fit for human consumption and that can also be used to restock the lake. The benefits are summed up by Project Director Dr. Diaa el-Quosy: "This technology costs only 10% of other technologies, it is environmentally friendly as no chemicals are used and the maintenance of this technology is very simple. The community knows about this new technology and by breeding fish we are creating a stock that can be used to produce more fish," he says.

Source: GEF 2012.

Box 2: Using natural catchment infrastructure to protect water quality

The use of natural infrastructure to protect water supplies, particularly drinking water for cities, is already widespread. For example, the Water Producer Programme, developed by the Brazilian National Water Agency, provides compensation to farmers to safeguard critical headwaters that supply water to nine million people in the São Paulo metropolitan region. Success has spawned similar approaches in other regions of Brazil (The Nature Conservancy, 2010). Likewise, the páramo grassland of Chingaza National Park, in the Colombian Andes, plays a crucial role in maintaining water supplies for eight million people in the capital city of Colombia, Bogotá. An innovative public/private partnership has set up an environmental trust fund through which payments from the water company are transferred to managing the páramo sustainably, potentially saving the water company around US$4 million per year (Forslund and others, 2009).

A key mechanism for implementing these approaches is payments for ecosystem service schemes (PES), whereby the users of a service (e.g., clean water) pay others to sustain its delivery (Smith and others, 2006). In 2006, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes adopted recommendations on PES as a part of integrated water resource management (IWRM) (UNECE, 2007).

2. Using natural infrastructure to manage water quantity

Natural infrastructure offers significant opportunity to meet the challenge of managing water availability, including sustaining mean availability (over the seasonal cycle) and regulating availability in the extremes of drought and flood (Boxes 3 and 4).

Box 3: Natural infrastructure solutions to flood risk reduction

Catastrophic flooding is emerging as one of the most significant sources of increasing vulnerability due to three main factors: increasing human populations and physical infrastructure development in high flood-risk areas (particularly megacities in deltas or floodplains in developing countries); loss of natural infrastructure, particularly wetlands services, that regulate water flows; and most probably the increasing frequency and severity of extreme weather events under climate change.

Most modern flood management plans now consider the use of natural infrastructure such as floodplains and wetlands, and increasingly are also using better management of soils and land cover. Key services of this natural infrastructure include their ability to absorb water rapidly and release it slowly (regulate), and to increase ecosystems resilience by regulating erosion, and therefore landslides, and sediment transfer. These services alone account for some of the highest land/nature values thus far calculated; for example, US$33,000 per hectare per annum for wetlands for hurricane risk reduction in the USA (Costanza and others 2008).

For example, in Viet Nam planting and protecting nearly 12,000 hectares of mangroves cost US$1.1 million, but saved annual expenditures on dyke maintenance of US$7.3 million (Tallis and others, 2008). Similarly, according to Emerton and Kekulandala (2003), the Muthurajawela Marsh, a coastal wetland in a densely populated area in North Sri Lanka, provides several more-visible ecosystem services (agriculture, fishing and firewood), which directly contribute to local incomes (total value: US$150 per hectare and per year), but the most substantial benefits, which accrue to a wider population, are related to flood attenuation (US$1,907 per hectare) and industrial and domestic wastewater treatment (US$654 per hectare).

China runs one of the largest payments for ecosystem services schemes worldwide: the Grain-to-Greens Programme to tackle soil erosion. Soil erosion is believed to be a principal cause of the extreme flooding that took place in 1998. Planting trees or maintaining pasture has restored 9 million ha of cropland on steep slopes. In addition to flood-risk reduction, co-benefits include wildlife conservation, such as positive impacts on Giant Panda habitats (Chen and others, 2009).

However, the economic arguments for natural infrastructure are not always clear-cut. For example, in the case of the Maple River Watershed, USA, Shultz and Leitch (2001) stated that ecosystem restoration delivered insufficient risk reduction.

In many highly managed systems some previous wetlands are now occupied by high-value assets such as buildings which are costly to remove , and there is often the perception that restoring natural infrastructure is an expensive option. But this is not always the case. Managed risk transfer at the catchment scale can be a solution to overall risk management. For example, parts of London (UK) are very

→vulnerable to flooding, and its physical flood-protection infrastructure is ageing rapidly; meanwhile, sea level is rising and extremes in precipitation are increasing. So flood risk managers are now committed to creating space for floodwater where possible through river restoration activities, for example, the London Rivers Action Plan (RRC, 2009). Dykes have historically been used in the upper catchment to protect agriculture, which has, in effect, diverted water more quickly towards London, increasing risks there. Based on the unsurprising fact that crops, livestock and agriculture infrastructures are less valuable than national monuments, major financial centres and high-value housing, and the high population densities in London, part of the flood management strategy now includes removing dykes, thereby restoring wetlands as natural water infrastructure, and compensating farmers for their increased risks. Massive infrastructure maintenance costs and flood insurance premiums for city inhabitants are reduced in the process. Agricultural productivity is not significantly affected and, indeed, could increase, except during the occasional extreme flood – providing evidence that restoring floodplain functionality does not necessarily result in significant losses in longer-term agricultural output. The issue is clearly one of risk, not productivity, and the solution is to understand natural infrastructure, how it works and compensate where increased risk exposure occurs, thereby increasing overall benefits.

Box 4: Rethinking water storage for agriculture: restoring soil functionality

The historical approach to increasing water storage for agriculture was through dam construction and irrigation. However, soil moisture is a major component of the water cycle and therefore to manage soil better is a major opportunity to improve water storage and security for crops. The Comprehensive Assessment of Water Management in Agriculture (2007) concluded that improving rain-fed agriculture, including rehabilitating degraded lands, is a major opportunity to increase agricultural production and achieve global food security. This issue is largely about managing moisture in soil ecosystems.

Conservation agriculture addresses soil water risks using three principles: minimal soil disturbance, permanent soil cover and crop rotation. Agricultural benefits include organic matter increase, in-soil water conservation and improvement of soil structure, and thus of the rooting zone. Other enhanced ecosystem services include regulated soil erosion (reducing road, dam and hydroelectric power plant maintenance costs), water quality, air quality, carbon sequestration, biodiversity/nature benefits and regulated water availability (including flood-risk reduction). Conservation agriculture holds tremendous potential for all sizes of farms, agro-ecological systems and zones. The approach is being adopted on a large scale, for example, in Brazil and Canada. It is also widely used to address water risks for food security in dryland areas, where its multiple benefits offer significant advantages over high-risk and capital-intensive irrigation options. For further reading on conservation agriculture see the FAO website: http://www.fao.org/ag/ca/index.html.

3. Sustaining broader system-wide ecosystem services

The topic of managing natural infrastructure to meet water-related goals often extends well beyond addressing water quantity and quality issues for direct human use. Water underpins all ecosystem functions, so water management potentially affects all ecosystem services. One of the greatest needs is to expand the thinking on water management beyond immediate-use issues into the broader context of balancing the delivery of all ecosystem services. This is a big topic, but an example of the need to think more broadly, demonstrating the value and importance of natural infrastructure, is illustrated by water-management issues and solutions for the Mississippi River delta (Box 5).

Box 5: Rethinking water management through an ecosystem services framework: disaster risk transfer and mitigation in the Mississippi Delta, USA

River deltas are dynamic and complex ecosystems driven largely by hydrology, including the regular transfer of sediments and nutrients from the catchment into lowlands and the estuary. Their functioning underpins numerous ecosystem services, in particular land regulation and formation. This, in turn, delivers benefits through the maintenance of coastal stability and erosion regulation, thereby, for example, reducing disaster vulnerability. The Mississippi River Delta, in common with many rivers, has been highly modified: its hydrology has been changed through water abstraction, principally for agriculture, while reservoir construction, also for hydropower, has interrupted sediment transfer. Additional infrastructure has had to be added, with high investment and operational costs, which effectively are required to compensate for losses in the services originally provided by natural infrastructure; examples include continual dyke and coastal defence development and maintenance in order to deal with a de-stabilizing estuary.

The resulting degradation of associated wetlands infrastructure is now widely regarded as a major contributing factor to the scale of economic and human losses resulting from hurricanes. Hurricane Katrina (2005), in particular, was a catastrophic reminder of the pitfalls of paying insufficient attention to managing natural infrastructure as an asset. If treated as an economic asset, the minimum asset value of the natural infrastructure provided by the delta would be US$330 billion to US$1.3 trillion (at 2007 values) in terms of hurricane and flood protection, water supply, water quality, recreation and fisheries. Importantly, studies suggest that rehabilitation and restoration of this natural infrastructure would have an estimated net benefit of US$62 billion annually. This includes reduced disaster-risk vulnerability and savings in capital and operational costs for physical infrastructure-based solutions (including factoring in the economic costs for existing users of reallocating water use).

Agriculture has historically been a key driver of water-allocation policy. Yet the value of food and fibres produced by agriculture represents only a fraction of the value of the multitude of other services provided by the ecosystem, particularly by wetlands. Historically, planning has achieved reduced risks to agriculture (i.e., by a more stable water supply for crops), using physical infrastructure, at the expense of transferring risks downstream by undermining natural infrastructure there.

→This example illustrates: (i) the importance of understanding how natural infrastructure functions and what it offers in terms of cost-effective solutions (or avoiding problems in the first place); (ii) the importance of valuing ecosystem services more holistically; (iii) the issue is not necessarily a choice between one benefit versus another (in this case agriculture versus wetlands downstream), but how to manage the river infrastructure (both physical and natural together) to achieve the optimal outcome – restoring natural river functions does not require agriculture to be eliminated, it requires a different water and risk management approach to it.

Source: Batker and others (2010).

4. Integrating natural and built infrastructure approaches

Often, natural infrastructure offers better solutions than built or physical infrastructure alternatives, but not always. Sometimes, after thorough assessment, physical infrastructure can be determined as the best option. But most often, natural infrastructure will exist and need to be managed alongside existing or developing physical infrastructure approaches (Box 6). Policy and management approaches need to shift from favouring one approach or another to identifying and implementing integrated solutions that deliver the most sustainable and cost-effective solution overall. In this assessment, it is critical that all the benefits that are delivered by all options, including those beyond just "water management", are identified, properly valued and compared impartially (Krchnak and others, 2011).

Box 6: Maximizing physical infrastructure benefits through restoring natural infrastructure in the Itaipu watershed, Parana River basin, Brazil

The important Itaipu Dam in Brazil is one of the largest dams in existence. The Itaipu watershed includes deep red ferralsols, with good fertility potential, located in a humid subtropical climate characterized by hot, humid summers and mild winters. There is high agricultural productivity, but violent rain storms lead to high erosion and flows of sediments and nutrients into Itaipu Lake. Eutrophication and sedimentation reduce the productivity of the dam. This is being addressed through the community-based "Cultivando Água Boa" (Cultivating Good Water) programme, supported by the Brazilian Federation of No Till Farmers Associations (FEBRAPDP), supported by Itaipu Binacional (Itaipu Dam Enterprise). Success is being achieved by simply transforming agriculture from tillage-based to no-till conservation agriculture (see Box 4). When the dam was built, its estimated working life was 60 years, but by managing soils as natural water infrastructure the life expectancy of the dam has increased tenfold, and farmers benefit through improved crop productivity and sustainability.

Source: Amir Kassam (kassamamir@aol.com), Ivo Mello (ivomello@via-rs.net), Herbert Bartz, Tom Goddard (tom.goddard@gov.ab.ca), Theordore Freidrich, Francois Laurent (francois.laurent@univ-lemans.fr), Norman T. Uphoff (Planet Under Pressure Conference, London, United Kingdom, 26–29 March 2012).

5. Examples of capacity-building approaches

The following two case studies illustrate approaches to using natural infrastructure in practice, focussing on their capacity-building elements. Following from the above, these centre on a "green economy" approach by harnessing the ability of ecosystems, and ecosystem services, to contribute to problem solving regarding water. They are examples of "green" approaches because they are based on the principle of working together with nature, instead of against it, to achieve sustainable economic benefits. Both examples also illustrate the opportunities to manage natural and built infrastructure together, capitalizing on the advantages both have to offer.

(a) Case Study 1: Capacity-building for the ecosystem approach to water resources management: the Tacaná watersheds of Guatemala

This case study was prepared by Welling R., Cordoba, R. and M. Smith (based on Cartin and others, 2012).

The Tacaná watersheds of Guatemala, on the Mexican border, begin in the high-altitude watersheds of the Suchiate and Coatán rivers. These poor and fragile areas are heavily dependent on ecosystem services for livelihoods, but are very vulnerable in terms of ecological and political factors. Unregulated land-use change has damaged the natural infrastructure of these steep catchments, with deforestation reducing the capacity of the landscape to retain water, which caused increases in runoff, a reduction in the soil water-storage capacity and increases in flood risk after intense rainfall. Tropical storms have also devastated the area in the past. Intensive animal farming and a relatively dense population, with associated poor waste and wastewater management, was contaminating rivers and affecting fisheries along the Pacific coast.

Governmental authorities are not well integrated, with little connection between local and national levels. This has led to weak institutional presence, inadequate laws and regulations, budgetary constraints, lack of technical coordination and mutual support among institutions, the absence of integrated policies and limited stakeholder participation and transparency. Historically, there has been no coordination of basin management between Mexico and Guatemala for the Coatán and Suchiate rivers. Furthermore, in parts of the basin the marginalization of indigenous peoples, high illiteracy and mortality rates, very high population growth and a complex system of land-tenure rights are also major challenges. Capacity-building was therefore needed in local communities, at the micro-watershed level and in local governments.

In response, IUCN and partners in Guatemala facilitated capacity-building workshops and training sessions on water-resource management for stakeholders and officials from local through municipal to national levels. During these capacity-building sessions, the interactions between how lower zones of the catchment are affected by the actions of people in the middle and upper zones were analysed and the importance of conservation and management to reduce adverse impacts understood. New knowledge was generated and shared on watershed manage-

ment and particularly on how to use watershed restoration and improved land management as a means of rebuilding natural watershed infrastructure to help meet communities' needs for water security, diversify farm livelihoods and reduced risk of flood disasters.

Capacity-building for these themes has been increasingly integrated under the banner of climate change adaptation. In 2009, IUCN held its first workshop in San Marcos, Guatemala, to train partners on the use of the CRiSTAL Tool (Community-Based Risk Screening Tool – Adaptation and Livelihoods). This was an important step in the development of strategies for climate change adaptation coordinated through ecosystem management and the integrated management of water resources. CRiSTAL helps communities, project planners and managers to understand systemically the links among climate, livelihoods and ecosystem services, including watershed functions. Participants learn to use CRiSTAL to evaluate the impacts of current or future projects on the resilience of vulnerable communities, enabling community initiatives and projects to be designed or reoriented to ensure that the most critical priorities are addressed. In the first workshop, 13 facilitators were trained, including staff from IUCN, OXFAM, EcoLogic Development Fund, the National Forest Institute of Guatemala and the Ministry of Environment and Natural Resources. Participants applied CRiSTAL in the Community of San Pablo in the Department of San Marcos, using a participatory approach in which 53 community members took part. The results obtained were used to update the workplan of the community of San Pablo. Further training workshops then followed to train students at the University of San Marcos to support applications in other communities.

Disaster preparedness is now a high priority for authorities and for water-management institutions when managing climatic variability and climate change adaptation in the region. Local government committees are now working together to be better prepared using tools such as a geographic information system to identify and map those areas more prone to landslides and the possible evacuation routes. Local communities have organized two micro-watershed Councils around the Coatán River and two around the Suchiate River. Built to lead watershed restoration and development that meets their priorities, the Councils were recognized by local governments from the start and mayors participated in the organization process. Learning from these community-led initiatives, a National Micro-watershed Commission has been established to recognize the watershed as a planning unit in Guatemala for environmental management and conservation.

The scaling-up of the micro-watershed approach and the creation of new institutions has improved social capital by making new skills related to water management and to disaster-risk reduction more widely used. By expanding this learning from the local to national level, experiences in the Tacaná watersheds have shown that it is possible to break through a "ceiling of impact" by building up adaptive capacity through the creation of new coalitions at the national level. Through capacity-building, empowerment and linkages at different levels, communities have been able to bridge the limits of their influence and send their messages up-

wards – including the imperative to sustain and restore the natural infrastructure of watersheds.

Further information on the project is available in Cartin and others (2012).

(b) Case Study 2: Capacity-building for the ecosystem approach to water resource management in the Pangani River basin

Prepared by Cross, K., Welling, R. and M. Smith based on Welling and others (2012).

Tanzania adopted its National Water Policy in 2002, followed by the National Water Sector Development Strategy 2005–2015. These ambitious reforms called for the implementation in Tanzania of a comprehensive, integrated and holistic approach to the management of water resources. Basin Water Offices were charged with overseeing the establishment of participatory institutions, including water-user associations (WUAs), which bring together water users across communities that share a water source and catchment forums that include representatives from WUAs across a catchment area. Basin Water Offices are responsible for coordinating water allocation to meet, first, basic human needs and, second, the needs of ecosystems. As a result, determining water requirements for the environment became a priority for the government in order to implement the Water Policy and accompanying Water Resource Management Act (2009).

The Pangani Basin Water Board (PBWB) was one of the first to begin piloting implementation of the Water Policy. Population growth, deforestation, increasing numbers of livestock and the expansion of cultivated land, as well as fishing, mining and hydroelectric power activities, have led to excessive pressures on the basin's water resources. A changing climate has also reduced water availability, with flows in the basin reduced from several hundred to less than 40 m^3 per second. The result of rising demand and falling supply has been the allocation of more water for use than is available, leading to conflict among users and ecosystem decline. With aquatic resources supplying up to 25% of household income in parts of the basin, the poorest have been the most adversely impacted.

Consequently, the Pangani River Basin Management Project was developed to generate technical information and build participatory forums to strengthen integrated water resources management in the Pangani River Basin. A component of the project focused on undertaking an integrated flow assessment (IFA) to understand the environmental, economic and social implications of different river-flow scenarios under expected climatic conditions, while increasing the capacity of technicians to collect and analyse flow-assessment information. The outputs are being used to manage the water-related and water-dependent benefits that the ecosystem provides to people in a more integrated and holistic fashion.

The IFA began in 2005 with the PBWB working with IUCN and other partners in the basin. The assessment was designed to gather data on the hydrology and economic, social and ecological impacts of changes in water allocations in the basin and on river-flow regimes. The data were targeted at supporting evidence-based

decision-making on water resource management and climate change adaptation and played a critical role in supporting dialogue and consensus building among stakeholders and sectors on water allocation and management of natural water infrastructure. The benefits of using, or restoring, natural infrastructure were an integral part of this approach. Examples included: land-use planning options, such as zoning, to protect drinking water supplies; soil protection and erosion control measures, including conservation agriculture, or the prescribed planting of trees, thereby improving the soil ecosystem infrastructure. The project also recognized the crucial role the Pangani River Basin's forests play in hydrology by regulating run-off, preventing soil erosion, storing water and improving water quality.

The assessment produced a series of 17 reports that have underpinned progress in achieving improved and more sustainable water management in the Pangani Basin, with the policy and scientific recommendations from the assessment applied to decision-making. Equally importantly for implementation of the 2002 Water Policy, the piloting of implementation in the Pangani basin has been the source of critical lessons and new capacity for water management in Tanzania. An international team of flow-assessment specialists was contracted to undertake the Pangani studies. Rather than simply managing the consultancy in the standard way, however, the assessment project was designed with an explicit strategy for capacity-building. The international experts on the assessment team were joined by a team of Tanzanian specialists. Funds and time were then allocated to training, coaching and mentoring the national specialists, with the aim of ensuring that one result of the assessment would be a capacity within Tanzania to implement future flow assessments as the Water Policy is rolled out to other basins.

In all, 14 Tanzanian experts were trained and mentored in flow assessment and management, including five staff of the Pangani Basin Water Office, two from the Ministry of Water and Irrigation and five scientists from the University of Dar es Salaam. These experts were joined by 14 others from the private sector and higher learning institutions in specialized studies and training workshops. In follow-up, the Tanzanian team of flow specialists are working on assessments of flow and river health in the Wami and Zigi basins as part of a further implementation of the Water Policy and Water Sector Development Strategy. Lessons learned in the Pangani Basin are being replicated in the preparation of IWRM for all Tanzanian river and lake basins and in development plans (eight other basins).

The PBWB implemented the project with technical assistance from IUCN, the Netherlands Development Organization and the local non-governmental organization Pamoja. The project was financially supported by the IUCN Water & Nature Initiative, the Government of Tanzania, European Commission through a grant from EU-ACP Water Facility and the Global Environment Facility through the United Nations Development Plan.

Further information on the project is available at: http://www.iucn.org/about/union/secretariat/offices/esaro/what_we_do/water_and_wetlands/prbmp_esaro/

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