UNEP

GOOD PRACTICES

FOR REGULATING WASTEWATER TREATMENT

Legislations, Policies and Standards

This report was commissioned by:
The UNEP Global Wastewater Initiative
in collaboration with WaterLex.

WaterLex

WaterLex is an international public interest development organization based in Geneva, Switzerland. It is a UN-Water Partner with UN ECOSOC special consultative status.
Its mission is to develop sustainable solutions based on human rights to improve water governance worldwide, particularly in regard to consistent water law and policy frameworks.
It works with an alliance of interested parties to improve water-governance frameworks, bringing them in line with country obligations under international human rights law.
It is an official member of the UNEP Global Wastewater Initiative.

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The Global Wastewater Initiative

The Global Wastewater Initiative (GW^2I) is a voluntary multi-stakeholders platform aiming to provide the foundations (including information, tools and policy mechanisms) for partnerships to initiate comprehensive, effective and sustained programmes addressing wastewater management.
The GW^2I intends to bring a paradigm shift in world water politics; to prevent further pollution and damage and emphasize that wastewater is a valuable resource for future water security.
The Secretariat for the GW^2I is provided by the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), a UNEP administered intergovernmental mechanism.

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Foreward

Wastewater management encompasses a broad range of efforts that promote effective and responsible water use, treatment and disposal, and encourage the protection and restoration of watersheds. In most countries, wastewater laws generally define institutional roles and responsibilities, laying the foundation for sustainable wastewater management. Other countries, however, may need to strengthen related legislation.

Through the Global Wastewater Initiative, hosted by the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), and other relevant activities, UNEP is committed to promoting sustainable wastewater management. This entails cross-sector global collaboration with governments and other agencies to develop and implement effective legislation, innovative financial mechanisms and wastewater management infrastructure, especially in developing countries.

Wastewater management is challenging on several levels at once.

In most countries, wastewater management is given less priority than water provision, although both are important. An effective national policy is needed to promote the importance of sanitation, set priorities and mobilize resources. However, even with such a policy in place, political will is vital to move from theory to action.

Another issue is the variation in laws, regulations and best practices for the operation and design of wastewater reuse facilities. These standards and guidelines help protect public health, as well as the environment. As such, they must be carefully adapted to local conditions. Lack of agreement about best practices, can however undermine the impact of laws and regulations, putting health and environment at risk.

This publication presents an objective and critical analysis of successful cases for regulating wastewater treatment and management in six selected countries: Argentina, Austria, Finland, Jordan, Singapore and South Africa. It also reviews procedures and processes in the implementation of wastewater legislation, thus providing an understanding of good practices. Whatever their current status with respect to wastewater legislation, all countries may find this compilation a useful tool for addressing the global wastewater challenge.

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Chapter 1. Executive Summary

There is increasing evidence that freshwater quality is in decline across the world. Over the past three decades, the continuous growth in volumes of untreated wastewater as well as the release of hazardous chemicals and materials into watercourses have created an urgent need to monitor and control water quality. In this sense it is both important and timely to examine different local responses to wastewater challenges that have proven their effectiveness. Where good practices exist, it is important that these be documented and shared as learning experiences and as a source of inspiration for both policymakers and practitioners looking for ways to surmount these challenges. This e-book is a response to this need, providing an overview of successful cases, procedures and processes in the implementation of wastewater legislation from different developed and developing countries around the world. This book has four objectives: First, it aims to provide an overview of wastewater legislation adopted by a range of developed and developing countries. Second, it aims to make local lessons in wastewater treatment, disposal and reuse accessible to those who may be considering reform of their own wastewater management practices. Third, it aims to promote the adoption of appropriate standards on the operation and maintenance of wastewater facilities. Finally, it aims to contribute to the exchange of wastewater legislation knowledge and best practices among experts and professionals within the field.

It is important to underline the fact that wastewater regulation and implementation can be highly context specific: Wastewater is managed in a large diversity of climatic systems, with varying water resources availability, levels of economic development, types of economic activity and settlement patterns, all of which impact on the general challenge of wastewater management / water quality management. In the selection of cases, care has been taken to ensure a broad geographical coverage, different levels of economic development and a diversity of wastewater challenges. The cases reviewed cover, amongst other things, subjects such as the contents of wastewater legislation, norms and standards used, water reuse options, and effluent quality standards. However, each case has a unique story to tell, with its own particular combination of historical background, wastewater management practices, operational challenges, operational opportunities, legal framework, and policy guidance. Therefore, each case is presented as a separate narrative, providing the opportunity to explore the internal dynamics and key features that make it stand out as a good practice.

However, the book does more than review cases: Chapter two is devoted to a global overview of emerging trends, looking at the emergence of wastewater treatment, disposal and re-use in a historical perspective. It analyses the variety of operational challenges arising from biological contamination, nutrient enrichment and inorganic pollutants as well as financial challenges in infrastructure development and maintenance. It provides an overview of generic solutions that have been developed in response to these challenges at the operational level, as well as describing the evolution of international thinking on wastewater issues, moving from international declarations and agreements over the decades to the various key anchor points in international law that are applicable in the context of wastewater management. Finally, chapter 2 turns to national law, covering the normative framework for licensing, prohibitions, sanctions and standards as well as procedural norms applicable to wastewater, before going into complementary legal families such as environmental law, public health law, and planning systems.

In chapter three, the first “good practice” case to be treated is the Matanza Riachuelo River Basin in Argentina, where human rights law was applied to overcome institutional fragmentation between the various jurisdictions in the basin and drive a process that led to a significant clean-up of the river. The case stands out in the sense that a change in the approach to river basin management was

driven by a ruling of the Supreme Court, and also by the rather unusual fact that a multistakeholder body from civil society was placed in charge of overseeing the implementation of the court ruling by government agencies.

The second case is from the city of Melbourne in Australia, where the cleansing capacity of nature itself is applied in one of the world's largest lagoon-based wastewater treatment plants, showing how "natural infrastructure" can be applied to good effect even for very large cities. Ten large ponds covering 11,000 hectares both cleanse the wastewater of 1.6 million people and are registered as a wetland of significance by Ramsar as they are a home to a large diversity of bird species.

Next, Finland is taken as an example of comprehensive success, embracing tailor-made technology choices appropriate to both urban and rural settings, institutional innovation in the form of water cooperatives, strictly enforced permit procedures under national law and good observance of EU directives and UNECE commitments. After this the attention turns to Jordan, where operational practices, driven by very high levels of water scarcity, have resulted in exceptionally high performance in wastewater treatment and effluent re-use. In addition the country boasts some of the highest rates of connection to wastewater systems in the Middle East and well developed, demand driven standards for wastewater treatment linked to re-use for irrigation. Singapore, the following case, illustrates the fact that high economic growth rates do not have to go hand in hand with wastewater problems. Singapore has invested heavily in production of water from wastewater treatment, installing some of the world's first plants for large scale indirect potable reuse. Water pollution was treated as a political priority, leading amongst other things to the development of discharge standards, pre-treatment requirements, the unification of pollution control, sewerage, drainage and environmental health under one ministry, the separation of rainwater used water-collection systems, and the introduction of regular water-quality monitoring.

Last but not least, South Africa faced increasing water scarcity in an economy with strong roots in the potentially highly polluting mining sector and a history of dispossession that required strong action to ensure access to safe water for the previously disadvantaged population. In the 1990s it replaced its Uniform Effluent Standards by more stringent Receiving Water Quality Objectives and formulated its commitment to ensure access of the previously disadvantaged to water supply and sanitation in the Water Services Act of 1997 and the masterly and much cited Water Act of 1998. The latter Act has clearly formulated water and sanitation as human rights, as well as the rights of future generations, translating human-rights objectives into clear and measurable targets, while emphasising the importance of participatory processes and sustainability.

Chapter 2. Background and Context of Wastewater Regulation

1. Historical perspective

Water is an essential resource for life and almost all kinds of economic activity. It is fundamental for our daily household activities, and it is a central aspect of public life. Unfortunately, water utilisation does often involve varying degrees of pollution, producing wastewater. This wastewater needs to be treated and safely disposed of, if it is not to negatively affect the water quality of other users or cause damage to ecosystems. Therefore the treatment and disposal of wastewater needs to be effectively regulated, and legal frameworks need to be effectively implemented, and enforced, for water resources to bestow a full range of benefits to humans, to ecosystems and to the environment and, ultimately, for sustainable development and operation to take place.

Wastewater has not been seen as a global concern until fairly recently. However, over the past decades, the continuous growth in volumes of untreated wastewater as well as the release of hazardous chemicals and materials into watercourses, and indirectly into groundwater as a result of wastewater disposal on the ground and underground, has created an urgent need to monitor and control water quality in the wastewater-receiving water bodies, above and below the ground. These challenges of managing wastewater have a long history: For instance, in the late 19th century and early 20th century, the first centralized sewage systems were developed in the United Kingdom and the United States. But as industrialisation, urbanisation and population pressure increased, so has the need to confront the increasing volume of wastewater which was polluting water bodies in and around cities and towns. The decades since the Second World War have seen an increasing emphasis by local governments, states and international aid agencies being placed on water quality, pollution control, and the provision of clean drinking water and sanitation.

Fortunately, recent developments in wastewater management have immense potential to help alleviate some of the problems of water supply, pollution control, waste recycling, health issues related to water-borne diseases, and environmental protection. There are a number of recent trends in wastewater management, which vary according to climatic differences and levels of development and financial resources available for investment. These affirm that far from being only a nuisance, wastewater is now increasingly being seen as a resource, as technologies have advanced and treated wastewater can now be used in industrial processes, for irrigation and for potable water. In terms of the water–energy nexus, wastewater is being recognized as a potential source of energy[1]. In several countries, water and sanitation companies are working towards becoming energy-neutral by generating energy from wastewater that equals the amount of energy consumed in their other operations. Many wastewater treatment plants have been able to generate biogas from wastewater or sludge and convert it to heat or electricity. In Stockholm, for example, public buses, waste collection trucks and taxis run on biogas produced from sewage treatment plants (Osterlin, 2012).[2]

At the same time, there is a rapid and recent increase in institutional momentum around wastewater treatment and disposal. Thus in the context of the Sustainable Development Goals, it is likely that a dedicated goal on water will be accepted by the UN General Assembly being elaborated during 2014, which includes a separate target on water quality. Furthermore, in order to share experiences and raise awareness on wastewater challenges and opportunities, the Global Wastewater Initiative

(GW^{2}I) was approved in 2013 by the UN Global Programme for Action (GPA) for the Protection of the Marine Environment from Land-based Activities. Under the leadership of UN-Habitat and UNEP, the GW^{2}I is a multi-stakeholder platform that aims to promote synchronised action in the field of wastewater management and stimulate partnerships that can initiate comprehensive, effective and sustained programmes tackling wastewater challenges. It is expected to strengthen policy and institutional mechanisms, develop tools for managing and monitoring the impacts of wastewater, and look at integrated approaches and solutions, including joint demonstration projects. Furthermore, the GW^{2}I is expected to be a key global mechanism in the context of the Post-2015 agenda for sustainable development, as wastewater has a direct negative impact on aquatic ecosystems as well as the water quality of downstream users. In this context a dedicated goal on the sustainable management of water in the Sustainable Development Goals (SDGs) needs to include targets and indicators related to the protection of freshwater bodies from pollution, which reverberate eventually on wastewater management and regulation.

i. Operational challenges

Wastewater management poses a number of operational challenges to governments and communities. A staggering 80% – 90% of all wastewater generated in developing countries is discharged without proper treatment into surface water bodies[3]. With increasing population, prosperity, urbanization and industrialisation, it remains a major challenge for municipalities in both developed and developing countries to collect, treat and dispose of increasing quantities of solid waste and wastewater.[4] Communities in direct contact with water bodies can also suffer from untreated sewage, as waterborne diseases transmitted through human excrement are a leading cause of illness and death worldwide, especially in the developing world. Some of the diseases caused by untreated human sewage are cholera, typhoid fever, paratyphoid fever, salmonella, dysentery, gastroenteritis, leptospirosis, meningitis, hepatitis, and various parasitic diseases.[5] According to the World Health Organisation, more than 840, 000 people are estimated to die each year from diarrhoea as a result of unsafe drinking-water, inadequate sanitation and poor hygiene. In addition, excessive concentrations of human waste damages the environment, because it is loaded with biological organisms that consume the natural oxygen content of the water, as well as by nutrients and pathogenic bacteria. Untreated sewage causes eutrophication, which includes the rapid spread of plankton and algal blooms such as red tide, as well as oxygen depletion of hypoxia eutrophication.

According to a study done by the United Nations University Institute for Water, Environment and Health (UNU INWEH), on average, high-income countries treat 70% of the wastewater they generate, while upper-middle-income countries treat 38%, and lower-middle-income countries treat 28%. By contrast, a mere 8% of wastewater generated in low-income countries undergoes any kind of treatment. In North America for instance, of the estimated 85 cubic kilometres of wastewater generated each year, 61 cubic kilometres (75%) is treated. Annually, however, just 3.8% of that treated wastewater is used.[6] Therefore there is a large potential opportunity to use untreated wastewater.

According to the 2010 UNEP/UN-HABITAT Sick Water Report, up to 90% of untreated wastewater flows are generated in densely populated coastal areas, resulting in high levels of pollution of rivers,

lakes, groundwater and coastal waters. The resulting de-oxygenated "dead zones," (caused by hypoxia or oxygen depletion through coastal eutrophication) are spreading, with impacts on fisheries, livelihoods and the food chain. The wastewater produced from agriculture and livestock production constitutes a considerable challenge for downstream users, containing organic and inorganic contaminants originating from fertilizers, pesticides, human waste, livestock manure and nutrients.[7] Similarly, the wastewater produced by mining and industry generates its own set of challenges resulting from water contamination by heavy metals, man-made organic pollutants, and micro-pollutants such as pharmaceutical products.

In addition to these numerous challenges, financing, operating and maintaining infrastructure for wastewater treatment, constitutes a major obstacle, especially in developing countries. The cost of investing in centralized wastewater-treatment systems is typically high. Global investments in modern water and sewer systems have been estimated at some USD $30 billion per year, and by 2025 it may cost USD $75 billion per year, excluding costs for operation and maintenance)[8] In centralized systems, wastewater transport and treatment facilities must be engineered to cope with these irregular extreme flows. For developing countries alone, it has been estimated that USD $103 billion per year are required to finance water, sanitation and wastewater treatment through 2015. Middle-income countries such as Brazil, China and India are all already committing considerable resources to develop their infrastructure.[9]

Although wastewater clearly generates numerous significant challenges, there are fortunately also a number of opportunities, which are listed in the section below.

ii. Operational opportunities

First, there are various ways in which wastewater *treatment* can be approached. Usually the initial stage of wastewater treatment is pre-treatment. This preliminary stage aims at removing solid waste, grease, oil, sand and more generally anything that could hamper subsequent treatment processes. The second stage is primary treatment. This stage is designed to reduce the Biological Oxygen Demand (BOD) of the wastewater by 20% - 30% and reduce the volume of total suspended solids in wastewater by 50% - 60%.

Secondary (biological) treatment removes the dissolved organic matter that escapes primary treatment by using microorganisms which consume the organic matter as food, converting it to carbon dioxide, water, and energy for their growth and reproduction. The biological process is then typically followed by the use of additional settling tanks (secondary sedimentation) to remove sludge produced by the microorganisms. A well running plant with secondary treatment can remove about 85% of suspended solids and reduce BOD. Secondary treatment technologies include the basic activated sludge process, the variants of pond and constructed wetland systems, trickling filters and other forms of treatment which use biological activity to break down organic matter.

Tertiary treatment is additional treatment beyond secondary. Tertiary treatment can remove more than 99% of all the impurities from sewage, producing an effluent free of pathogen. Unless specific conditions allow for extensive tertiary treatment (such as large available space and warm climates) the related technology can be very expensive, requiring a high level of technical knowledge, trained plant operators, a steady energy supply, chemicals and equipment, which may not be readily

available. An example of a tertiary treatment process is the modification of a conventional secondary treatment plant to remove additional phosphorus and nitrogen. Below several options for wastewater management and the use of recycled water are discussed. [10]

An alternative form of wastewater treatment is through the use of "extensive" processes, whereby sufficient time and surfaces are allocated so to provide conditions for nature to assimilate wastes and reduce pollution in the water. For instance, wetlands act as natural filters, removing pollution from waters flowing through them, while recharging aquifers below. Water is cleansed as wetland soils and vegetation trap sediments, heavy metals and pathogenic microbes. Wetlands also sift out nutrients such as nitrogen and phosphorus that cause eutrophication, or the increased production of organic matter that can degrade water quality and threaten fisheries. The economic value of this natural filtering is immense, reducing the need for costly water purification facilities. Wetlands can be natural or manmade.[11]

Secondly, there are a number of options to ***reuse*** treated wastewater. These include the use of treated wastewater for irrigation, for industrial use, for the production of biogas and even to use as drinking water. Some of these uses of wastewater will be described here, along with some methods of wastewater treatment. Examples can also be found in the case studies in the next chapter.

Wastewater can be used to supplement irrigation in regions where irrigation water supplies are limited. However, the quality of the treated wastewater determines which crops can be irrigated, as highly saline drainage water cannot be used to irrigate salt-sensitive crops. In many cases it can be reused on tolerant forages or in a saline agriculture-forestry system.[12] The agriculture-forestry system for the productive use of drainage water and its disposal into a solar evaporator has been developed in semi-arid conditions in California and other regions. According to the Global Wastewater Initiative, wastewater is also a huge source of water and nutrients, which could supply much of the fertilizer required for crop production.[13]

Direct Potable Reuse (DPR) and Indirect Potable Reuse (IPR) are two further uses of wastewater. Indirect Potable Reuse is the reclamation and treatment of water from wastewater (usually sewage effluent) and eventually returning it into the current/natural water cycle upstream of the drinking water treatment plant with intent to reuse the water for potable use. Australia, for instance, has two large IPR projects around the cities of Perth (the Groundwater replenishment scheme) and Brisbane (the Western Corridor Recycled Water Project). Direct Potable Reuse can be defined as either the injection of recycled water directly into the potable water supply-distribution system downstream of the water treatment plant, or into the raw water supply immediately upstream of the water treatment plant either into a service reservoir or directly into a water pipeline. The world's first direct potable reuse plant was commissioned in Windhoek in Namibia in 1968, a region that regularly suffers from severe water scarcity. Currently improvements in technology are finding increasing application in the treatment plants; as highlighted by the recent NEWater plants in Singapore (see chapter 3).

Furthermore, post-consumer waterborne waste is a significant renewable energy resource that can be exploited through thermal processes (incineration and industrial co-combustion), landfill gas utilization and the use of anaerobic digester biogas. Waste has an economic advantage in comparison to many biomass resources because it is regularly collected at public expense. The

energy content of waste can be more efficiently exploited using thermal processes than with the production of biogas: during combustion, energy is directly derived both from biomass (paper products, wood, natural textiles, food) and fossil carbon sources (plastics, synthetic textiles).[14] In the sewage treatment systems of developed countries, large amounts of energy are used to aerate and treat sewage, therefore if energy can be drawn from human waste through the production of biogas, it can help to substantially reduce the costs of wastewater treatment; the anaerobic digestion process both treats sewage and also produces energy rather than consuming it. Another technology gaining traction is the use of water-source heat pumps. Water-source heat pumps are being used in Japan, for instance, to extract residual heat energy from wastewater, after treatment and before discharge by outfall. Similar heat-extraction technology is now developing for extracting heat from wastewater in sewer pipelines. Wastewater temperatures average around 16 degrees Celsius and this heat can be used as an energy resource. Biogas is a green energy source and therefore generating power and heat from burning it can potentially reduce GHG emissions and other air pollutants if it replaces fossil fuels. Due to its benefits, implementation of combined heat-and-power (CHP) plants at wastewater treatment plants is growing as a way to reduce environmental impacts and increase efficiency. In the United States of America, there are 104 wastewater treatment plants using biogas to produce a total of 190 MW (US EPA, 2011).[15] Sewerage systems can also feed turbines where sufficient slope is available. Several small power plants in Switzerland produce electricity with wastewater mains[16].

Affordable, effective and sustainable waste-management practices create multiple benefits for public health and safety, and their environmental benefits may include the reduction of GHG emissions, the prevention of water and soil contamination, the conservation of natural resources and the production of renewable energy.[17]

iii. International initiatives

Over the last eight decades, networks of international experts have emerged in water management, while a series of international initiatives and conferences have contributed to fostering agreement on international programmes and policies and the strengthening of the international legal framework which addresses the issues of wastewater management and the provision of safe drinking water and sanitation.

The development of more comprehensive water regulation and the sharing of technology in the period after the Second World War began with the establishment of the International Water Supply Association, in 1947, and the International Water Quality Association, which transformed into the International Association for Water Pollution Research in 1965. The two groups merged in 1999 to form the International Water Association (IWA).[18] With its headquarters in London, a global secretariat in The Hague and offices in Beijing, Bucharest, Nairobi, Singapore and Washington DC, IWA is a non-profit organisation providing a global network for water professionals to advance standards and best practices in sustainable water management. IWA hosts specialist conferences and workshops annually and annual events coordinated by the IWA include World Water Monitoring Day, to create public awareness and involvement in protecting water resources around the world.[19]

The year 1990 was a landmark in international collaboration on water and sanitation issues. In 1990 the World Health Organisation and UNICEF joined forces to create the Joint Monitoring Programme (JMP), which increased the capacity of the global effort to estimate and document global coverage in access to water-and-sanitation services. This greatly increased insight into the global water and sanitation delivery effort, and enabled comparisons to be made between different countries. Similarly, the Water Supply and Sanitation Collaborative Council (WSSCC) was created through a UN General Assembly resolution, at the close of the International Drinking Water Supply and Sanitation Decade (1981-1990). The WSSCC focuses on sustainable sanitation, better hygiene and safe drinking water. It works on global advocacy and policy initiatives, including the Advocacy and Communications Working Group on Post-2015 WASH targets and indicators, and the Sanitation and Water for All partnership.[20]

A number of international conferences have played a pivotal role in promoting pollution control and wastewater management at both national and international levels. These include the United Nations Conference on the Human Environment in Stockholm, which took place in June 1972, the International Conference of Water and the Environment in Dublin in January 1992, the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, which took place in June, 1992, and the World Summit on Sustainable Development (WSSD) which took place in Johannesburg in 2002. These conferences led to the development of international norms on water management as contained in key politically endorsed declarations and agendas for action serving as reference documents, such as the Action Plan for the Human Environment at Stockholm, the Dublin principles, the Rio principles, Agenda 21 and the Johannesburg agenda for action. These documents represent major milestones in the evolution of international environmental (soft) law.[21]

First, at the Conference on the Human Environment in Stockholm many recommendations were made regarding water management. These included the call for development assistance agencies to accord higher priority to supporting governments in financing and establishing services for water supply, disposal of water from all sources, and liquid-waste and solid waste disposal and treatment as part of the objectives of the Second United Nations Development Decade. Other recommendations dealt with the role of UN agencies such as FAO, WHO, UNESCO and development agencies in the area of water quality governance. International co-operation was recommended in the research, control and regulation of national activities where these affect the aquatic resources of other nations in both freshwater and marine areas, including the regulation of discharges of toxic chemicals, heavy metals, and other wastes.[22]

Second, the International Conference on Water and the Environment (ICWE) attended by 500 experts was held in Dublin in January 1992. The conference adopted the Dublin Statement consisting of four guiding principles concerning water and sustainable development, an action agenda and the Conference Report. The action agenda included a clean water supply and hygienic sanitation, as well as water conservation and reuse. It was considered that recycling could reduce consumption of many industrial consumers by 50% or more and reduce pollution. Application of the "polluter pays" principle and realistic water pricing would encourage conservation and reuse. Compliance with discharge standards would enable downstream

Dublin Principles

Principle No. 1 - Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all level.
Principle No. 3 - Women play a central part in the provision, management and safeguarding of water.

Principle No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good.

consumers to safely reuse water, presently too contaminated after the first use (reuse of untreated wastewater is a common situation in many countries). Conference participants called for political commitment and involvement from the highest levels of government to the smallest communities, backed by investment, legislative and institutional changes, technology development, capacity building, education and communication programmes.[23]

Third, in 1992 at UNCED in Rio de Janeiro, key developments included the adoption of a statement of principles for sustainable development as well as Agenda 21, a comprehensive international agreement on development and environmental protection. Chapter 18 of Agenda 21 focused on the protection of the quality and supply of freshwater resources and included recommendations for artificial groundwater recharge, the use of marginal-quality water, wastewater reuse and water recycling, the generation of energy from wastes and wastewater reuse in agriculture. Chapter 21 in turn deals with environmentally sound management of solid wastes and sewage-related issues.[24] In order to help implement Agenda 21, an international organisation, the International Council for Local Environmental Initiatives (ICLEI) was founded in 1990 and now counts more than 1,000 local government members. Operations began in 1991 at the World Secretariat in Toronto, Canada, and the European Secretariat in Freiburg, Germany.[25]

Ten years after UNCED, the World Summit on Sustainable Development (WSSD) was held in Johannesburg in South Africa in September 2002. At WSSD, the Johannesburg Plan of Action was adopted to promote implementation of the goals agreed on at Rio in 1992.[26]

Another important development in the regulation of wastewater and the protection of the marine environment was the adoption of the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, known as the London Convention (entry into force 30 August 1975). Since 1977, the International Maritime Organisation (IMO) administers it. In 1996, Parties adopted a Protocol to the London Convention (known as the London Protocol), which entered into force in 2006. The Protocol should eventually replace the 1972 Convention and prohibits all dumping, except for possibly acceptable wastes on the so-called "reverse list," contained in an annex to the protocol. The London Protocol stresses the precautionary and the polluter pays principles affirmed at UNCED and emphasizes that Contracting Parties should ensure that the protocol should not simply result in pollution being transferred from one part of the environment to another.[27]

Another important initiative for marine protection, the UN *Global Programme for Action (*GPA*): Protection of the marine environment from land-based activities* was adopted in 1995 by 108 governments to prevent the degradation of the marine environment from land-based activities. The GPA looks at pollution from land-based activities that affect coastal regions such as industrial production and agriculture, addressing the connectivity between terrestrial, freshwater, coastal and marine ecosystems. Providing guidance for authorities on integrated coastal zone management, GPA experts help design and implement action plans to prevent and reduce marine degradation from land-based activities. This includes the elaboration of norms, indicators and strategies to address the impacts of contaminants such as sewage, persistent organic pollutants and heavy metals on food security, poverty alleviation, public health, as well as on coastal and marine resources.[28]

In order to coordinate actions to improve wastewater management, the GPA endorsed the development of the Global Wastewater Initiative (GW^2I), a voluntary network of stakeholders with a Secretariat under the leadership of UN-Habitat and UNEP/GPA. As a platform to exchange information and best practices for wastewater management and to encourage new investments in wastewater, the GW^2I is comprised of UN agencies, international organizations, government agencies, scientists, the private sector and other stakeholders to provide the basis for partnerships and programmes to address the challenges and potential of wastewater.[29]

There are a number of areas where the GW^2I is making contributions to this developing sector, which include the post-2015 discussion on SDG targets and indicators related to wastewater; dissemination of good practices linking wastewater management with food security (agricultural and energy production), poverty alleviation, climate change and water use efficiency. GW^2I has undertaken a study on the economic valuation of wastewater to evaluate the cost of the loss of coastal and marine ecosystems services and which weighs the failure to take preventive measures against the cost of effective wastewater management (*in press*). Pilot projects and communication and outreach campaigns on wastewater management are also among the GW^2I activities, in addition to a biannual scientific and policy conference on wastewater issues.[30]

At the UN General Assembly in September 2000, 147 heads of state signed the Millennium Declaration to create a global framework to support poverty reduction and sustainable development. Eight Millennium Development Goals (MDGs) were established. Millennium Development Goal 7c: was developed to halve, by 2015, the proportion of the population without sustainable access to safe drinking-water and basic sanitation**.** Wastewater management is a key component in terms of this MDG, as drinking water sources need to be separated from the wastewater from sanitation facilities. The WHO/UNICEF Joint Monitoring Programme (JMP) is the formal mechanism to track the progress of the targets of MDG Goal 7c.[31]

In 2014, and in the context of the debate on a dedicated goal on water (goal 6) in the SDGs, three UN agencies -- the UN Environment Programme (UNEP), the UN Human Settlements Programme (UN-HABITAT) and the World Health Organization (WHO) -- formulated a proposal for the development of a monitoring mechanism that would allow reliable and efficient global monitoring of progress towards the proposed water resources and water quality related indicators 6.3-6.6, and for the subsequent proof-of-concept testing of the proposed indicators and methods. This initiative is referred to as the Global Enhanced Water Monitoring Initiative (GEMI). UN-Water, the UN inter-agency coordination mechanism for freshwater-related matters including sanitation, provides the platform for the initiative. In 2014, the initiative expanded to include other agencies with long-standing experience in monitoring water issues: the FAO, UNICEF, UNESCO and the WMO.[32]

2. International framework regulating wastewater management

i. *General principles*

The development of international environmental law during the past three decades has led to the emergence of a number of principles and norms. Amongst others these include the precautionary principle, the polluter pays principle and the preventative principle, in addition to the generalization

of the Environmental Impact Assessment as a monitoring tool which helps to implement these principles. On the other hand, the recognition of access to water and sanitation as a human right have recently led to the articulation of national laws and policies in the field of Water, Sanitation and Hygiene (WASH) complying with the principles and procedures existent in human rights law.

There are a number of general legal principles governing international water law, which apply to the management of watercourses and aquifers common to (or « shared » by) two or more States by virtue of forming the international boundary line or of being crossed by such lines, and which attempt to minimize pollution and to preserve the quality of "shared" water sources. Past experience has shown that remedial actions to clean up polluted sites and water bodies are generally much more expensive than applying measures to prevent pollution from occurring. The principle of ***preventative action*** requires action to be taken at an early stage and if possible before damage has actually occurred**,** requiring that an activity which does or will cause damage to the environment in violation of the standards established under the rules of environmental law to be prohibited. One obligation that flows from the concept of prevention is prior assessment of potentially harmful activities. Since the failure to exercise due diligence to prevent transboundary harm can lead to international responsibility, it may be considered that a properly conducted Environmental Impact Assessment might serve as a standard for determining whether or not due diligence was exercised. Preventive mechanisms also include monitoring, notification, and exchange of information, all of which are entrenched obligations under customary international water law, and are reflected in almost all recent environmental agreements.[33]

Because there can be chemicals in industrial waste and pathogens in wastewater originating from sanitation facilities, the ***precautionary principle*** is important in protecting watercourses from pollution and, in particular, groundwater resources from irreversible damage. The precautionary principle evolved from Principle 15 of the Rio Declaration, which provides that, "Where there are threats of irreversible damage, lack of full scientific certainty shall not be used as reason for postponing cost-effective measures to prevent environmental degradation." The exercise of precaution with respect to risk management can take many forms, including, most commonly, taking pollution-prevention actions or placing the burden of proof safety on the person or persons carrying out or intending to carry out an activity that may cause harm. International agreements in which the precautionary approach appears include: the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea and the 2001 Stockholm Convention on Persistent Organic Pollutants.[34]

Liability rules are deemed necessary to ensure that environmental damage is restored and the costs incurred in cleaning up contamination caused by enterprises are not placed on the public bill, encouraging private enterprises to "internalise" external environmental costs and urging industry to take measures to avoid environmental damage.[35] Since 1972, the Polluter Pays Principle (PPP) has gained increasing acceptance, has expanded in its scope to include all costs associated with pollution, and has moved beyond the developed country context.[36]

Environmental Impact Assessment (EIA) is a practical tool that can help to implement the principles above and the great majority of countries in the world have adopted informal guidelines or mandatory regulations on EIAs, applicable not only to public projects but often also as a direct obligation of citizens. In addition, in many countries informal procedures of impact assessment for governmental activities have been developed. EIA is also widely accepted as a mechanism for public

participation in planning processes and decision-making and a tool to provide information and data to the public regarding projects and other activities.[37] References to EIA are also made throughout Agenda 21.

In terms of human rights relating to wastewater management, one could refer to right to water and sanitation, the right to food, the right to a healthy environment and the rights of indigenous peoples. Linking water governance to human rights law has implications for water-quality management at various levels: First, the human right to water and sanitation requires water to be safe and states party to the International Covenant on Economic Social and Cultural Rights are obliged to ensure that water resources are protected from pollution by harmful chemicals and pathogenic microbes such that water used for personal and domestic purposes is free from micro-organisms, chemical substances and radiological hazards. Second, in terms of the human right to food, there is an implication that water resources should be used sustainably in order to ensure the long term sustainability of food production and such that food can be produced without containing "adverse substances."

Third, in terms of the human right to a healthy environment, it should be noted that more than 177 countries now have explicit reference to this right in their constitutions and it has been used, such as in Argentina, to enforce a clean-up of a polluted river. This issue is discussed in more detail in the case study on Argentina in chapter 3. Under the right to a healthy environment states also have an obligation i) to assess environmental impacts and make environmental information public; (ii) to facilitate public participation in environmental decision making and (iii) to provide access to remedies for harm. Fourth, the rights of indigenous peoples include the principle of self-determination in the governance of natural resources including water, and interventions in these territories require the Free Prior Informed Consent of the groups in question. Improper knowledge of indigenous peoples' rights may, for instance, lead to mining or other concessions being approved that may detrimentally affect the water resources of indigenous people.

On 28 July 2010, through Resolution 64/292, the UN General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights. The resolution calls upon States and international organisations to provide financial resources, help capacity-building and technology transfer to help countries, in particular developing countries, to provide safe, accessible and affordable drinking water and sanitation for all. On 28 September 2011, the UN Human Rights Council passed a new resolution A/HRC/RES/18/1, the human right to safe drinking water and sanitation. The resolution calls on States to ensure sufficient financing for sustainable delivery of water and sanitation services. This constitutes the culmination of a long process for the recognition of the right to water and sanitation, marked by the 2002 General Comment No. 15*:* The Right to Water of the Committee on Economic, Social and Cultural Rights. The human right to sanitation was explicitly recognized through these two instruments, even if it is generally linked to the right to water, which has been explicitly mentioned in several international conventions:

- The Convention on the Elimination of All Forms of Discrimination Against Women, adopted in 1979 *(art. 14 (2))*
- International Labour Organization (ILO) Convention No. 161 concerning Occupational Health Services, adopted in 1985 (art. 5)

- The Convention on the Rights of the Child, adopted in 1989 (*articles 24 and 27 (3)*)
- The Convention on the Rights of Persons with Disabilities, adopted in 2006 (*art 28*)

In the four decades since the *Stockholm Declaration*, recognition of the right to a healthy environment rapidly expanded across the world. As of 2012, 177 of the world's 193 UN member nations recognize this right through their constitutions, environmental legislation, court decisions, or ratification of an international agreement. The only remaining countries not to do so are the United States, Canada, Japan, Australia, New Zealand, China, Oman, Afghanistan, Kuwait, Brunei Darussalam, Lebanon, Laos, Myanmar, North Korea, Malaysia, and Cambodia. Even among these countries, some subnational governments recognize the right to a healthy environment, including six American states, five Canadian provinces or territories, and a growing number of cities.[38] The environmental dimensions of rights are found in a number of human rights treaties – the International Covenant on Civil and Political Rights (ICCPR), the International Covenant on Economic Social and Cultural Rights (ICESCR), the European Convention on Human Rights (ECHR), the American Convention on Human Rights (AmCHR), and the African Convention on Human and Peoples' Rights (AfCHPR).[39] In its preamble the Aarhus Convention asserts that "every person has the right to live in an environment adequate to his or her health and well-being, and the duty, both individually and in association with others, to protect and improve the environment for the benefit of present and future generations."

ii. International treaties

a. Transboundary water basin conventions

As wastewater affects transboundary watercourses when industrial or sewage effluents and agricultural run-off flow into international rivers and lakes or groundwater aquifers, there are a number of legal obligations for states sharing transboundary waters. At customary International water law, there are three key obligations for states sharing international watercourses, in terms of non-navigational uses, rules of law characterized as substantive norms: (i) the obligation to utilize an international watercourse in an equitable and reasonable manner (equitable utilization) ; (ii) the obligation of due diligence not to cause significant harm to other riparian states (the so-called "no-harm rule"); and iii) the "duty to cooperate," which is essential for the elaboration of procedural rules to attain and maintain an equitable allocation of the uses and benefits of an international watercourse. This is usually accomplished through the establishment of a joint body or commission to regulate the transboundary watercourse.[40] Customary international water law also prioritizes "vital human needs" (minimum individual water requirements) under the rule of equitable and reasonable use.

These substantive norms and procedural rules stem from the articles of the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses.[41] The procedural rules consist of the administrative and other measures to fulfil these obligations.[42] Substantive norms and procedural rules are also contained in the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Initially negotiated as a regional instrument, the Convention turned into a universally available legal framework for transboundary water cooperation, following the entry into force of amendments in February 2013, opening it to all UN Member States for accession.[43]

Concerning transboundary waters, there are many well-developed agreements which detail substantive norms and procedural rules governing transboundary rivers and lakes. For instance, Article 5 of the 1995 Agreement on the cooperation and sustainable development of the Mekong River Basin mentions the obligation to utilize an international watercourse in a reasonable and equitable manner. Another example is the 1995 Protocol on Shared Watercourses in the Southern Africa Development Community (SADC) (revised in 2000), which complies with the principles of the 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses. This protocol also contains some articles related to navigation. The international legal architecture regulating international watercourses remains fragmented where 158 of the world's 263 international basins lack any type of cooperative framework; and of the 106 basins covered by agreements, approximately two-thirds do not include all basin states. While such statistics do not account for global and regional treaty regimes, or rules and principles of customary international law, they demonstrate that governance frameworks at basin level are often either lacking or inadequate.[44]

b. Environmental protection

Because wastewater can result in significant pollution of soil and water resources and negatively affect biodiversity and the quality of drinking supplies, there is a need to regulate wastewater through environmental law, which deals with pollution and hazardous waste. Sources of environmental harm include chemicals from industrial sources such as pulp and paper mills, iron and steel works, petroleum refineries, petrochemical refineries, petrochemical industries, fertilizer factories and pharmaceutical plants amongst others.[45] Legislation and conventions have developed in response to transboundary pollution and to a number of industrial accidents which badly affected watercourses and the communities surrounding them, exposing serious gaps in the legal framework.[46] The 2006 EU Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) was developed and is unique in that the burden of proof will be transferred from member States to industry to ensure that risks to human health and the environment are avoided or adequately controlled, which is in line with the Polluter-Pays Principle.

Modern agriculture relies heavily on chemical pesticides and insecticides. These substances enter the environment as agricultural run-off and irrigation overflows. Nitrates from fertilizer and animal manure can also cause significant pollution and this is regulated in a number of countries, for instance in the European context the 1991 Council Directive 91/76/EEC *concerning the protection of waters against pollution caused by nitrates from agricultural sources* helps to establish codes of good agricultural practice and designates areas of Nitrate Vulnerable Zones (NVZ).

There are a number of international and regional conventions, which have developed regarding the management of hazardous substances and chemicals and their impact on ecosystems and human health. European legislation on transboundary water pollution provides a comprehensive regime and includes conventions and directives on liability, pollution control, environmental impact assessment, strategic environmental impact, as well as procedural rules regarding public access to information, decision-making and justice on environmental matters. See the table below for a list of environmental conventions and directives.

Table 2.1 Environmental conventions and directives relevant to water quality management

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted 22 March 1989 (entry into force, 5 May 1992).
The Bamako Convention on the ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa was adopted in Bamako, Mali, 30 January 1991 (entry into force 10 March 1999).
Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Sep. 10, 1998, (entry into force Feb. 24 2004).
Convention on Persistent Organic Pollutants, 22 May 2001, (entry into force May 17, 2004).
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy Official Journal of the European Union L 327, 22/12/2000 P. 0001 – 0073.
REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH),establishing a European Chemicals Agency, Official Journal of the European Union L 396 30 December 2006, (entry into force 1 June 2007).
Convention on Environmental Impact Assessment in a Transboundary Context, Feb. 25, 1991 (entered into force Sept. 10, 1997), reprinted in 30 I.L.M. 800 (1991).
Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, Kiev, 23 May 2003 (entry into force 11 July 2010).
Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Mar. 17, 1992 (entry into force Oct. 6, 1996), reprinted in 31 I.L.M. 1312 (1992).
Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, Jun. 25, 1998 (entry into force Oct. 30, 2001), reprinted in 38 I.L.M. 517 (1999).
Kiev Protocol on Pollutant Release and Transfer Registers under the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, 21 May 2003, (entry into force 8 October 2009).

c. Public health – The World Health Organisation and the UNECE London Protocol

Global multilateral treaties and conventions are binding to states which have ratified them and numerous “soft law” instruments set forth legal standards and normative principles. Soft law, in turn, includes declarations, guidelines, and other instruments that are not subject to ratification by States. Finally, some international organisations are empowered with producing non-binding guidelines, such as the World Health Organisation (WHO). The WHO guidelines on drinking water quality, recycled water for agricultural use and the guidelines for water for recreational use are influential, although they are not legally binding. Within the area of water, microbiology and guideline-setting, there are three areas: drinking water, wastewater reuse and recreational water. The WHO Guidelines for Drinking-Water Quality (GDWQ) were published in 1958 as International Standards for Drinking-Water and were revised in 1963 and 1971 under the same title. To encourage countries of advanced economic and technical capabilities in Europe to attain higher standards, and to address hazards related to industrial development and intensive agriculture, the European

Standards for Drinking-Water Quality were published in 1961 and revised in 1970 (WHO, published by IWA).[47]

In the past two decades, recycling of urban wastewater for agricultural use has been receiving more attention from decision makers as a result of the rapid dwindling of easily accessible freshwater sources, including groundwater and the consequent rise in cost of procuring irrigation water. Reduction in environmental pollution caused by wastewater disposal was seen as a benefit from the recycling of human waste. With this change of paradigm in urban water-resources management, there was a need for guidance on health protection. Representatives from UN agencies, The World Bank and various research institutions developed new guidelines for the reuse of human waste and wastewater. WHO published guidelines on wastewater reuse in agriculture and aquaculture in 1989. In 2006, the WHO published a third edition of its *Guidelines for the safe use of wastewater, excreta and greywater in agriculture and aquaculture*. In four volumes, the guidelines propose a flexible approach of risk management linked to health-based targets that can be established at a level realistic under local conditions, to be backed by strict monitoring measures.[48]

Coastal areas and beaches adjacent to rivers and lakes can be the recipients of industrial, agricultural and sewage waste, affecting the quality of bathing water. The Guidelines for Safe Recreational Water Environments are published in two volumes and Volume 1: Coastal and Fresh Waters (2003) and provide an assessment of the various health hazards encountered during recreational use of coastal and freshwater environments of the health hazards associated with recreational waters of this type.[49]

At present, about 110 million people in Europe, or 12% of the population, still live in homes which do not have access to safe drinking water. According to the best estimates of the World Health Organization (WHO), in the pan-European region more than 13,000 children under the age of 14 die every year from water-related diarrhoea, mostly in Eastern Europe and Central Asia.[50] In 1999, the member States of the UN Economic Commission for Europe (UNECE) adopted the Protocol on Water and Health to the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which entered into force on August 4, 2005, aims to protect human health by better water management, including the protection of water ecosystems, and by preventing, controlling and reducing water-related diseases.[51] The protocol is a legally binding instrument for the States which have ratified it. It is the first international agreement of its kind adopted specifically to attain an adequate supply of safe drinking water and adequate sanitation for everyone, and protect water used as a source of drinking water. Parties to the Protocol commit to set targets in relation to the entire water cycle and this is monitored through a compliance review mechanism.[52]

3. National framework regulating wastewater management

i. Structural level

a. Command/control law : Licencing procedures, prohibitions, sanctions and standards

So-called “command and control” laws rely on prescribing rules and standards and using sanctions to enforce compliance with them. Command and control regulation relating to wastewater requires polluters to meet specific emission-reduction targets and often requires the installation and use of specific types of equipment to reduce emissions. Command regulation in the form of standards

implemented through licenses has been the cornerstone of government attempts particularly in industrialised countries to prohibit or restrict potentially polluting activities.[53] Licenses or permits may use discharge standards, environmental quality standards, and technical specifications. In national law, licensing regimes, and the standards they incorporate, require sufficient regulatory resources to ensure enforcement, as well as adequate scientific evidence to formulate the standards. An example of a licensing regime is contained in the 1991 Water Resources Act of the United Kingdom, whereby no one may discharge polluting substances to water without holding a discharge consent granted by the Environment Agency, allowing the Agency to control the quality of a particular stretch of water by placing limits on the number of consents and attaching conditions to those consents (the majority of consents are given for sewage effluent).[54]

Sanctions will vary from country to country, but will often include certain formal options, such as can be found in the 2011 Enforcement and Sanctions Statement (applicable to England and Wales). In addition to criminal prosecution, sanctions can include: issuing a warning; statutory enforcement notices and works notices; prohibition notices; suspension or revocation of environmental permits; variation of permit conditions; injunctions; carrying out remedial works; civil sanctions; other civil and financial sanctions including Fixed Penalty Notices; issuing a formal caution; prosecution and orders ancillary to prosecution; and sanctions used in combination.[55]

Normally a monitoring system needs to be in place to ensure compliance with water-quality standards and regulate discharges of wastewater. For instance, in Mexico all individual and legal entities must obtain permits from the *Comisión Nacional del Agua* (CAN) for any continuous, intermittent or accidental wastewater discharges into receiving water bodies, or for wastewater discharges infiltrating under the ground to the risk of contaminating the subsoil, including groundwater.[56] Individuals or corporations that carry out discharges are responsible for treating wastewater to ensure compliance with the Mexican Official Norms (NOMs). Article 137 of the 1992 National Water Law (Ley de Aguas Nacionales - LAN, revised on April 29, 2004) requires that all those responsible for discharging wastewater into receiving bodies need to conduct wastewater-quality monitoring and sampling (point 9) and comply with any other regulatory or permit requirements (point 11).

Standards form the benchmarks against which to monitor and assess water quality and processes related to wastewater management, and they are in turn based on the key attributes of national laws which set the normative framework. ISO is a network comprising the national standards institutes of 166 countries. ISO's has developed more than 260 water quality standards which provide a common terminology, water sampling methods and reporting and monitoring guidance to check presence of bacteria, purity and other characteristics. ISO's water standards benefit state authorities and regulatory bodies; industries using water for processing and cooling purposes; the agricultural sector; laboratories and consultants engaged in monitoring activities; water and wastewater service providers; manufacturers of water-related infrastructure; planners, designers, contractors and construction companies; and consumers. [57] ISO technical committees developing standards for water include, ISO/TC 224 *Service activities relating to drinking water supply systems and wastewater systems -- Quality criteria of the service and performance indicators*, ISO/TC 147 *Methods for the measurement of water quality,* ISO/TC 282 *Water Reuse*, which covers both centralised and decentralised or on-site water reuses, direct and indirect ones. This technical committee integrates the work of project committee ISO/PC 253 on treated wastewater reuse for irrigation, which is

working on a best practice standard to prevent any adverse impacts on public health, the environment, soils and crops, as a result of irrigation with treated wastewater.[58]

European Standards (ENs) are documents that have been ratified by one of the three European standardization organizations (ESOs: CEN, CENELEC or ETSI) recognized as competent in the area of voluntary technical standardization per the EU Regulation 1025/2012. The main technical committee developing wastewater standards in the European region is CEN/TC 165 Waste water engineering. A European Standard (EN) automatically becomes a national standard in each of the 33 CEN-CENELEC member countries. They support the essential requirements of EU Directives which are described in the annex ZA of each standard.[59]

In general, each country or economy has a single recognized national standards body (NSB). A national standards body is likely the sole member in ISO. ISO currently has 166 members (as of February 2015). National standards bodies usually do not prepare the technical content of standards, which instead is developed by national technical societies.[60] NSBs may be either public or private sector organizations, or combinations of the two. For example, the Standards Council of Canada is a Canadian Crown Corporation, the Dirección General de Normas is a government agency within the Mexican Ministry of Economy, and the American National Standards Institute (ANSI) is a non-profit U.S. organization with members from both the private and public sectors. Although standards are voluntary with no automatic legal obligation to apply them (which can be an advantage in case the standards are not suitable or don't match with local realities), many laws and regulations may refer to standards and even make compliance with them compulsory. National standards are often approved through a regulation, for instance in South Africa the 2001 Regulations Relating to Compulsory National Standards and Measures to Conserve Water (Compulsory National Standards) was published to give effect to section 9 of the Water Services Act, which provides minimum standards for basic sanitation.[61]

b. Procedural law : Information, participation, access to justice

In most democratic states there are procedural rules which deal with public participation, access to information, and access to justice. The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, (the Aarhus Convention), and its Protocol on Pollutant Release and Transfer Registers (PRTRs) provide a solid and comprehensive framework of procedural rules for governments to engage the public effectively in sustainable development. Both instruments are open for global accession.[62] Under the PRTR reports on releases can be usefully organized according to environmental medium, such as releases to surface water, groundwater, marine waters, air and soil. Releases into a public wastewater-treatment system may also be considered releases for reporting requirements.[63]

Wastewater can affect communities in terms of livelihoods and public health, as well as ecosystems, so the procedural rules regarding public participation can be quite central in monitoring the effectiveness of a regulatory system and improving the enforcement of environmental law. For instance, in order to assess compliance the public require access to monitoring data.[64] Access to information is also important for pollution alerts and for public participation in decision-making. Article 4 of the Aarhus Convention sets out a framework through which the public can gain access to environmental information from public authorities and, in some cases, from private parties,

establishing procedures for providing information or refusing to provide it. Article 5 obliges the parties and public authorities to actively collect and disseminate environmental information to the public, which includes environmental reports, law and policy documents, and pollutant-release-and-transfer information. The UNECE Water Convention requires certain kinds of information, including water-quality objectives, permits and results of sampling and compliance checks, to be available to the public at all reasonable times for inspection, free of charge, and requires the parties to provide members of the public with reasonable facilities for obtaining copies of such information from the parties, on payment of reasonable charges (article 16).[65]

An example of a public participation provision in a national law can be found in the South African National Environmental Management: Integrated Coastal Management Act of 2008, [66] which stipulates that there must be consultation with the ministers, MECs or municipalities and that public that will be affected by a project.

Other examples of public participation are associations or forums which form around an issue or river basin stakeholder organisations. One example of an issue-based group is the Highland Water Forum created in Jordan in 2010, as a response to the over-consumption of groundwater resources. Promoting stakeholder dialogue amongst 60 stakeholders from the agricultural water users, government institutions, NGOs and research institutions, its goal is sustainable management of aquifers in the highlands. An example of an organisation at river basin level is the Danube Environmental Forum (DEF), a network of NGOs working to protecting the Danube River and its tributaries. Targeting pollution reduction and transboundary cooperation, the UNDP-GEF Danube Regional Project has worked to strengthen the DEF regional NGO network and to establish a regional secretariat to coordinate its activities and projects in various countries. The Danube Environmental Forum has a secretariat, 174 member organizations and national focal points from 13 Danube countries.[67]

Participation can have different levels of legal force. For example, public participation is a mandatory substantive requirement for the granting of planning permission. In other situations, participation is facilitated by a procedural "right" to be consulted or heard at an inquiry. In other circumstances, consultation takes place voluntarily in an attempt to use best practice or to settle issues of environmental risk. [68]

ii. Functional level

In terms of the functional level this section will look at three branches of law linked to wastewater management within national legal frameworks, which are environmental, public health and planning law.

a. Environmental laws

In terms of the regulation of wastewater in the legal framework, in addition to a national water act or law, environmental legislation often helps complement the regulation of wastewater. For instance, in South Africa the National Environmental Management Act 1998 (act no 107 of 1998) establishes institutions to promote cooperative governance and coordination of environmental functions exercised by the organs of State. The Integrated Coastal Management Act (act no 24 of 2008) is concerned with protection of the coastal environment including the control of dumping of waste.

Most countries have both sectoral legislation and a framework environmental legislation, while some countries have one or the other or neither. There are countries that have consolidated all of their environmental laws in one single comprehensive statute or code. For example, Sweden has consolidated some sixteen national laws into a single code. The main cause of the development of framework laws in recent years was the realization of synergies within the ecosystems and the linkages in environmental stresses that not even a combination of sector-specific resource legislation and anti-pollution laws were sufficient to safeguard the quality of the environment or to guarantee sustainable development.[69] Framework environmental legislation is a single law that provides the legal and institutional framework for environmental management. It was developed in response to the deficiencies inherent in the sectoral approach to environmental management. It represents an integrated, ecosystem-oriented legal regime that permits a holistic view of the ecosystem, the synergies and interactions within it, and the linkages in environmental stresses and administrative institutions.[70] At the European level, the Water Framework Directive and the Integrated Pollution Prevention and Control Directive are good examples. The directives are transposed into the national laws of the member states. The initial IPPC Directive (96/61/EC 24 September 1996) and the 2008 and 2010 amendments regulate industry to protect the environment through a single permitting process.

In some countries there is an environmental act or code which regulates wastewater. For instance, in New Zealand, under the Environment Protection Act 1970, there is a Code of Practice (COP is prescribed for the management of domestic wastewater: *New Zealand: Code of Practice for Management of Domestic Wastewater* (Ministry for the Environment). A code of practice is a systematic collection of rules, standards and other information relating to the practices and procedures followed in an area and generally demonstrate best practice. The New Zealand COP applies to on-site systems that treat and dispose of, or recycle, domestic wastewater at unsewered sites and on-site systems that treat and recycle domestic grey-water for garden irrigation, toilet flushing and use in washing machines. The code applies to all systems, as defined above, at premises such as industrial sites, residential complexes, hotels, food businesses, community and recreation facilities, schools, shopping centres and camping areas.[71]

b. Public health laws

Public health laws in relation to wastewater relate to the protection of the sources of drinking water supplies from the disposal of wastewater and to protecting the population from contaminants in water, as well as waterborne diseases induced by wastewater disposal practices. Sanitation plays a vital role in everyone's life. Defecating in the open, on streets and in fields is an unacceptable reality experienced daily by over one billion people. Women in particular must protect their dignity by urinating or defecating only under cover of darkness – thereby risking their safety from attack by men or animals, and their health, as they cannot urinate or defecate when they need to. Even where people are able to use a dedicated toilet or latrine, these are frequently unhygienic, unaffordable, or at too great a distance from the home or workplace.[72] In many parts of the world wastewater collection is a huge issue, and when collected, treatment and disposal and/or reuse of domestic or sanitation wastewater is not considered, with wastewater released back into water bodies or into

the ground without treatment. This has an extremely negative impact on the environment, on the quality of water, including drinking water and ultimately on human health.[73]

The strongest domestic legal frameworks exist where explicit recognition of the rights to water and sanitation is included in the national constitution. As the principal legal instrument describing the relationship between the State and residents, as well as the roles and responsibilities of each, the constitution also provides a critical reference point for policymakers, government ministries, judicial bodies, and civil society, all of which aim to influence policy, set standards and hold the relevant actors accountable. At present, many countries have recognised the right to water in their constitutions, including, Bolivia, the Democratic Republic of Congo, Ecuador, Kenya, the Maldives, Nicaragua, South Africa and Uruguay. A few of these constitutions also recognise the right to sanitation.[74]

Concerning wastewater treatment plants, although the primary concern of a wastewater treatment plant is to remove contaminants and inactivate pathogens in the wastewater to protect human and environmental health, there are also several air emissions that should be considered in the protection of human and environmental health. Air emissions from wastewater treatment plants are a health concern for the plant operators and a nuisance concern for neighbours. Contaminants such as pathogens and volatile organic compounds can become airborne in the process of treating the water, especially at sites of gaseous releases or mechanical agitation, such as denitrification, aeration, or mechanical oxidation. Another site of high airborne emissions can be at the exit of pipes. Some of the main nuisance odorous compounds include (hydrogen sulphide, mercaptans, and ammonia), volatile organic compounds (such as hydrocarbons), and bio aerosols. Hydrogen sulphide has an offensive smell even at very low concentrations. It also can be toxic and even fatal at higher concentrations, although more common symptoms include dizziness, headaches, and nausea. Hydrogen sulphide is often controlled using scrubbers, bio filters, or upstream chemical addition. Its formation can be prevented by minimizing anaerobic conditions.[75] Volatile organic compounds (VOCs) are often categorized as Hazardous Air Pollutants (HAPs). Industrial processes are often the source of these organic compounds present in wastewater. VOCs are associated with health effects, and also cause safety problems due to flammability. Most wastewater treatment plants are subject to regulation, for instance in the United States, emissions of VOCs are regulated by the Hazardous Air Pollutant component of the Clean Air Act Amendments of 1990. Releases must be reported to the Toxic Release Inventory, which is accessible to the public. VOC control options include bio filtration, incineration, and carbon absorption.[76]

In terms of drinking water, most countries have laws protecting drinking water sources from contamination sources, notably, the disposal of wastewater, and setting standards for drinking water. An example of national legislation is the Safe Drinking Water Act (SDWA) in the United States, which is the main federal law to ensure the quality of drinking water. Under the SDWA, the Environmental Protection Agency (EPA) sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The law was amended in 1986 and 1996 and requires protection of drinking water and its sources: rivers, lakes, reservoirs, springs, and groundwater wells (but not private wells serving fewer than 25 people.)[77]

In terms of the recreational use of water, legislation concerning the quality of beach water is important because of the risk of exposure to disease-causing microorganisms originating from wastewater disposal operations. In the US the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, an amendment to the Clean Water Act (Section 406) that authorizes the EPA to award grants to eligible states, territories and tribes to develop and implement beach water quality monitoring and notification programs for coastal and Great Lakes recreational beach waters.[78]

c. Planning laws

The decision whether planning permission is granted is usually made by a local planning authority and because of its control usually through a licensing system, the planning authority determines the location of the sources of pollution and the location of the recipients of pollution. By granting planning permission for any new development, planning authorities in effect are also sanctioning a new source of waste and pollution. [79] Municipal and local authorities need to collect wastewater and decide upon the best way to treat it through intensive (mechanical) processes or through extensive processes such as wetlands. The choice of approach and technologies of a wastewater management system be it centralised or decentralised is that it should be context-specific and needs to be made based on the local environment (temperature, rainfall), culture and resources (human, financial, material and spatial).[80]

But it is not always easy to integrate planning law and wastewater legislation, as can be seen in the following example. In an analysis of the state legislation of Pennsylvania, the Environmental Law Institute (ELI) illustrates how sometimes planning laws and wastewater legislation are not necessarily linked in an overall planning process. Two state laws adopted nearly 40 years ago set the rules for sewage facilities and land use. Pennsylvania's Sewage Facilities Act, enacted in 1966, requires every municipality to adopt an official "sewage facilities plan" and to revise it continuously as circumstances change. The Municipalities Planning Code (MPC), enacted in 1968, empowers municipal governments to plan and zone for land use and development.[81] Although the MPC was enacted two years after the Sewage Facilities Act and has been amended several times since then, it makes no reference to that act or its requirements. The MPC provides that a comprehensive plan

"may identify those areas where growth and development will occur so that a full range of public infrastructure services, including sewerage can be adequately planned and provided as needed to accommodate growth." But identification of such areas is not required, and again there is neither a consistency requirement nor a link to the official sewage facilities plan.[82] The ELI goes on to make recommendations to amend the legislation to link the planning regulations with the rules for sewage facilities.

Wastewater treatment plants themselves can be a source of nuisance for a community. The treatment processes employed within wastewater treatment plants can, and sometimes do, have an impact on the environment with the emission of offensive odours the most significant concern to nearby residents. Often buffer zones are recommended to help with this problem. For instance in the U.S., the EPA recommends the implementation of buffer distances for wastewater treatment plants in its *Recommended Buffer Distances for Industrial Residual Air Emissions*, EPA Publication No. AQ 2/86, July 1990 (Buffer Guidelines). Buffer distances are intended to discourage the development

on land within a designated area that is sensitive to the operation of wastewater treatment plants. The Buffer Guidelines provide for variations to recommended buffer distances, but only after specified criteria, such as effectiveness of emission control technology, complaints history, plant size and topographical, are considered. [83]

Conclusion

As the timeframe for the Millennium Development Goals (MDG) nears completion, attention is now turning to the post-2015 development agenda. It is increasingly being recognized that the issues of wastewater management and water quality have cross-linkages with a range of other issues, such as the water, energy and food nexus. There is an understanding that wastewater management clearly has a role in achieving future water security in a world where water stress will increase (OECD, 2012). Against this backdrop, there is an emerging consensus on the need for a dedicated water goal in the post-2015 Development Agenda, one which includes explicit recognition of the importance of good wastewater management and its contribution to protecting water quality.[84]

Untreated wastewater is a key factor in the rise of de-oxygenated dead zones that have been emerging in the seas and oceans across the globe. According to the World Water Council, this is becoming increasingly a global problem as urban populations are projected to nearly double in 40 years, from current 3.4 billion to over 6 billion people – but already most cities lack adequate wastewater management due to aging, absent or inadequate sewage infrastructure. According to the 2012 Fourth World Water Development Report, presently only 20% of globally produced wastewater receives proper treatment. Treatment capacity typically depends on the income and the capacity and commitment of public utilities to spend a portion of this available income into wastewater treatment. It also depends on how public utilities are regulated for that matter. Up to 90% of wastewater in developing countries flows untreated into rivers, lakes, underground and highly productive coastal zones, threatening health, food security and access to safe drinking and bathing water (Corcoran et al., 2010).[85]

With the increasing pressures on water resources with population growth, industrialisation and urbanisation, wastewater offers opportunities to help alleviate problems related to pollution, water supply, environmental protection and health issues related to water-borne diseases. Wastewater can be used as an energy source and for reuse in agriculture and industry, which can help to diminish freshwater abstractions. Recognising wastewater as a resource reduces water pollution by preventing the disposal of contaminated wastewater into water bodies. Reusing wastewater has therefore two main advantages: it improves the living conditions of the local population through the generation of economic opportunities, better food production and reduction of water pollution in these areas.[86]

Wastewater treatment can help alleviate the widespread problem of eutrophication due to nutrient loading from agriculture and industry. The deterioration in water quality resulting from eutrophication is estimated to have already reduced biodiversity in rivers, lakes and wetlands by about one-third globally, with the largest losses in China, Europe, Japan, South Asia and Southern Africa. The quality of surface water outside the OECD countries is projected to deteriorate further in the coming decades as a result of nutrient flows from agriculture and poor/non-existent wastewater

treatment, with the number of lakes at risk of harmful algal blooms expected to increase by 20% in the first half of the century (OECD, 2012)[87]

As this chapter demonstrates, the right to water and sanitation and the right to a clean environment are being increasingly integrated into international law and national law. The case studies in the next chapter will also demonstrate how these rights, when present in national law, can empower citizens to pressure government or industry into action to protect the health of local populations, as well as the environment. The procedural rules to facilitate these rights, access to information, decision-making and justice, are also becoming more integrated into national legal systems in democratic states. Regional conventions like the UNECE Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, (the Aarhus Convention) help to implement these procedural rights by the citizens of states which ratify the convention.

Wastewater treatment has an important role to play in terms of protection of human health from pathogens, heavy metals, pharmaceutical residues and therefore public health law has also been a factor in this sector. International conventions such as the Basel (hazardous waste), the Rotterdam Convention (hazardous chemicals and pesticides) and Stockholm Conventions (persistent organic pollutants) provide governments with the legal and monitoring tools to control the substances entering watercourses in order to protect public health and the environment. At the regional level, the European REACH legislation along with a number of other EU Directives such as the 1991 Urban Waste Water Treatment Directive, the 2000 Water Framework Directive, the 2010 Directive on industrial emissions (integrated pollution prevention and control), the 1991 Nitrates Directive and the 2008 Marine Strategy Framework Directive all address issues such as control of chemicals, nitrates, heavy metals and other pollutants in wastewaters from damaging the status of the waters of both freshwater and coastal areas. In addition to these directives, there are a number of UNECE conventions which deal with transboundary issues which can be found in table 2.1. There are also international river and lake basin commissions that monitor and collaborate with different stakeholders to manage transboundary watercourses and wastewater management is a key component of the issues that these commissions deal with, in line with the trend to integrated water resources management. So taken together, human rights law, multilateral environmental agreements, public health law and transboundary water law have created a comprehensive legal framework for the management of wastewater.

The question of investment and resources available for the construction of infrastructure and maintenance of wastewater systems is one that not only developing countries face, as the infrastructure in many developed countries is aging and needs significant investment to be renewed. The issue of financing will be addressed further in chapter four of this book. Technology is also changing providing different options, such as the use of wetlands and lagoons and decentralised or small-scale wastewater technologies for rural areas or villages. Local standards should match the local reality and authorities need to take local conditions into account when choosing amongst these options, some of which are described in the section operational opportunities of this chapter. There is another side to the investment question, and that is financial losses due to loss of productivity and healthcare costs where sanitation systems are inadequate. Improving access to safe water and basic sanitation could have huge economic returns. World Bank studies in five South-East Asian countries estimate that ~2% of their combined GDP is lost because of poor sanitation, and in the worst case

(Cambodia) this figure rises to over 7% (World Bank, 2008*a*). Economic benefits due to saved time provided by the proximity of a sanitation facility (which will eventually be spent on productive activities), improvements in health include lower health system costs, fewer days lost at work or at school through illness or caring for an ill relative (Hutton et al., 2007). The prevention of sanitation- and water-related diseases could save ~USD $7 billion per year in health system costs, and the value of deaths averted, based on discounted future earnings, and would add a further USD $3.6 billion per year (Hutton et al., 2007).[88]

It is clear that there are new opportunities to use wastewater, but that those opportunities have yet to reach their potential. A paradigm shift is now required in water politics and wastewater management, not only to protect human health, biodiversity and ecosystems, but also to change our view to seeing wastewater as a resource and that effective management of wastewater can contribute to future water security.

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Chapter 3. Case Studies

Argentina: Matanza-Riachuelo River Basin

1. Practice

With an area of 2,736,690 km^2, Argentina is composed of 23 provinces and the government of the City of Buenos Aires, the federal capital. In 2013, the overall population was 41.5 million, out of which 92% urban[1]. Although most of the population has access to improved water and sanitation facilities (99% and 97% respectively)[2], in 2001 only 42.5% of the population was connected to the wastewater collecting system and treatment[3] and in 2014 only 11.75% of collected sewage was treated before being discharged[4].

During the 20th century, water and sanitation services went from being nationalised at the beginning of the century to being decentralised at the province-level in the 1980s, and finally, underwent a strong privatization process starting the early 1990s[5]. In the Greater Buenos Aires region, the private concession to *Consorcio Aguas Argentinas* stopped in 2006 and water and sanitation services are since provided by a public regional company, *Agua y Saneamientos Argentinos S.A.* (AySA)[6].

The 64-km long Matanza-Riachuelo River is located in Buenos Aires Province, and it flows through Buenos Aires City, discharging into the La Plata River. Its catchment area is 2,240 km² and it is home to 6.1 million inhabitants[7]. The basin falls within various jurisdictions: the National Government, the Provincial Government (Buenos Aires) of the Autonomous City of Buenos Aires and 14 municipalities located in the southern suburbs of the province of Buenos Aires[8].

The highest concentration of urban poor in Argentina can be found in the river basin, with approximately 10% living in informal settlements often affected by floods or close to open garbage dumps. The lowest income households living along the river are also those most affected by the river contamination, which ranges from untreated organic waste to toxic industrial chemicals[9].

The river is heavily contaminated by urban domestic wastewater. In 2009, the four AySA wastewater treatment plants only treated 5.3 % of Buenos Aires City's wastewater. At that time, another treatment plant was under construction, to increase the City's treatment capacity by 120,000 m^3 per hour (current output is 2,249,494 m^3/day)[10].

The river's other main source of pollution is untreated effluents from industrial discharges. The catchment area is very dynamic, with 3,000 - 4000 industries producing 25% of the country's GDP, but this industrial activity has also generated heavy pollution. It is estimated that 83,000 m³ of untreated refuse were dumped into the river each year, with 80% of the pollution being produced by just 65 companies: in 2002, the sources of pollution were 33% petrochemical, 11% paper and textiles, 7% metals, 4% food producers, 3% animal skins and 2% meat and dairy. The dumping by tanneries and slaughterhouses gave the river its red colour and its name ("Matanza" means "slaughter"). Among the most dangerous contaminants were heavy metals at dangerous levels: arsenic, chromium, lead and mercury. Child mortality was twice as high as in the rest of the province and half of all children between ages 7 and 11 had lead in their blood and some chlorine in their urine[11].

The acute environmental and social degradation of the river basin is the result of limited public infrastructure investment, poor environmental management, lack of adequate urban and industrial

planning, and limited public infrastructure investment[12]. The river's pollution has been a contentious political subject since the end of the 19th century but attempts to clean up were only initiated in 1993. Despite a multi-million dollar Inter-American Development Bank loan, the corresponding environmental management plan was never implemented, due to inadequate institutional and legal frameworks to coordinate the involvement of different government jurisdictions[13].

In 2002, citizens' complaints from the neighbourhood of La Boca ("the mouth" of the river, i.e. where it discharges into the La Plata River) had been sent to the National Ombudsman, based on the human right to a healthy environment which is protected by the Argentinian Constitution, as well as on the human right to water and sanitation which has been recognized by Argentina. The Ombudsman, who leads the National Human Rights Institution of Argentina, filed a complaint[14] that led to an investigation. During the investigation, the Ombudsman worked with universities, well-known NGOs[15] and local ombudsmen to clarify the problems and to mobilize additional public opinion. They produced several reports in 2003[16] and 2005[17] presenting first-ever data compilation on the issues at stake in the river basin and allowing the issue to be recognized as a national priority[18] by the then President Nestor Kirchner[19].

On the basis of this comprehensive period of study and public consultation, the National Ombudsman recommended the establishment of an inter-jurisdictional Basin Authority. In parallel to this process, in 2004 a group of citizens brought the case to the High Court of Argentina, invoking the constitutional right to a healthy environment. Two years later in 2006, after the publication of the second report written by the Ombudsman, the Court ruled that the accused (municipalities, the Province of Buenos Aires, central government and the companies) should submit a joint plan to clean up the river, which would be submitted to the community through public hearings before the Supreme Court[20]. As part of the ruling, the Court also summoned the private companies to prepare reports detailing the measures they would take in order to halt and reverse the pollution in the river basin [21].

In September 2006, the first public hearing took place, in which the government authorities presented the Riachuelo Basin Clean-Up Plan as well as the creation of an inter-jurisdictional committee on the basin –the Matanza-Riachuelo River Basin Authority (ACUMAR), which was henceforth in charge of the implementation of the plan.[22] After several other public hearings, on 8 July 2008, the Supreme Court gave its final sentence in what is now known as the Mendoza Ruling[23]. The Court ruled "that the Government of Argentina, the City of Buenos Aires, and the Province of Buenos Aires were equally negligent and responsible for not controlling the degradation of the Matanza-Riachuelo."

The Court also ordered an accelerated action programme for the clean-up of the river, consisting of seven components:

1. Providing public information;
2. Controlling industrial pollution control;
3. Closing unsanitary solid-waste dumps;
4. Constructing water supply, drainage, and sewerage networks;
5. Improving the river banks;
6. Attending to the environmental public health crisis; and
7. Enforcing and monitoring the implementation of the court ruling[24].

To implement the last component, the Court authorised the National Ombudsman and the NGOs involved in the case to establish a Chartered body to oversee the implementation of the clean-up plan; set the Auditor General of Argentina to take financial and budgetary control over the programme; and designated

a federal judge to oversee the programme, whose decisions are final and cannot be appealed[25]. It is important to point out that the Supreme Court dealt with the environmental aspects of the case only, leaving other aspects aside and assigned to other courts (such as the civil case for damages, which will take several more years before any decisions are taken).

Since the 2008 ruling, the National Ombudsman has been coordinating this Collegiate Body composed of representatives of civil society and NGOs, which has held weekly monitoring meetings, produced periodical reports and presented hundreds of statements in court[26]. In order to strengthen public participation in the process, they also held discussion forums and coordinated actions with relevant stakeholders[27].

As a result, so far, 70,000 tonnes of refuse have been removed from the river and 243,000 m³ of rubbish dumps have been cleaned[28] through state funds. The Government of the City of Buenos Aires has been very active in cleaning up its portion of the river, with the Environmental Protection Agency implementing various programmes (including monitoring the quality of the water, promoting biodiversity restoration to support absorption of contaminants and developing environmental education)[29].

The public company providing water and sanitation services, AySA, and the Government of Argentina have responded to the Court ruling by developing a comprehensive and ambitious wastewater investment program which includes conveying wastewater to two large pre-treatment plants to screen for trash removal and skim floatable materials, before discharging the wastewater through long outfalls to the La Plata River with diffusers to dilute the wastewater. To complement this, a number of smaller secondary wastewater treatment plants are also being built in distant urban areas. The 2020 water quality objective for the Matanza-Riachuelo River is to achieve Class IV standards suitable for passive non-contact recreation[30].

The National Human Rights Institution (NHRI) of Argentina, which took on a leading role in ensuring a human rights based approach towards the violations revealed in relation to the River Basin, has been instrumental in these major developments[31]. Unfortunately, for the last three years, no Ombudsman has been appointed to head this institution (the ombudsperson must be elected by two-thirds of the bicameral Congress and no consensus has been found recently), which greatly slows down the implementation of the various judicial decisions to clean up the river basin.

Despite this weaker institutional context, the environmental branch of the Ombudsman's office holds session every two weeks with civil society to effectuate progress on implementation forward. Apart from public hearings, public access to information on the Collegiate Body's work is made public through a website (in Spanish), i.e. http://www.dpn.gob.ar/areas.php?cl=24&act=list. As part of the social monitoring project led by the Foundation for the Environment and Natural Resources (FARN), another website (in Spanish) is also in place with a map presenting the main sources of contamination and efforts to clean up: http://quepasariachuelo.org.ar/. It provides geo-referenced information, enabling local actors to report incidents and monitor the clean-up plan, as well as other sources of information such as a documentary[32].

The Matanza-Riachuelo case is interesting from various points of view. Firstly, it shows how progress can be achieved in cleaning up a highly polluted river. Although the process of reducing pollution has not been completed, the case is interesting in demonstrating how institutional momentum can be generated in this direction. Secondly, the legal origins of the change are in fact not codified in or based on classical wastewater legislation, but are rooted in human rights law, i.e. the human right to water and sanitation and the human right to a healthy environment.

2. Legal framework

Argentina has a national water framework *(National Law Nr. 25.688 - Environmental Management Regime of Water*)[33], which sets the minimal environmental requirements for water preservation and its rational use. This law considers the watershed as the environmental unit for the resource management and sets the role of the Basin Committee, formed by the various jurisdictions that comprise them[34].

Each province enacts legislation related to natural resources. In the case of Buenos Aires Province, the law concerning water resources is *Law Nr. 12.257 - Water Code of Buenos Aires Province*[35]. It provides that water planning is a function of the Water Authority[36] (Art. 5), which is responsible for the creation of Basin Committees (Art. 121)[37].

Several articles of the Argentinian *National Constitution* were instrumental in the case of the Matanza-Riachuelo River Basin. The first of these were *Articles 86 and 43* which were introduced via the constitutional reform in 1994, establishing the Ombudsman's Office. The Ombudsman's Office is an autonomous institution whose objective is to investigate and protect the rights and interests of individuals and the community against acts and omissions by the national public administration and the control of the public administration activity. It can propose legislation. In Argentina, the Ombudsman has a strong environmental focus and deals with water and sanitation as part of the broader theme of environmental governance, which covers pollution from industrial and domestic sources, environmental risks faced by children, environmental impacts of the use of agrochemicals, mining, deforestation, watershed management, social participation and management of urban solid waste. In cases where water and sewage related public utilities are involved, the Ombudsman deals with individual complaints on service quality and investments plans through its public services division. As coordinator of the Collegiate Body, the Ombudsman monitors compliance based on the orders of the Supreme Court in the Matanza-Riachuelo River Basin case. It reports to the Court about the enforcement of programmes submitted by the authorities, makes observations on the proposed measures and has requested inclusion of pending issues onto the agenda[38].

Another core article of the Constitution for the Matanza-Riachuelo case is *Article 41 on the right to a healthy environment* (also from the amended Constitution in 1994). The appeal to the High Court of Argentina in this case was predominantly based on this human right:

> *Article 41. All inhabitants enjoy the right to a healthful, balanced environment fit for human development, so that productive activities satisfy current needs without compromising those of future generations, and have the duty to preserve the environment. Environmental damage shall generate as a priority the obligation to repair it under the terms that the law shall establish.*
>
> *The authorities shall provide for the protection of this right, for the rational use of natural resources, for the preservation of the natural and cultural patrimony and of biological diversity, and for information and education on the environment.*
>
> *It falls to the Nation to dictate laws containing a minimum budget [necessary] for protecting the environment, and to the Provinces [to dictate] those laws necessary to complement the National laws, without such laws altering local jurisdictional [authority].*

The entry into the National territory of dangerous or potentially dangerous wastes and of radioactive materials is prohibited[39].

Finally, the human right to water is implicitly recognized in the Argentinian Constitution, which includes through its article 75 inc. 22, the Human Rights Treaties ratified by Argentina, among which the International Covenant on Economic, Social and Cultural Rights (Articles 11 and 12); the Convention on the Rights of the Child (Article 24.2.c); and The Convention on the Elimination of All Forms of Discrimination Against Women (art. 14.2.h)[40].

In addition to these Constitutional articles, *General Environment Law No 25.675* (2002) also played a very central role in providing a legal framework to take action and curb the environmental degradation of the watershed. The General Environmental Law lays out the organizing principles and the basic framework of Argentina's environmental policy. The law is organised around the precautionary principle, and policy instruments include the evaluation of environmental impacts, a control system of the development of human activities, environmental education and information dissemination, and the promotion of sustainable development. It calls for "the competent authorities" to take measures to protect the environment, to implement voluntary restrictions, as well as incentives and measures to promote environmental management[41].

3. Policy and guidance

In Argentina, as in many other countries in the world, water management is characterised by a sectorial and institutional fragmentation, both at national and provincial level. Further, lack of resources, technology and judicial gaps in the legal framework limit the capacities of competent authorities to develop policies, efficient management and monitoring and control functions[42].

The Water Resources Federal National Plan (2006) is a joint initiative of the Federal Water Council and the Water Resources Secretariat. It is based on the "Guiding Principles of Water Policy in Argentina." Its objective is to promote Integrated Water Resources Management (IWRM), through a participatory process to facilitate coordination and cooperation among all agencies that have an impact on water management[43].

In 2008, the judgement of the Supreme Court condemned the state government, provincial government and the City of Buenos Aires to establish a clean-up plan for the Matanza-Riachuelo river basin, with three main objectives: to improve the quality of life of the watershed's inhabitants, to improve the state of the environment (water, air and land) and prevent future damages[44].

In 2009, the Collegiate Body coordinated by the National Ombudsman published a report synthesizing the results of the monitoring work undertaken relating to the Court's decisions. In it, it highlighted the positive aspects and those measures that needed to be further developed, in particular by the Basin Authority in charge of implementing the clean-up plan. Among the positive aspects, the fact that specific targets had been set (by 2010, creation of a public register of dangerous substances emitted for the whole of the industrial and services sector, by 2015 50% decrease in all industrial spillages of chrome, cadmium, mercury, lead and discharges of degradable organic matter or nutrients leading to potential eutrophication and by 2020, elimination of all spillages, discharges, emissions, etc.), that inspections were being held to control industrial contamination, that there were works planned for an integrated storm water management in the basin – a crucial issue for this flood-prone area[45].

Negative aspects included:

- The absence of a measuring system to monitor progress in the implementation of the measures decided by the Court;
- The absence of a register of contaminating agents;
- No real public information system was in place;
- The need for the institution to be strengthened both financially and in terms of human resources;
- The extremely slow rhythm of inspections;
- Inconsistencies in the regulations and standards related to recuperating the quality of the waters: resolutions 1/2007 (Acceptable Limits for discharges of Liquid Effluents, 1/2008 (Regime of Contaminating Agents), 2/2009 (Regulation for the conformation to programs of industrial reconversion) and 3/2009 (Regulation on Uses and Objectives of Water Quality);
- Weak measures to dismantle and relocate the highly contaminating Dock Sud Petro-Chemical Complex;
- Unclear public information provided on the state of the environment in the watershed (water and air) with no comparable parameters, thus preventing contamination assessment;
- Lack of interest in mechanisms of citizens' participation, required to build consensus and implement policies in the watershed; and
- Insufficient territorial planning[46].

In 2010, the Basin Authority presented a new plan of action to the Supreme Court, taking into account the limits identified in the Collegiate Body's report[47]. That year, the Basin Authority started an intense industrial pollution programme focusing especially on the most polluting industries, in particular the slaughterhouses, tanneries and electroplating enterprises. In two years, it had surveyed 85% of the industries (over 9,500) and identified 1,500 as pollution sources, out of which 84% had presented their pollution control plan[48]. In 2013, progress was identified in the following areas: production of environmental information, partial removal of open-waste dumps, studies on health and development of plans of public works[49]. Still pending, however, are more technical clean-up objectives, infrastructure works to contain sewage contamination, achievement of inspection of all polluting companies and the development of a land management plan for the basin[50].

The Blacksmith Institute identified the Matanza-Riachuelo river basin as one of the 10 most toxic threats in 2013, which shows the long path still ahead[51]. However, a USD 838 million lending programme from the World Bank (approved in 2009 and expected to terminate in 2016) will provide support to the government's integrated basin clean-up, while improving sanitary conditions and providing conditions for long-term safe disposal of wastewater from the Buenos Aires Metropolitan Area. In addition to strengthening the institutional framework for the clean-up of the river basin, the programme focuses on improving sewerage services by expanding transport and treatment capacity, supporting the reduction of industrial discharges and improving decision-making for sustainable land-use and drainage planning[52].

Conclusion

The Matanza-Riachuelo River Basin case illustrates how a legal framework strongly supportive of human rights (right to a healthy environment, right to file complaints to a national human rights institution) can start reversing a process of environmental contamination linked to untreated industrial and domestic wastewater. As highlighted by the Collegiate Body, which monitors the implementation of the river basin's clean-up plan, after decades of inaction and lack of initiative from the competent authorities, it was the ruling from the Supreme Court of Justice, which finally forced the governmental authorities to start

improving the socio-environmental conditions of the watershed[53]. Some of the experience generated by the Matanza-Riachuelo river basin case, one of the 30 most polluted river basins worldwide, can be shared to contribute to improve the cleaning up and environmental restoration of other basins facing similar conditions[54].

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Australia: Melbourne

1. Practice

With 7,741,220 km2, Australia is the world's sixth largest country by land area[1]. Its population of 23.5 million is concentrated in the capital cities of two coastal regions – the south-east and east and the south-west[2]. The climate is humid subtropical with some tropical and oceanic zones. The Gross Domestic Product is USD billion 1,560.4[3] and the country enjoys the 2nd highest Human Development Index[4]. Improved water and sanitation facilities are accessible to 100% of the population[5].

The country is also the driest inhabited continent and water scarcity has been worsening with growing population and climate change effects, especially decreasing and irregular rainfall patterns and increased number of droughts. The relatively high availability of water per capita hides the fact the resource is totally used. Total renewable internal freshwater resources per capita is 21,272 m³/inhab./year and total water withdrawal is 22.6 million m³/year, allocated between agriculture (74%), municipal demand (16%) and industry (11%)[6]. Water allocated to agriculture has steadily declined with droughts and policy changes to return water flows to rivers, so despite important water conservation steps across the most affected states, water reclaimed from wastewater has become a major resource for irrigation since the 1990s[7]. Recycled water for agriculture schemes have been established successfully in the states of South Australia, New South Wales, Victoria and Queensland by the heavily-subsidised development of agricultural zones close to wastewater treatment plants[8].

More than 92% of wastewater is treated[9]. The country has 580 municipal wastewater treatment facilities that treat 2 billion m³ of wastewater/year and direct use of treated municipal wastewater is 21%, including 14% for irrigation purposes. There are more than 270 water reclamation schemes in the country, with 237 million m³ of reclaimed water being used for pastures, dairy farming and horticulture, while golf courses, sports grounds and parks use around 33 million m³[10]. Overall, agriculture uses 82% of all recycled water[11].

Melbourne, the capital of Victoria State and one of Australia's largest and driest cities, faced eight droughts since its establishment as a city in 1847–the last one being the Millennium Drought from 2002 to 2010[12]. Over the past decade, the 4-million-inhabitants city has managed to overcome water scarcity by achieving large-scale wastewater reuse for two large peri-urban irrigation schemes, both located near the city's two wastewater treatment plants[13].

The public water company, Melbourne Water, manages the Western Treatment Plant (WTP) which started operating in 1897 and currently serves 1.6 million people, and the Eastern Treatment Plant (ETP), which started operating in 1975 and serves 1.5 million people. Together, both plants allow to produce almost 50 million m3 of recycled water per year, used mainly for agriculture irrigation[14].

The uniqueness of this case is the fact that almost 52% of the city's wastewater (or 500 million m³/day) is treated in 11,000 ha of lagoons in the Western Treatment Plant, a world leader in environmental and technical innovation[15]. Located 30 km west of Melbourne, on the coast of Port Phillip Bay, the plant was

initially known as the Werribee Farm, a mixture of ponds, wetlands and grazing fields to manage the pasture produced by sewage irrigation. Land filtration (in the summer) and grass filtration (in the winter) alternated starting the 1930s[16]. The livestock yielded a substantial return of about Australian dollars 3M/year, which significantly reduced the cost of sewage treatment for the city. Starting 1996, ponds and traditional land and grass filtration were progressively phased out and replaced by modern lagoons to cut nitrogen discharge into Port Phillip Bay and reduce its eutrophication[17]. The plant's $160-million full upgrade was achieved in 2004, allowing to produce recycled water[18]. As a result, 2005 marked the first large-scale wastewater reuse irrigation scheme, with 60,000 m³ per day of tertiary treated water (ultraviolet disinfection and chlorination) provided to 170 customers in the Werribee Irrigation District[19]. Indirect benefits of the upgrade included reduced greenhouse gas emissions and odours by trapping methane under lagoon covers, which is then used to generate electricity and allows the site to make significant energy savings[20].

The plant is made up of three lagoon systems with 10 large ponds, each of which can hold around 600,000 m³ of water. The wastewater is progressively treated through the ponds for approximately 30 days, after which the treated effluent is either recycled or discharged to Port Phillip Bay. As such, the water meets Class C recycled water quality requirements and it is used onsite to maintain habitat for migratory birds and for agricultural activities. To meet Class A recycled water quality requirements, it undergoes further treatment (ultraviolet disinfection and chlorination), and is then partially used for irrigating food crops and public open spaces, such as sports grounds and gardens. The remaining part receives additional treatment to reduce the salt load before being distributed for non-drinking domestic use[21]. Each year, the treatment plant produces over 40 million m³ of recycled water[22].

The area around the plant hosts thousands of birds and is listed as a wetland of international significance under the Ramsar Convention since 1982. It is also a centre for education and research and as such, is visited by thousands of people each year[23].

Western Treatment Plant (©Melbourne Water)

Land-use in the Western Treatment Plant will be diversified according to the vision for 2025, which includes private sector involvement and prioritisation of higher value uses of recycled water: onsite conservation for biodiversity and habitat and onsite irrigation for salinity management, potable and river water substitution, onsite irrigation for agriculture[24].

The Eastern treatment Plant is a more classic plant that started operating in 1975 (with primary and secondary treatment) and was upgraded in 2012 to include advanced tertiary treatment (ozone and biological media filtration coupled with ultraviolet and chlorine disinfection) to minimise the impact of discharge in the ocean[25]. It delivers 5 billion litres million m³ of Class A recycled water/year for irrigating market gardens, golf courses, racetracks and residential developments, making it the largest ultrafiltration plant of Australia. The Eastern Irrigation Scheme, which also started in 2005, and which supplies 35,000 m³/day of tertiary treated water to 80 customers, does not face the same difficulties as the Western Irrigation Scheme, as its inflows are mainly of domestic origin (not industrial) and thus less heavily loaded with salts[26].

Illustrating the major change of mind-set that Melbournians have experienced in favour of water conservation following the 1982-1983 and the 2002-2010 droughts –which led to a close to 40% reduction in per capita consumption between 2000 and 2009[27]- other pathways to substitute potable water are also being explored. These include greywater irrigation at the household level (70% of Melbournians reported domestic greywater reuse in 2007), use of rainwater tanks (encouraged by government rebates), use of treated wastewater for non-potable domestic uses (toilet flushing, garden watering, car washing and irrigation of public amenities), treating storm water for irrigation of public open spaces and desalination[28].

2. Legal framework

In Australia, each state and territory has the responsibility to regulating and manage natural resources and public health within its jurisdiction[29]. In the State of Victoria, the legislation and most of the regulation for wastewater management and recycling is thus the responsibility of the Environment Protection Authority (EPA) Victoria, with an approval or support role from the Victorian Department of Health and Human Services[30].

The *Environment Protection Act 1970*, which embodied the need to reduce the input of nutrients into inland rivers and the ocean for pollution prevention, covers[31]:

1. On-site wastewater treatment plants, which are defined by their size (less than 5000 litres per day design capacity) and cover the treatment and dispersal of domestic wastewater (either sewage or greywater). This regulatory framework covers both the disposal and recycling of wastewater. The approval to install a system is with the local government. EPA Victoria maintains a list of on-site systems that may be installed through a "Certificate of Approval" system. There is also the active policy that on-site blackwater recycling is not encouraged where a reticulated sewerage system is available. Covered today by the *2008 Guidelines for Environmental Management Code of Practice – on-site wastewater management*

2. Wastewater treatment plants that discharge to the environment and have a design capacity of greater than 5000 litres per day. These are required to be approved or licensed by EPA Victoria under the *Environmental Protection (Scheduled Premises and Exemptions) Regulation 2007*. However, water recycling schemes that meet the relevant EPA Victoria guidelines are eligible for

an exemption from licensing: *2003 Guidelines for Environmental Management: Use of Reclaimed Water, 2005 Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes - Health and Environmental Risk Management* and 2008 *Guide for the Completion of a Recycled Water Quality Management Plan: For a Class A Scheme*. Under these guidelines, the Department of Health works with EPA in individually assessing and endorsing schemes that involve the use of Class A recycled water. "Class A" is the quality of recycled water required for high exposure uses including those in residential developments (e.g. "dual pipe" systems for toilet flushing and garden use), the irrigation of public open spaces where access is unrestricted, and the irrigation of crops that are consumed raw or unprocessed[32].

3. Large schemes (greater than one mega litre per day). These require approval from EPA Victoria and Class A schemes (where recycled water is used for purposes with a high likelihood of direct contact) require both EPA Victoria approval and endorsement from the Department of Health and Human Services.

The Victorian Parliament has passed the *Environment Protection and Sustainability Victoria Amendment Act 2014,* which provides for changes to institutional and governance arrangements for the waste and resource recovery sector but does not impact the wastewater sector[33].

Along with dwindling water supplies due to the droughts of the 1980s' and 2000s, it was the Victorian EPA's amendment of the waste discharge licence for Melbourne's Western Treatment Plant (to achieve a reduction of 500 tonnes/year of nitrogen by 1 January 2005) which prompted the development of the large-scale water recycling scheme. This was following the 1992-1996 environmental study conducted by the Commonwealth Scientific and Industrial Research Organisation to assess the health of Port Phillip Bay[34].

Wastewater reuse legislation first started in the 1970s, as a result of the government's change of standpoint to consider wastewater as a resource following the 1972-1973 drought[35]. It is covered by acts relating to food safety, public health and/or environmental protection. Among these, the *Health (Amended) Act 1977 and Health (Use of Waste Water) Regulations 1978* regulate the use of wastewater reuse (with microbiological standards). Each state authority is responsible for defining the quality of water that can be used to irrigate fruits/vegetables and each state and territory has guidelines for reclaimed water use. Recycled water guidelines establish targets to remove pathogens, nutrients, toxicants and salts[36].

The Water Act 1989 (Victoria) sets out the powers, duties and functions of Melbourne Water, which include management of Melbourne's water supply and sewerage systems, waterways, drainage, storm water and recycled water[37].

Monitoring and enforcement of the legislation still needs improvement; in particular, the Victorian EPA needs to make publicly available the number of licences and complaints of suspected breaches of the 1970 Environment Protection Act and carry out appropriate prosecutions[38].

Standards

Until a few years ago, both the National and State guidelines for recycled water use were based on matching defined classes of water (established according to their pathogen burden, biochemical oxygen demand and turbidity) with preapproved uses. The highest quality of recycled water - class A - could be used for a range of non-drinking purposes, such as firefighting, irrigating a variety of food crops including those which can be consumed raw, watering parks, gardens and sports grounds, toilet flushing, laundry use, car washing and garden watering. The lowest classes - C or D - could only be used for irrigation of non-food crops (e.g. flowers, woodlots, etc.)[39].

In 2006, in the face of increasing pressure on freshwater resources, the National Water Quality Management Strategy Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (AGWR) was released, to establish consistent standards for reclaimed water schemes across the country and to introduce the risk management framework promoted by the World Health Organization's Guidelines for Drinking-water Quality. The AGWR does away with the class-based system and advocates a risk assessment-based approach. The national guidelines are not mandatory, and several states have elected not to adopt the new approach. For Victoria, the preventative risk management framework, microbial risk assessment for the determination of log removal requirements and the need for validation of treatment processes were already present in state guidelines[40]. In Victoria, the Class A water quality objectives described in EPA publication 464.2 are no longer applied: the Department of Health has adopted the "fit-for-purpose" approach outlined in the Australian guidelines for water recycling[41].

3. Policy and guidance

Among the most influential policies related to wastewater management, the *2004 National Water Initiative* was signed by all of Australia's state and territorial governments to ensure a homogeneous approach across the country in how water is measured, planned for, priced and traded[42]. It encouraged water conservation in cities, via increased use of wastewater among others[43]. This national water reform is led by the National Water Commission, with regular assessments being made[44].

At the same time, the Victorian Government's *2004 White Paper: Securing our Water Future together* was written in response to the drought, exploring alternative water sources including recycled water and providing an action plan to better use and manage Victoria's water resources[45].

Many specific guidelines were developed throughout the decades, at both State and national level[46]. Among the most recent:

- *2003 Guidelines for Environmental Management: Use of Reclaimed Water (EPA Victoria)*: for recycled water schemes from sewage treatment plants, outlining the regulatory requirements for the scheme and the basis under which an exemption from an EPA Victoria licence can be granted.
- *2005 Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes – Health and Environmental Risk Management (EPA Victoria)*: developed to address Class A schemes that

require endorsement by the Department of Health. Dual pipe schemes entail that both potable water and recycled water are supplied to the household in two different pipes, the latter for non-potable uses such as toilet flushing, car washing, household-garden watering. Several such schemes have developed in Melbourne, either as housing developments around the Western Treatment Plant or the Eastern Treatment Plant, or as residential estates with their own treatment plant, such as the 25,000-resident Aurora development in the north-eastern corridor of Melbourne. In this area, more than 50,000 additional residences are planned to have dual pipe connections within the next 20 years[47].

- *2006 National guidelines for water recycling*: each reclaimed water scheme is individually assessed; water quality targets, treatment processes and additional preventative measures are tailored to produce a safety level consistent with the proposed end use of the reclaimed water.

  The emphasis is no longer on end of line testing but on developing a multi-barrier approach to reduce risk to an acceptable level[48].

In Melbourne, the institutional set-up for wastewater management is the following:

- The Melbourne and Metropolitan Board of Works (now known as Melbourne Water) was established in 1891 to oversee the construction and management of the city's sewerage system,

  to counter the typhoid and other health-related issues brought on by the city's four-fold population expansion due to the gold rush of the 1850s[49]. The public company owned by the Victorian government now manages water supply catchments, sewage treatment, water recycling, protection of rivers and creeks, as well as major drainage systems through

  partnerships with government and industry (developers, builders and landowners, among others)[50].

Melbourne Water works in close collaboration with the governmental institutions involved in wastewater recycling[51]:

- The Victorian Environmental Protection Agency (EPA) is responsible for developing and applying best practice management guidelines for reclaimed water irrigation, as well as auditing and reviewing their effectiveness.
- The Department of Health and Human Services is responsible for ensuring that Class A reuse schemes do not pose a risk to public health.
- The Council/local government controls development zoning, minimum subdivision size, infrastructure size, infrastructure provision, and land use controls. Depending upon the selected application of the recycled water, a large recycled water development requires approval from the council for setting up/construction of the required infrastructure for recycling.

Conclusion

Melbourne, a city of 4 million inhabitants, is home to one of the world's largest lagoon-based wastewater treatment plants. Over the past decade, the Western Treatment Plant has produced recycled water which is used mainly for irrigation and also increasingly for non-potable domestic use. This large-scale wastewater reuse reflects the mind-shift Melbournians have had to make in favour of

water conservation, facing increasing episodes of drought as has happened at the beginning of the 21st century.

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Finland

1. Practice

Finland leads several international comparisons related to water, such as the Water Poverty Index (WPI), which ranks countries according to resources, access, capacity, use and environmental impact; Finland was placed at number one in 2002.[1] The total area of inland waters in Finland is some 10% of the total area of the country. In terms of the population served by water services the population connected to the drinking water network is 90% and the coverage for connection to a wastewater network is 81%.[2] Finland has a substantial sector to collect and treat wastewater with close to 85% of wastewater being treated, and about 150,000 km of water and sewage networks. Some of this sewage infrastructure, built 50-60 years ago, now needs renewal. The case study looks at the practices and the legal and policy framework, which has contributed to the efficiency of Finland's wastewater sector.

Finland has a number of wastewater plants using the energy content in the sludge from wastewater to produce biogas. One example is the Viikinmäki wastewater treatment plant run by the Helsinki Region Environmental Services Authority (HSY). This plant, the largest in Finland and the Nordic countries, started operations in 1994 and is serving about 800,000 inhabitants. Together with the tunnel leading to the sea, it has replaced several smaller treatment plants. Roughly 270,000 m³ of wastewater per day flows through the plant, and an average of 100 million m³ of wastewater is treated each year, of which about 85% is domestic wastewater and 15% industrial wastewater. With the energy produced from biogas at the plant, the treatment plant is self-sufficient in heating and about 50% self-sufficient in terms of electricity. The plant produces about 60,000 tonnes of dried waste sludge per year, which after processing is used as soil for landscaping. In the Viikinmäki plant, all solid and oxygen-consuming substances as well as 95% of the phosphorus and 90% of the nitrogen are removed. The plant must comply with the quality requirements of the Helsinki City Council's policy regarding the Baltic Sea. Air and water emissions related to specified compounds must be communicated to the Finnish National Pollutant Release and Transfer Register.[3]

In Finland, a variety of small-scale wastewater treatment systems are available for rural areas where it is not possible, because of high costs or an isolated location, for a building (i.e. households or farm buildings) to join a centralized sewer system, or to be a part of any other cluster system. These small-scale plants governed by the Finnish Government Decree on Domestic Wastewater Treatment in Areas Outside of the Sewage Network (209/2011) usually contain a pre-treatment stage, combined biological and chemical treatment stage and offtake for phosphorous. Usually both electricity and chemicals are required for the operation of these plants. The different types of package-plants include batch plants, active sludge plants, biorotors and biological-chemical plants. There are models

An example of a small-scale plant

Photo Satu Miettinen.

available for single-family use, but also for use by several households connected to one system. The systems operate either by treating toilet waste and washing waters separately or by treating toilet and washing waters together. [4]

Another interesting aspect of water management in Finland is the co-operative: a small, private, not-for-profit water organisation. The first water co-operatives in Finland were established about one hundred years ago. Rural municipalities established piped water supply systems to cover urban municipalities, but they could not afford extending water distribution to sparsely populated, predominantly farming areas, outside urban centres. In the beginning water co-operatives were usually established for water supply only, but over the years many co-operatives have expanded their services to sewerage and wastewater treatment. Some Finnish co-operatives are quite large serving more than 10,000 people.[5] Currently Finland has some 1,400 water co-operatives, most of them supplying a fairly small number of users. Yet, despite their generally small size, these co-operatives play a central role in providing water and sanitation services especially in the rural areas.[6] Co-operatives are regulated by the 2001 Co-operatives Act, which provides the basic legal framework.

2. Legal Framework

The Finnish legal system is considered as part of the civil law. The water legislation of 1902 and 1961 was designed to protect both public interests, as well as the private interests of land and water owners, the regulation could not be classified solely as private law or public law, and led to the creation of the Water Courts pursuant to the 1961 Water Act. The Water Court's jurisdiction dealt with a wide range of judicial and administrative matters, with its role as a permit authority being the most prominent.[7]

Today, water protection in Finland is based on the legal provisions of the 1961 Water Act (last amended in 2011), the 2000 Environmental Protection Act (last amended 2014) and the national implementation of the EU Water Framework Directive through these and other laws and regulations. Finland has strict permit procedures, according to which environmental and water permits are required even for small projects and production facilities. Permit procedures involve assessments of the environmental impacts of specific operations, and the consequent setting of controls. Permits are granted only after considering factors related to water use and impacts on the status of waters covered by the relevant river basin management plan.[8] Other national legislation related to implementation of the EU Water Framework Directive,[9] which defines the minimum efficiency of wastewater, as well as legislation related to the implementation of the Waste Water Directive and the Nitrates Directive, as indicated below.

- The 2004 Act on Water Resources Management. In 2011, the Act on Water Resources Management was amended with a new chapter on management of the marine environment management. Consequently, the name of the act was changed to "Act on Water Resources and Marine Environment Management" (272/2011).
- The 2006 Decree on Water Resources Management
- The 2006 Decree on Hazardous and Harmful Substance on Aquatic Environment
- The 2004 Decree on Water Resources Management Regions is the main regulation for organisation of river basin management.
- The 2006 Government Decree on Urban Waste Water Treatment deals with the treatment of wastewater from industrial facilities and municipal wastewater collection systems..

- The 2011 Government Decree on Treating Domestic Waste water in Areas Outside Sewerage Networks sets minimum standards for wastewater treatment and treatment facilities for households not connected to main sewer networks.
- Finland's 2000 Nitrates Decree controls the use of nitrate fertilisers in farms across the country in compliance with the EU Nitrates Directive.[10]

In the period from 1961 to 1995, environmental regulation in Finland was based on a sectoral approach. Permits for sewerage or dealing with wastewater from industry were issued by the water courts. County governments were responsible for other sectors. Local authorities (municipalities) could issue permits only for small-scale activities (which then covered all relevant environmental elements). Administrative reforms in 1995, merged the environmental permitting and enforcement authorities at the regional level, but it was not until 2000 that a major legislative and administrative reform enabled a fully integrated approach to the permitting and enforcement of industrial activities on all scales including the permit to discharge wastewater.[11] Pursuant to this reform, the Environmental Permit Offices (now known as the Regional State Administrative Agencies) replaced the Water Courts. The Regional State Administrative Agency acts as the state permit authority in the field of the Environmental Protection Act and the Water Act. The Vaasa Administrative Court, in part derived from the former Superior Water Court, hears appeals of this agency, as well as of the municipal agencies. It is the only administrative court in the area of environmental protection and water law in Finland, with both judges (justices) and full-time expert members (non-lawyer) with technical and ecological expertise.[12]

As a member of the EU, Finland must implement the Urban Waste Water Treatment Directive,[13] to protect the environment from the adverse effects of discharges of urban wastewater from settlements and of biodegradable industrial waste water from the agro-food sector (e.g. dairies, meat industry, breweries). The Directive requires sewage collection and regulates discharges of wastewater by specifying the minimum type of treatment to be provided and setting maximum emission limit values or the major pollutants.[14] Wastewater treatment plants must meet the requirements of environmental permits. In the technical assessment of the Wastewater Directive published in 2012, Finland scores high on a number of the articles in the implementation of the Directive.[15] Implementation of the Directive is linked to meeting the environmental objectives in the WFD and the Marine Strategy Framework Directive.[16] Despite Finland’s good performance in implementing the Wastewater Directive, the European Commission brought a case against Finland (Case C-335/07, Commission of the European Communities v Republic of Finland) for failing to fulfil obligations under the Directive to require more stringent treatment of nitrogen in treatment plants of urban wastewater from agglomerations of more than 10,000 inhabitants. In the judgment of October 6, 2009, The European Court of Justice dismissed the Commission’s action against Finland noting that the Waste Water Directive does not provide for a general obligation to require tertiary treatment of nitrogen from the discharges of every treatment plant of urban wastewater from such agglomerations.[17]

The Environmental Protection Act transposes the EU Integrated Pollution Prevention and Control (IPPC) Directive into the Finnish law with regard to industrial emissions. The IPPC Directive has now been replaced by the 2010 Directive on industrial emissions (which integrated pollution prevention and

control).[18] The 1996 IPPC Directive and its amendments of 2008 and 2010 regulate industry to protect the environment through a single permitting process. To obtain a permit, operators have to show that they have developed proposals to apply the Best Available Techniques (BATs), which are to be found in guidance documents known as BREFs.[19]

With regard to transboundary cooperation on water, Finland has three bilateral commissions with its neighbours Sweden, Norway and Russia and, corresponding, bilateral agreements. Commissions collaborate on issues such as water management, fisheries, flood risk management and environmental protection with the municipalities, the private sector, public authorities and other stakeholders. Wastewater from industries, like steel mills and pulp and paper, as well as nutrient loading from municipal wastewater plants and agriculture are the basis of some of the transboundary water issues affecting the region. It will be recalled here that the Baltic Marine Environment Commission (also known as the Helsinki Commission or HELCOM), leads the transboundary collaboration concerning the Baltic.

As a member of the EU, Finland has ratified a number of UNECE Conventions in addition to international conventions, which deal with environmental impact assessment, chemicals, pollution, hazardous waste management and public participation. Please refer to the table in chapter 2 for a list of these UNECE Conventions. Finland has also ratified the 1992 UNECE Convention on Transboundary Watercourses and International Lakes and the 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses, two key conventions in transboundary water management.

The right to water and sanitation and the right to environment

The right to water and sanitation is not explicitly enshrined in the Finnish constitution but the right to environment is contained in *Section 20 - Responsibility for the environment,* which states: "Nature and its biodiversity, the environment and the national heritage are the responsibility of everyone. The public authorities shall endeavour to guarantee for everyone the right to a healthy environment and for everyone the possibility to influence the decisions that concern their own living environment."[20]

Finland has ratified several international conventions containing provisions in relation to the right to water and sanitation such as the Convention on the Elimination of All Forms of Discrimination against Women, the International Labour Organization (ILO) Convention No. 161 concerning Occupational Health Services, the Convention on the Rights of the Child and the Protocol on Water and Health to the 1992 UNECE Water Convention, which contains provisions for an adequate supply of safe drinking water, adequate sanitation for everyone and the protection of water used as a source of drinking water. This in addition to the International Covenant on Economic, Social and Cultural Rights. Section 6 of the 2001 Water Services Act provides that, when there are a relatively large number of inhabitants or health considerations or environmental protection, a municipality must make sure that appropriate measures are taken to establish a water supply plant to meet the need and secure the availability of sufficient water services. This would not apply to Finland's more scarcely populated rural areas, with dispersed settlements where water services are small-scale and often set up by individual households. The Water Services Act also provides that water services should provide a sufficient amount of household water with respect to health, as well as appropriate sewerage in terms of the protection of health and the

environment and household water supplied by the plant should meet the quality requirements of the Act on Health Protection (736/1994). It stipulates that the general supply conditions for water services must be fair and equitable.[21]

Standards

The 1998 EU Drinking Water Directive lays down the essential quality standards at European Union level. A total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly. In general, the WHO guidelines for drinking water and the opinion of the Commission's Scientific Advisory Committee are used as the scientific basis for the quality standards in the drinking water.[22] The Directive also requires providing regular information to consumers.

Drinking water quality monitoring has to be reported to the European Commission every three years. In the last reporting period of 2008 to 2010, the data indicates that Finland has a well-organized monitoring system in place and no major issues were identified. In 2010, sample compliance of 99% was reached for the microbiological parameters and chemical parameters. [23]

3. Policy and Guidance

The Ministry of the Environment (MoE) and the Ministry of Agriculture and Forestry are responsible for water protection. The MoE prepares national objectives for water protection, develops water protection legislation and other methods to reduce negative impacts on water bodies. It also assesses the condition of water bodies and factors affecting their condition and approves management plans and assesses their implementation. It is also participates in international cooperation. The MoE is also responsible for the Centres for Economic Development, Transport and the Environment (ELY Centres) and the Finnish Environment Institute (SKYE), although the Institute's work related to water resources is supervised by the Ministry of Agriculture and Forestry. Municipalities and their environmental authorities are local partners of these Centres. The Ministry of Agriculture and Forestry is responsible for water supply and sewerage, regulation of water bodies, flood risk management, drainage and irrigation, dam safety and maintenance of water constructions, as well as State obligations regarding permits under the Water Act.[24] The Finnish Environment Institute provides expert advice on implementing the river basin management plans by preparing national guidance and by taking part in national coordination of the implementation of the Water Framework Directive and it coordinates research and development projects, which support implementation of the WFD. The Government approves the river basin management plans and the first river basin management plans were approved on 10 December 2009. [25]

In 2006, the Finnish Government approved a new set of national Water Protection Policy Guidelines to define measures needed to improve water quality and to restore the good condition of inland waters, coastal waters and groundwater by 2015. To control eutrophication, the Ministry of the Environment

Programme to promote the recycling of nutrients and improve the status of the Archipelago Sea (2012–2015) aims to reduce the environmental load of agriculture.[26] As a result, nutrient emissions from Finland's coastal towns, agriculture and fish farms into the Baltic Sea have declined significantly. This programme includes measures to improve the condition of the Baltic Sea with other states. The Baltic Sea has an 8,000 km coastline shared by nearly one hundred million people with a number of

commercial ports on its shores**.** The member states work on the issues of eutrophication, maritime traffic emissions and oil and chemical spills which contribute to pollution.[27] Plans related to management of the Baltic Sea include the EU Marine Strategy, the Baltic Sea Action Plan of the Baltic Marine Environment Commission (also known as the Helsinki Commission or HELCOM) and the EU Strategy for the Baltic Sea Region.

In Finnish environmental policy related to the industrial sector, industry and other stakeholders are involved in preparing new legislation and sectoral programmes. Transparency and easy access to environmental information is a principle of Finnish environmental policy. The rationale behind joint preparation is to look at possible negative side-effects of policy measures, as well as to achieve a commitment of all parties to policy implementation. This approach attempts to reconcile conflicting views and early involvement in preparing legislative measures. It also provides industry with adequate time to inform operators of upcoming requirements and to prepare for legislative changes.[28]

Conclusion

This case study shows that Finland has a comprehensive and participatory approach to wastewater management both at the national level and at the regional level as a member of the European Union. One of the keys to Finland's success is its effective legislation, both at the national level and the regional level in terms of the EU Directives and UNECE Conventions, as well as the agreements governing the Baltic Sea. Finland has also been very active in the implementation of international conventions like the Basel and Stockholm Conventions. Another positive factor in Finnish wastewater management is a high level of technological development and investment in the wastewater sector. Through a twinning programme in wastewater utility management with St. Petersburg, Finland has shared its expertise and good legislative practices and helped to improve the status of the waters in the Gulf of Finland. Finland has also been very active in the region through the work of the Helsinki Commission (HELCOM) to protect the unique ecosystem of the Baltic Sea.

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Jordan

1. Practice

Jordan is one of the 10 countries most affected by water scarcity worldwide[1]. The available renewable water resources are dropping drastically to an annual per capita share of around 130 m^3 in recent years, compared to 3,600 m^3 per capita in 1946[2]. At the same time, the country has one of the highest average growth rates in the world, among other causes due to successive waves of immigrants (Palestinians, Iraqis and Syrians). In addition, its population is highly urbanised: about 73% of Jordanians currently live in urban areas concentrated in the northern and middle parts of Jordan[3].

In 2006, water demand was estimated at 1,512 Mm^3, 64% of which was used for agriculture, 31% for domestic use and 5% for industry[4], while available water resources represent only 925 Mm^3[5]. This makes the exploitation of non-conventional water resources (desalinated water and reclaimed water) of strategic interest to the Jordanian authorities, to reduce the water deficit and to meet future water demands.

Jordan's first wastewater treatment plant was built in the early 1960s. During the International Drinking Water Supply and Sanitation Decade (1981–1990), the Jordanian government carried out a number of significant wastewater management projects with the objective of improving sanitation utilities[6]. Consequently, 98% of the population in Jordan now has access to improved facilities, [7] and about 65% are connected to the wastewater treatment system[8]. These are some of the highest rates in the Middle Eastern North African (MENA) region.

Wastewater generation currently amounts to around 115 Mm^3/year (2010)[9], and the Jordanian Ministry of Water and Irrigation plans to increase the amount of reused wastewater to 232 Mm^3/year by 2020. In 2013, the total number of treatment plants reached 28, treating about 98% of the collected wastewater with the goal of providing high-quality treated water for reuse. The result is that 90% of the effluent is reused in agriculture[10], mainly in the Jordan Valley and after being mixed with rainwater. This mixture has replaced around 15% of the freshwater previously used for this purpose.

Initially, the approach of the Jordanian authorities regarding sewage reuse was to treat the wastewater and then either discharge it into the environment, where it mixes with freshwater flows and is indirectly reused downstream, for direct aquifer recharge (Aqaba project 1.91 Mm^3/year), or to use the resulting effluent to irrigate a restricted group of relatively low-value crops. Since 2002, in view of the challenges of water scarcity and rapid urbanisation, the objective has become to make better use of resources by increasing the surface area of irrigated lands with reclaimed water and to use it directly in the cultivable lands around the treatment plants. In 2009, 152 contracts were established between farmers and the Water Authority of Jordan to reuse the wastewater produced by 13 different plants for irrigation purposes.

At the same time, in order to minimise health risks and their implications, effluent quality standards were set in 1995 and revised in the 2000's. Most wastewater treatment plants have now been upgraded to meet these standards.

Jordan has more than doubled the number of wastewater plants since 1993. Among the several wastewater treatment plants and projects that were completed in recent years, there is one notable example in terms of performance, reuse opportunities and financing scheme: the As-Samra wastewater treatment plant. This plant is the largest in Jordan, treating the wastewater of Amman-

Zarqa (2.5 million inhabitants), or about 70% of all wastewater treated in the country. The plant started operating in 1985, initially using stabilisation pond technology. However, it was overloaded after 10 years of use and rebuilt in 2008 using activated sludge technology. This was accomplished through a Public Private Partnership contract between the Jordanian Government and a consortium led by SUEZ ENVIRONNEMENT comprising internationally renowned firms in the sector such as Ondeo, Degremont and Morganti for finance.

This contract, signed in 2002 for a period of 25 years, was the first Build Operate Transfer (BOT) in Jordan. The cost of the project was USD 169 million, mostly provided by a grant from USAID, a loan from a consortium led by a local bank and two smaller contributions from the Jordanian government and SUEZ ENVIRONNEMENT and its partners. This innovative financing scheme, combining private, public and international donor funds for the establishment of a wastewater facility, was the first in Middle East (As-Samra Wastewater Treatment Plant Company)[11].

Also notable is the fact that the As-Samra plant is 95% self-sufficient in energy, powered by the digestion of biogas and hydraulic turbines (2008). The plant has an average daily capacity of 267,000 m^3/day and discharges water that is in perfect conformity with Jordanian and international standards, positively impacting both the environment and agriculture. 65% of the plant's capacity is used for agriculture, significantly improving both the quantity and quality of the water used for irrigation in the Jordan Valley: the effluent is discharged into the Zarqa River which flows into the King Talal Dam, where it is diluted with rainwater and used to irrigate an area of approximately 10,000 ha.

In June 2012 the government signed a new contract with SUEZ ENVIRONNEMENT for the expansion of the treatment plant to a capacity of 365,000 m^3/day[12] under a new 25-year BOT with a total cost of USD 223 million.

2. Legal framework

In Jordan, the legal framework relating to water resources in general is fragmented: there is currently no water act in place at the national level and the provisions regarding wastewater are dispersed throughout various laws and regulations governing specific areas such as soil protection, groundwater, public health and environmental protection. The Jordanian authorities plan to codify the provisions contained in these dispersed legislations regarding water resources management and bring them together, but this project, initially scheduled for 2009, is lagging behind.

The first law regarding the operation of municipal sewer systems was established in 1955. Public health standards were first enacted in 1971, followed by the Forestry and Soil Protection Law of 1972. Since the late 1980's, a number of laws have been passed to better align with public policy on water resources management and environmental protection[13]. As a result, the more prominent laws have been geared towards the establishment of the principal institutions that would apply this policy measure (the Water Authority of Jordan law of 1988, the Ministry of Water and Irrigation by-law of 1992 and the Jordan Valley development law of 1988 amended in 2001) and the definition of their status and activities. These laws also included general provisions and principles regarding water resources management, such as public ownership of water resources (art 25 of the WAJ law), criminal provisions in case of damage to hydraulic infrastructures (art 30 of the WAJ law), provisions regarding protection against water pollution (art 38 of the JVD law) and several rules relating to water resources monitoring (art 10 of the MWI law).

Additionally, several specific laws and regulations have been enacted recently, including provisions directly or indirectly relating to wastewater such as groundwater:

- The 2002 by-law containing provisions on groundwater located on private property (Art 3) or protection against pollution (Art 16);
- The Environmental Protection Law of 2006 containing provisions on environmental impact assessment reports (Art 13) or specifying a series of measures and procedures to decrease environmental pollution (Art 19); and
- The Public Health Law of 2008, which includes two articles (51 and 52) on wastewater, instructing the Ministry of Health to monitor wastewater quality, plants and systems in collaboration with the relevant departments. This law authorises the ministry to take the necessary actions to prevent harm to public health.

The right to water and sanitation and the right to environment

Jordan has not yet recognised the right to water and sanitation and the right to environment in its legislation. Former Special Rapporteur on the human right to safe drinking water and sanitation Catarina de Albuquerque specifically mentioned this with regard to water and sanitation in her report on Jordan in 2014[14]. She recommended that the Jordanian government "adopt a comprehensive water law that recognises the human rights to water and to sanitation for all." Nevertheless it should be noted that Jordan has ratified the main international human rights conventions enshrining the right to water, i.e. the Convention on the Elimination of all forms of Discrimination Against Women[15], the Convention on the Rights of the Child[16], and the Convention on the Rights of Persons with Disabilities[17], in addition to the International Covenant Economic Social and Cultural Rights[18].

Standards

Jordan has up–to-date and appropriate standards on reclaimed wastewater to regulate both water reuse and environmental discharges. The Jordanian standards that specify the quality of the treated effluents to be discharged in watercourses or for reuse in agriculture require a secondary level of treatment. They comply with the WHO guidelines for the safe use of treated effluent in irrigation and include acceptable rates of BOD5, COD, TSS, TDS, NH4 and PH[19]. The principal standards regarding wastewater are:

- Jordanian Standard 893/2006 on discharge of treated domestic wastewater, initially published in 1995 and amended in 2002 to adapt to the reuse for irrigation. The current version of this standard, issued in 2006, applies to the discharge of treated wastewater into streams, wadis, or water bodies, reuse, or for artificial recharge of groundwater[(4)]. This includes seven categories of wastewater reuse standards, such as irrigation of vegetables that are normally cooked, tree crops, forestry and industrial processes, cut flowers and animal fodder;
- Jordanian Standard 202/2007 on industrial wastewater discharges, defining the quality for final discharge of industrial wastewater to water bodies or for incorporating irrigation. This standard recognises the problem of salt in reclaimed wastewater for agricultural use. A limit of 2000 mg/l of total dissolved solids is specified and remains in force for industrial effluents; and
- Jordanian Standard 1145/2006 on the use of treated sludge and sludge disposal, focusing mainly on the reuse of bio-solids in agriculture, application procedures and rates that are suitable to local conditions, as well as potential locations for land applications.

Additionally, there are several standards for crop monitoring, such as the standards on sampling of fresh fruits and vegetables and derived products, for example Jordanian Standard 1239/1999, 1246/1999 or 1247/1999, which could be mentioned regarding reclaimed water used for irrigation.

3. Policy and guidelines

The Jordanian water sector policy focuses on improving resource management, with particular emphasis on the sustainability of present and future uses. Special care is advocated for protection against pollution, quality degradation and depletion of water resources. This policy has proved successful and is based on the following guidelines and structures:

The Wastewater Management Policy of 1998: The Ministry of Water and Irrigation and the Prime Minister of Jordan issued a set of strategies and policies on water and wastewater. This policy institutionalised 62 points regarding the future use and management of wastewater. The official policy requires that treated effluent be considered as a water resource and not separated in policy or thought from other water resources. The policy incorporated the following important assertions into the national wastewater strategy:

- Wastewater shall not be disposed of; instead, it shall be a part of the water budget.
- There shall be basin-wide planning for wastewater reuse.
- Use of recycled and reclaimed water for industrial use shall be promoted.
- Fees for wastewater treatment may be collected from those who use the water.
- Any crops irrigated with wastewater or blended waters shall be monitored.
- Ultimately, the role of the government shall be regulatory and supervisory. Private operation and maintenance of utilities shall be encouraged.

The "*Water for Life Strategy*"[20], sets out the national water strategy for water and sanitation for the period 2008-2022. It's a set of guidelines that define the country's vision up to 2022, primarily "*to achieve national water security and to serve the overall development objectives*", with particular attention to the development of land and water resources in the Jordan Rift Valley in view of its important agricultural production.

In this context, agricultural water users associations play a key role in protecting water resources from pollution, increasing the efficiency of the irrigation infrastructure and minimising operation and maintenance costs – all of which are part of the National Water Strategy. As a specific response to the over-consumption of groundwater resources, the Highland Water Forum was created in 2010. The forum brings together 60 stakeholders from agricultural water users, government institutions, NGOs and research institutions to promote dialogue among stakeholders and work towards sustainable management of aquifers in the highlands. The "Water for Life Strategy" includes investments of USD 8.24 billion over a period of 15 years, corresponding to more than 160% of Jordan's GDP. It also calls for a decreasing reliance on groundwater (from 32% in 2007 to 17%), increased use of treated wastewater in agriculture (from 10% to 13%) and increased use of desalination (from 1% to 31%). The plan also envisages institutional reforms such as enacting a new water law, separating operational and administrative functions, production from distribution operations, creating a Water Council with advisory functions, and establishing a Water Regulatory Commission.

The *National Water Master Plan*[21]*:* Launched in 2004, this integrated digital plan enables decision makers to set policies and strategies based on planning scenarios derived from sectoral water consumption trends. The Master Plan is based on the Water Information System (WIS) which contains all monitoring data related to demands and resources. With its extensive WIS, the MWI has become a leading user of GIS-based digital tools for Water Master Planning activities in the region, offering the framework, databases and tools necessary to manage water data and providing water specialists with data and information for water sector monitoring, management and planning. Software-based analysis and planning tools such as WEAP, WIS, ArcGIS and PIS are used and integrated into the Ministry's planning and operations processes.

At the same time, Jordan has set up a strong institutional structure for water resources management and service delivery involving several public entities as well as the private sector and civil society; this currently includes government institutions.

The Ministry of Water and Irrigation (MWI)[22], established in 1988, is the official body responsible for developing national water strategies, policies and planning, subject to approval by the Council of Ministers. It is also responsible for the overall monitoring of the water sector, water supply and wastewater system and related projects, planning and management, formulating national water strategies and policies, research and development, information systems and procurement of financial resources. Its role includes the provision of centralised water-related data, standardisation and consolidation of data. In addition, the MWI supervises the two most major entities, the Water Authority of Jordan and The Jordan Valley Authority.

The Water Authority of Jordan (WAJ)[23], was established in 1983 as an autonomous corporate body with financial and administrative independence and has full responsibility for the public water supply, wastewater services and related projects, as well as for overall water resources planning and monitoring, construction, operations and maintenance. This entity is the asset owner of the water systems and responsible for WWTP's operation and maintenance. The Performance Management Unit (PMU), established as part of the WAJ in 1997 during the implementation of the Management Contract in Amman, is currently responsible for monitoring and auditing the performance of private water companies, promoting private sector participation in water services and management, developing public-private partnership, and planning and providing strategic advice to decision makers.

The Jordan Valley Authority (JVA)[24], as established in 1977, is responsible for the socio-economic development of the Jordan Rift Valley, including the operation of water canals and water distribution to farmers including distribution of irrigation.

Additionally, several public institutions have a role to play in the implementation of wastewater management strategies in Jordan, such as the Ministry of Environment for water quality monitoring, the Ministry of Agriculture for on-farm advice, the Jordan Food and Drug Administration for crop monitoring and the various public water companies such as Miyanuna, the Aqaba Water Company and the Yarmouk Water Company.

It should also be noted that the Jordanian authorities now consider the private sector to be a full partner on several levels. Private sector participation took shape in 1993 when it was decided to bring in a private company under a management contract to run the water and sewerage system of Amman (the contract ended in 2007)[25], and then through several PPP contracts including the As-Samra plant or the DISI Water Conveyance project brought about under BOT agreements[26]. In addition, numerous micro private sector participation contracts are ongoing at the governorate level, taking over identified functions like billing, revenue collection and leak repairs.

Finally, civil society, especially through the water users associations, and farmers are actively involved in the sector. The Jordan Valley Water Forum, established in 2012[27], is a shining example of public participation in water resources management. These forums take place twice per year and give the various stakeholders the occasion to meet and make recommendations regarding the sector at the local level.

Conclusion

As an arid country, Jordan faces a number of challenges regarding water-resources management. Whilst the legal framework is somewhat fragmented, codification of the various laws regulating water resources is a project on the agenda of the Jordanian government. The legal fragmentation is compensated for in Jordan's policy instruments, which include a specific policy for wastewater management, as well as a National Water Strategy for Water and Sanitation. The normative framework is well developed, providing adapted and demand-driven standards for wastewater treatment focused on reuse for irrigation. Wastewater is considered as an integral part of the available water resources. Additionally, the institutional framework is comprehensive. Collaboration among government, the private sector and civil society has contributed to a growing wastewater sector which may help contribute to alleviating the pressure on water resources in this country, which isone of the most affected by water scarcity.

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Singapore

1. Practice

Singapore (officially the Republic of Singapore) is a city-state located in Southeast Asia, at the southern tip of the Malaysian peninsula. Since independence from the United Kingdom in 1963 and from Malaysia in 1965, its rapid and successful economic development led to it being known as one of the original four "Asian Tigers" in the 1980s. Today, it is a well-known hub for financial services, trade and manufacturing, transport and logistics, including ship-repair services; its port being the second largest worldwide in terms of exports.

Over the past 50 years, the country's territory, composed of a main island and about 60 islets, expanded through land reclamation by almost one fifth, reaching a current total of 718 km². With a population of 5.5 million, Singapore has the second highest density in the world (7,713 inhabitants per km²).

The country's tropical rainforest climate is hot (between 22 and 35°C) and humid (84% humidity on average), with little seasonal variations. However, with limited catchment area to store rainfall and no natural aquifers or lakes, the country is classified as being water scarce and ranks 170th out of 190 countries in terms of freshwater availability[1]. Currently, water demand in Singapore is 1,824,000 m³/day[2]. To cover its freshwater needs, the country has developed a strategy based on what is locally referred to as "The Four Taps":

- Water imports from Malaysia (cover 40% of total needs);
- Water reclamation – the NEWater Initiative (30%);
- Rainfall, collected in reservoirs and water catchment areas (20%); and
- Seawater desalination (10%)[3]

In 2000, the NEWater Initiative was launched, based on advanced reuse of water, i.e. the production of "new" drinking water reclaimed from wastewater treatment plants. A 10,000 m³/day demonstration plant was commissioned, incorporating conventional water treatment processes (secondary treatment, stability control and chlorination) with more modern techniques such as dual membrane (via microfiltration and reverse osmosis) and ultraviolet disinfection. A two-and-a-half year health effects testing programme using both fish and mice for the first time, was commenced. The results of this extensive sampling and monitoring programme provided the go-ahead sign for the government to proceed with planned indirect potable reuse[4]. In 2002, two full-scale plants were operational, which initially served the high-tech industry and indirect potable re-use was initiated in 2003[5]. This made Singapore one of the first large-scale (and thus sustainable) wastewater reuse systems for potable water production.

NEWater is now Singapore's own brand of reclaimed water. The country currently has 4 water reclamation plants which produce 547,200 m3/day of recycled water[6]. This recycled water is mainly used for industrial purposes - wafer (semiconductor material) fabrication, electronics and power generation industries - and for air conditioning cooling purposes in commercial and institutional buildings[7]. This liberates potable water for domestic consumption. A small percentage of NEWater (2.5 % of the total water demand) is also used to feed raw water reservoirs, which after treatment, supply consumers with tap water. By 2060, NEWater capacity is planned to cover up to 55% of the future water demand, in order to reach water independence[8].

According to the World Bank, 100% of the population has access to improved water and sanitation facilities[9]. The country recognised the Human Right to Water and Sanitation in 2010, which implies that additional attention will need to be paid to providing domestic water of sufficient quality and monitoring the impact of wastewater flows.

Overall, the innovative experience of Singapore in overcoming its water challenges has earned it a reputation of role model for future cities. But it is not just the technology and innovation that have triggered its success: additional key factors have been leadership, good governance, collaboration and political will. The water management successes and environmental sustainability of Singapore are the result of successive pioneering political generations[10]. A key ingredient was also the integration of public policies from many sources and covering many dimensions, including public housing, urban management, industrial regulation and education[11]. Singapore's holistic approach to water resources management also included strong attention for legislation and enforcement, water pricing and public education.

2. Legislation

Immediately after independence in 1965, Singapore experienced a difficult economic and social period, with declining export in staples, growing unemployment, a lack of a hinterland, limited natural resources, and a growing population. To reinforce the sense of nation, it was urgent to improve the population's quality of life. Therefore in spite of the need for foreign investment to ensure industrial and commercial development, strict and evolving legal and regulatory frameworks and enforcement schemes were developed to control increasing water, air and land pollution. Stringent environmental laws and their enforcement through command-and-control tools were balanced with economic development, and today Singapore is considered an even greater success as it was able to attract significant investments despite strict environmental requirements[12] [13].

The institutions involved in water management (which are presented in more detail in the next section on Policy and Guidance) were also involved in the formulation of policy principles, regulations and their amendments, penalties and standards to be applied, allowing legislation to remain relevant and effective. In addition to a solid legal system, a combination of well-educated officials, regular inspections of pollution control facilities and swift actions on complaints have ensured effective law enforcement. Between 2002 and 2010, an average of only 16.5 incidents of water pollution per year are indicative of an excellent enforcement record in a highly industrialised economy[14].

Facing rapid urbanisation and industrialisation, the island-nation was able to build on its uniqueness (it has only one level of government) to put in place an integrated approach to land use planning, combining strategies centred around prevention, enforcement and monitoring. This ensured that all new developments incorporated clear indications of measures to control air, water and noise pollution, and the management of hazardous substances including toxic waste[15].

In the 1950s and 1960s, environmental laws dealt primarily with the protection of public health, such as public cleaning, sanitation and hygiene (excluding air and water pollution). In 1968 the Environmental Public Health Act was passed, and the government stated its clear objective to improve the quality of life in this highly urbanised city-state and transform Singapore into a "Garden City." In 1970, the Environment Public Health (Amendment) Bill increased the number and scope of cleaning standards, addressing garbage dumping into streams, and polluting reservoirs, lakes and catchment areas[16].

Water pollution laws and regulations were initially ineffective and managed by several institutions under three different ministries (Ministry of Trade and Industry, Ministry of National Development and Ministry of

Health), which complicated the enforcement process. In 1971, water pollution was identified as a national priority and several new regulations and amendments were passed, such as the Environmental Public Health (Prohibition of Discharges of non-domestic Effluents into Water Courses) Regulations, which specified standards of chemical and solid discharges and prescribed installation of pre-treatment plants[17] for discharging into the sewerage system for further treatment.

A first institutional integration was realised when, following a worldwide trend, Singapore created its Ministry of the Environment in 1972, which absorbed the departments responsible for pollution control, sewerage, drainage and environmental health that were previously under the ministries of National Development and Health[18].

The new Ministry's Sewerage Department was put in charge of water pollution control. It launched a programme in 1972 to ensure discharge of all sewage into sewers and to sewage treatment works. Industries unable to respect the effluent pre-treatment standards were charged proportionally to the pollution load, and tariffs evolved over the decades to reflect wastewater treatment costs. Regular inspections resulted in prosecution of industries found discharging acidic effluents into the sewers. The Pollution Control Department made on average 2,425 tests per year, where 310 failures were detected. Control measures were financed by governmental investment in environmental management (1% annually of GDP in the 1980s, amounting to S$ 609 million in the early 1990s – exchange rate with USD at the time was 1.6)[19].

To fill a growing need for comprehensive legislation on water pollution control, the Water Pollution Control and Drainage Act was passed in 1975. Discharging any toxic substance into any inland water causing environmental hazard was made a punishable offence with a penalty of S$ 5,000 (USD 4,025 at July 2014 exchange rate), and where no proof of fault was required (offense of strict liability). In 1985 the penalty was raised to S$ 10,000 (USD 8,050) or six months imprisonment, increasing with subsequent offenses. The Act and related legislation prohibited the discharge of non-domestic effluent into watercourses or public sewers without the written consent of the Director of Water Control and Drainage. If needed, the industries received technical support from the government[20].

The Prevention of Pollution of the Sea Act 1990 and its regulations gave effect to the International Convention for the Prevention of Pollution from Ships 1973 as modified and added to by the Protocol of 1978, and to other international agreements relating to the prevention, reduction and control of pollution of the sea and pollution from ships; to make provisions generally for the protection of the marine environment and for the prevention, reduction and control of pollution of the sea and pollution from ships, and for matters related thereto"[21].

In 2001, institutional integration was pushed one step forward with the recognition of the comprehensive water cycle which includes water catchments and supply, drainage, water reclamation and sewerage. All water-related services, controls and administrations were placed under one sole institution, the Public Utilities Board, which was transferred to the Ministry of Environment. The Sewerage and Drainage Act 1999 and Environmental Pollution Control Act 1999 stipulated control of discharges into public sewers and watercourses. To reflect a broader scope (covering both protection and management of the environment and resource conservation), the latter act was amended and renamed the Environmental Protection and Management Act 2008[22]. Its regulations, which include Trade Effluents and Toxic Industrial Waste, cover water pollution control, discharge of toxic and hazardous substances into inland waters, treatment of trade effluents, removal and clean-up of polluting substances and listing of toxic industrial waste[23].

The Code of Practice on Sewerage and Sanitary Works 2000 guides planning and designing of sanitary and sewerage systems, providing good engineering practices[24].

The Public Utilities Act 2001 reconstituted the PUB as the national water agency, and included strict regulation of certain offenses such as making unauthorised connections, contaminating water, wasting water, wilfully interfering with or disrupting supply of water, with fines of S$ 1000 (approx. USD 760), as well as the creation of a water conservation tax (more details in the next section). The Public Utilities Water Supply Regulations made water metering and water saving devices mandatory[25].

The Environmental Public Health Act 1987 was amended several times until 2002. Its chapter 95 deals with water pollution control. The EPH Quality of Piped Drinking Water Regulations 2008 empowered the National Environment Agency to set standards for the quality of piped drinking water, based on WHO's 2006 Guidelines for Drinking Water Quality[26]. Singapore's tap water is well within the World Health Organisation's Drinking Water Guidelines and US EPA's Drinking Water Standards[27]. In meeting (and sometimes exceeding) international standards for water supply, sanitation and wastewater treatment, the country also prevented significant health and social costs[28].

It is the institutional coordination between the ministries and their agencies across various sectors, which was instrumental in enabling an effective implementation of laws and regulations related to water and wastewater[29].

3. Policy and guidance

To ensure a sustainable national water supply, Singapore has implemented both water supply and demand strategies[30].

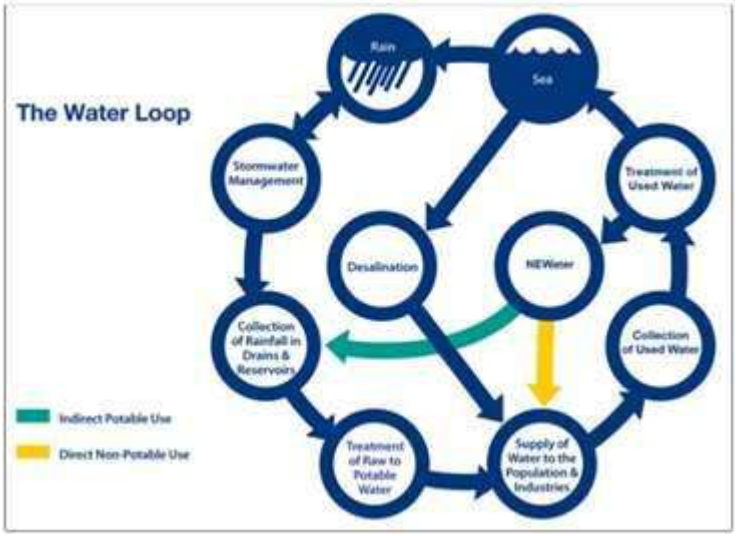
Supply-side policy instruments

In 1963, a Public Utilities Board (PUB) was established as part of the Ministry of Trade and Industry to coordinate the supply of water, electricity and piped gas. Its mandate also included improving and expanding the water sources, which at the time counted only three reservoirs[31], while the catchment area covered 11% of the city-state (today there are 17 reservoirs and the catchment area is two-thirds of the land)[32]. Sewerage and drainage were, on the other hand, the responsibility of the Ministry of Environment, which was created in 1972 to tackle issues such as pollution control and environmental health.

The country's first water master plan was developed in 1972, outlining the strategies to ensure a diversified local supply to meet future projected needs: local catchments, recycled wastewater and desalinated water[33]. Two years later, PUB built a pilot plant to recycle wastewater into potable water, based on membrane technology - the precursor of the current NEWater factories. But it was not until 1998 that technological costs had lowered sufficiently to allow for big-scale use and the first NEWater plant was completed in 2000. While the initial plants were public, the two later ones were designed under a Public-Private Partnership approach, with design, build, own and operate (DBOO) contracts[34]. Another public-private partnership is underway to develop the latest plant, planned for completion by 2016, which will produce 228,000 m³/day of NEWater[35].

In 2001, the Public Utilities Board was transferred to the Ministry of Environment (which became Ministry of the Environment and Water Resources in 2004, thus reflecting its expanded role)[36]. Since then, PUB is Singapore's National Water Agency. It is a comprehensive water authority which optimises the use of Singapore's water resources, integrating sewerage & drainage departments, to oversee the whole water

cycle (see diagram below). It manages reservoirs, water works, rivers, the drainage system, water reclamation plants and the sewerage system.



PUB's Water Loop: http://www.pub.gov.sg/about/Pages/default

The integration of water and wastewater management in one sole agency was conducive to tapping into synergies and allowed considerable progress in water reuse[37].

Also part of the same ministry, a National Environment Agency was created in 2002, which focuses on the implementation of environmental policies such as pollution prevention, solid waste management, energy efficiency and partnerships with the 3P sectors (People, Public, Private).

Unlike in most other countries, in Singapore there are separate networks to collect wastewater (called "used water" in Singapore) and rainwater, which reduces the pollution that gets into the waterways and helps ensure the quality of the water harnessed from the catchments[38]. The country's water management strategy combines the NEWater plants with the Deep Tunnel Sewerage System, which ensures the collection of all used waters (585 million cubic metres in 2013) as well as their treatment and purification in four water reclamation plants, allowing them to be discharged into the sea or further purified into NEWater. The treated water meets international standards stipulated by the US EPA and the World Health Organisation.

A comprehensive water quality monitoring programme covers the entire delivery chain of NEWater (from source control to wastewater treatment, NEWater production up to the taps). A total of 300 parameters are regularly screened, including physical characteristics, organic and inorganic contaminants, radiological and microbiological quality, as well as contaminants of emerging concern. Both an internal and external audit panel review the operations and water quality every six months[39]. In 2002, after two years of analysis, the recycled water was found to be safe for drinking and outreach policies were put in place to educate the public about this. The NEWater strategy, which aims at helping the population view water as an indefinitely reusable resource by reducing the negative connotation associated with wastewater, also included some new wording: wastewater became "used water," recycled wastewater became "NEWater," and wastewater treatment plants became "water reclamation plants."[40]

Today, one of the countries' main targets is to increase the supply of water from non-conventional sources such as desalination and water recycling, to meet up to 30% and 50% (respectively) of future water needs by 2060 (the current water import agreement with Malaysia expires one year later).

Demand-side policy instruments

The Public Utilities Board has put in place a comprehensive water demand management policy based on pricing, conservation requirements and public support.

To finance part of its investment programme, the Public Utilities Board issued a bond to raise S$ 400 million (or USD 254 million)[41]. At the same time, to increase its income while preventing water wasting, water tariffs were increased in 1973, which effectively reduced domestic water consumption[42]. Since, additional tariff increases were necessary to promote more efficient water use.

Today, water is priced in order to recover the full cost of its production and supply. The monthly water bill includes[43]:

- The water fee (covering the costs incurred by different stages of water production: collection of rainwater, treatment of raw water, distribution of water through network of pipes), which varies according to the amount of water consumed;
- The water conservation tax, imposed as a percentage of the total water consumption since 1991 (it was set at 30%, but a 45% tax level is applied to domestic consumption above 40 m3 per month and connection);
- The waterborne fee and sanitation appliance fee (both of which are tax contributions to the national used water system).

This conservation approach is combined with targeted assistance from the government to low-income families, and ensures that all Singaporeans have access to an affordable, high quality water for the long term[44]. On average, for a consumption of 20m3 per month, the average urban domestic water and sewer tariff is USD 1.88 per m3 (in 2012).

The Public Utilities Board was able to progressively increase water tariffs due to its autonomy and the strong political and public support it benefits from. In turn, this has allowed the company to invest in future activities while ensuring good quality operation and maintenance[45].

Alongside water pricing, the Public Utilities Board also launched several water conservation campaigns – from the 1972 "Water is Precious" to the 1981 "Let's not waste precious water", but these had limited impact as soon as dry seasons were over, which spurred the development of the water conservation tax as a more efficient incentive[46].

The third strategy for demand-side management has been to build public support, via awareness and education campaigns. In 1992, Singapore produced the Green Plan for Environmental Protection and Improvement, a holistic plan mapping policies and strategies to transform the city into a model green city, including public consultations. It evolved into the Singapore Green Plan 2012 (published in 2006), which included massive awareness and environmental education campaigns[47].

In 2006, the Public Utilities Board launched its ABC –Active, Beautiful, Clean- Waters educational and outreach programme to bring the population closer to the network of canals, drains and reservoirs through the creation of community spaces close to these drainage and water storage areas. This programme is an

integral part of the vision of transforming Singapore into a City of Gardens and Water[48]. A good example is the Marina Barrage, Singapore's sole city reservoir, which is also an important recreation area[49].

In terms of water demand management, the country's main targets are currently: 1) to reduce daily per capita domestic water consumption to 147 litres by 2020, and 140 litres by 2030; and 2) to partner the 3P sectors (People, Public and Private) to generate greater awareness of the importance of conserving, valuing and enjoying water and develop a sense of shared ownership of water resources.

The Vision of the Public Utilities Board "Water for all – Conserve, Value, Enjoy" reflects this dual water supply and demand management approach it has progressively developed and implemented over the past five decades ("Water for all" relates to supplying water to all inhabitants through the Four National Taps, while "Conserve, Value, Enjoy" summarises the demand management approaches)[50]. It reflects the emphasis put on ensuring sustainability of water resources in the most efficient way (wise use of water, outreach programmes to create ownership and development of leisure activities to trigger care).

Illustrating the "outstanding performance of the PUB and, clearly, the fact that Singapore has one of the best urban water and wastewater management records in the world" [51], the National Water Agency received more than 20 prestigious international awards over the last few years, including the Global Water Awards, the Stockholm Industry Water Award (for its holistic approach to water resources management), the International Water Association's Marketing and Communications Award, as well as the UN-Water's Best Practices Award (for its stakeholder-centred approach in engaging partners to foster ownership of the country's water bodies).

Conclusion

Singapore underwent a strong increase in population and gross domestic product (GDP) over the past 50 years (three-fold and 30-fold, respectively[52]). Despite being a water-scarce country with little ground- or surface water resources, it has managed to face consequent increased water demand and is now on its way to becoming water self-sufficient. This has been possible through a fruitful combination of a political vision (recognising water as a strategic resource at the national level); heavy investments in technology research and development over three decades; institutional restructuring and coordination (amongst government ministries and agencies and with the private sector); and the integration of public policies, effective legislation, and the involvement and cooperation of the population. High population densities also contributed to efficient wastewater collection at relatively low cost. Such a holistic approach has positioned Singapore "as a world leader in innovative and sustainable water technologies and best management practices."[53] This should enable the country to face its growing water demand, expected to double over the next 50 years[54].

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South Africa

1. Practice

South Africa has a population of 52.772 million in 2013[1], a GDP estimated at $350.6 billion (2013)[2] and a Human Development Index of 0.658 (2013)[3], registering a poverty headcount ratio around 45.5% (2011) according to the World Bank. In terms of water availability, South Africa is regarded as the 30th most water scarce country in the world[4], in 2004, 98% of South Africa's water yield, as well as 41% of the annual usable potential of groundwater were allocated to use. Of this allocated use, 60% went to agricultural activities, 27% to domestic demand, 23% to urban needs, 4% to rural, mining and bulk industry 6%, afforestation 3% and power generation 2%[5].

Regarding wastewater treatment, the country has built a substantial wastewater management industry composed of more than 1000 treatment plants, extensive sewage network transporting and treating more than 7.5 Mm3/day, even if recent studies have shown that the majority of small plants located outside metropolitan areas are facing problems of maintenance and operation particularly due to the age of the installations.

South Africa is also considered as a leader in terms of wastewater treatment research and development. From the beginning of the 20th century it was among the first states with US and UK to experiment innovative wastewater processes such as low-loaded trickling filter plants on an industrial scale[6]. In 1972, James L. Barnard a South African scientist, has succeeded to combine the post- and pre-denitrification reactors and to introduce recycle flows to control the nitrate entering the pre-denitrification reactor[7].

South Africa implemented since the second half of the 20th century major innovative wastewater treatment plants, among which the World's first Direct Potable Reuse application in 1968 in Windhoek (when it was under the South African domination), the first use of ozone and GAC in water reclamation (Pretoria 1978), the world's first turning acid mine drainage water into drinking water plant (eMalahleni Water Reclamation Plant 2007)[8] or the Durban water recycling project (2001) delivering a high quality reclaimed water directly used in industry.

On another level, by the end of the apartheid regime, more than 20 million of South Africans[9], the majority belonging to the black community, were living without adequate sanitation services but currently access to improved sanitation stands around 78% (according to Statistics South Africa2013) recording an increase of 30% comparatively with 1990.The Water for Growth and Development Framework (2009) stated that the Department of Water Affairs (DWA) had reached the Millennium Development Goals (MDGs) targets with respect to sanitation backlogs in 2008.

At a local level, in 2014 eThekwini Water and Sanitation, a unit of the eThekwini municipality serving the Durban metropolitan area has been named the winner of the Stockholm Industry Water Award, "for its transformative and inclusive approach to providing water and sanitation services"[10]. In the past 14 years, 700.000 people have been provided with access to toilets in its area of intervention.

It's worth noting that as part of the Free Basic Services Policy adopted in 2001, the Free Basic Sanitation Implementation Strategy, approved by the Minister of Water Affairs and Forestry in 2009 allowed a number of municipalities to provide essential and basic sanitation services free of charge

for poor households. But in spite of the progress made, many South Africans still did not have access to sanitation services and even if the government had set an ambitious target to achieve universal access to basic water and sanitation services for all by the end of 2014, this objective has obviously not been yet reached.

The South African achievements relating to the sector have been made possible thanks to a comprehensive and updated legislation and a bold policy in accordance with the national challenges.

2. Legal Framework

The South African legal framework relating to wastewater management has been largely influenced by the political changes which took place in the early 1990s[11]. By the end of the apartheid the country has embarked on major reforms concerning all the aspects relating to the sector. A series of laws have been enacted covering health and safety, housing, environment protection, wastewater utilities, etc., with human rights and sustainable development as central focuses.

Among this comprehensive and up to date legal framework, can be mentioned:

The Constitution of the Republic of South Africa promulgated in 1996[12] and recognizing explicitly the right to have access to water for everyone, and the obligation on the State to take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of this right (Section 27: 1(b) and 2).

In addition and according to the section 24 of the constitution, the right to environment is enshrined in no uncertain terms with an emphasis on notions such as the protection of the environment "for the benefit of present and future generations", "sustainable development" or "use of natural resources while promoting justifiable economic and social development". As with the right to water, reasonable legislative and other measures are recommended to achieve these objectives.

It should be noted that the South African constitution recognizes as well the right to have access to adequate housing through its section 26, what has been interpreted by the Constitutional Court as including appropriate services such as the removal of sewage[13].

Subsequently to these declarations, the Water Services Act N°. 108 of 1997 [14]recognized through its article 3 the right of access to basic sanitation calling upon the water services authorities to take measures to realize this right. That makes South Africa a leader in terms of legal recognition of the rights to water and sanitation, years before these rights were officially recognized by the UN General Assembly in resolution A/64/292 of 28 July 2010 and the General comment N°15 of the UN Committee on Economic, Social and Cultural Rights in 2002 on the right to water.

Concerning the right to environment, the National Environmental Management Act N°. 107 of 1998 [15]and its subsequent amendments confirmed the constitutional provisions, announcing in Chapter 1 called "National Environmental Management Principles" that "*Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably*", also insisting on the fact that "development must be socially, environmentally and economically sustainable". Among these principles emphasis is also placed on "environmental justice", "equitable access to environmental resources" and non-discrimination. This chapter refers also to the principles of prevention, precaution and polluter-pays

and the following nine chapters of the act describe the procedures and the institutions in charge of implementing and monitoring these rules.

Besides that, the primary piece of the South African legislation regarding water resources is the National Water Act N°.36 of 1998[16] developed through an extensive consultative campaign involving different stakeholders. This comprehensive law composed of 17 chapters and 164 articles legislates the way in which the *"water resources are protected, used, developed, conserved, managed and controlled"* on the basis of an IWRM approach, "sustainability and equity" are described as central guiding principles. This act also includes provisions on pollution prevention and remedies, governs how a municipality may return effluent and other wastewater back to the water resource and establishes a national monitoring system and information system. A chapter is dedicated to International Water Management, demonstrating the interest of the South African authorities to the international cooperation around transboundary water resources management. Another chapter is dedicated to the Water User Associations considered as water management institutions operating at a restricted localised level, according to the model of co-operative associations.

Another important act is the Water Services Act mentioned above which defines with great details the role of municipalities as water services authorities as well as the role of other institutions involved in the provision of water services (therefore including sanitation) such as providers, water boards and intermediaries. The act prescribes also the standards and tariffs for water services, sets out rules on monitoring water services institutions and establish a national information system on water services ensuring public access to information.

In order to better protect its coastal environment (2500 km) and address marine pollution, South Africa has recently enacted the Integrated Coastal Management Act N°.24 of 2008[17] establishing a system of integrated coastal management, including norms, standards and policies promoting the conservation of the coastal environment and the use of natural resources in a way socially and economically justifiable and ecologically sustainable.

This Act includes a chapter dedicated to "Marine and coastal pollution control", with a specific article concerning "Discharge of effluent into coastal waters". This article prohibits explicitly effluent discharge that originates from source on land and describes in great details the procedure for exceptional permissions and authorizations.

This act is the result of a long process of consultations and policies initiated by the government and involving the different stakeholders in order to move from a fragmented approach regarding coastal management to an integrated one.

South Africa's Department of Environmental Affairs' Integrated Coastal Management Act received in 2012 the honourable mention of the World Future Policy Award [18]celebrating policies that create better living conditions for current and future generations. The award is granted by the World Future Council, an international policy research organisation that provides decision makers with effective policy solutions.

Additionally, there is a series of other legislations indirectly relating to wastewater management, such as the Local Government: Municipal Systems Act N°.32 of 2000 defining the principles, mechanisms and processes among others to ensure universal access to essential services, the Housing Act N°. 107 of 1997 governing *"sustainable housing development process",* the Occupational Health and Safety Act N°85 of 1993 aimed *"to provide for the health and safety of persons against*

hazards to health and safety", the Development Facilitation Act, No 67 of 1985, the Local Government Transition Act, No 61 of 1995, the Conservation of Agricultural Resources Act, No 43 of 1983 and the National Forests Act, No 84 of 1998.

Standards

Concerning standards relating to wastewater, South Africa has changed totally its approach in the 1990's moving from a system based on the Uniform Effluent Standard which emerges in the Water Act of 1956 and the subsequent regulations, to the more stringent Receiving Water Quality Objectives (RWQO) approach. This change appears clearly first through the White Paper on Water Policy of 1997 and then through the provisions of the National Water Act addressing pollution risks.[19]

The National Water Act provisions are complemented by a comprehensive range of standards and guidelines applying to the various stages of wastewater collection and treatment: Discharge standards stipulated by the Department of Water Affairs (DWA), Regulations Relating to Compulsory National Standards and Measures to Conserve Water (8 June 2001), National Norms and Standards for the Construction of Stand Alone Residential Dwellings Financed through National Housing Programmes (2007) (National Norms and Standards) and a Guide to the Design of Sewage Purification Works by the Institute for Water Pollution Control.

3. Policy and guidance

After the end of apartheid, the South African authorities adopted several policies aiming to improve sanitation services, wastewater management and water resources protection, the most important of which are:

The White Paper on Water Supply and Sanitation Policy (1994) drafted before the adoption of the National Water Act in 1998 with the objective to set out the policy of the new Department of Water Affairs and Forestry (DWAF) on the basis of a human rights and sustainable development principles. The paper provides standards and guidelines for basic service delivery among which a ventilated improved pit latrine, a special attention is given to poor communities unable to afford basic services.

This white paper was followed in 1996 by the National Sanitation Policy designed "to clarify many items of sanitation policy" and "to develop a national sanitation strategy". This policy is based on a series of principles such as development should be demand-driven and community based, environmental integrity and sanitation is a community responsibility and several axes which are: health and hygiene education and promotion, community issues and human resources development, environmental impact, financial and economic approach, technical considerations, and institutional and organisational framework.

In 2001, this policy was revised and a White Paper on Basic Household Sanitation was developed followed by the National Sanitation Strategy of 2005 setting the objective of mobilising resources at all government and community levels to eliminate the backlog and achieve universal access to basic sanitation by 2010, but despite the efforts made by the different stakeholders and the significant progress made, this has not been achieved and the deadline was extended to 2014 also without success.

Provided in chapter 2 of the National Water Act, the National Water Resources Strategy is a legal and biding instrument designed to ensure that water resources are protected, used, developed,

conserved, managed and controlled in an efficient and sustainable manner. The first version of this strategy was published in 2004 and reviewed in 2013 for a period of 5 to 10 years in accordance with the National Development Plan of 2011 objective to eliminate poverty and reduce inequality by 2030. Among the actions provided regarding wastewater management, there is the implementation of water reuse projects according to a National Water Reuse Strategy included in the whole strategy, the refurbishment and upgrading of wastewater treatment plants or the minimisation of pollution from wastewater treatment works through a better efficiency of water use in order to reduce the amount of municipal sewage produced.

Lastly, concerning municipal wastewater treatment monitoring, the government has launched in 2009 a certification process called the "Green Drop Certification Program" measuring and comparing the results of the performance of Water Service Authorities and their Providers relating to wastewater management. In 2009, 449 wastewater treatment plants were assessed and the results showed that 7% were classified as excellently managed, 38% performed within acceptable standards and 55% did not perform within acceptable standards and in May 2011, 7 out of 159 water supply authorities were certified with the green drop, and 32 out of 1,237 wastewater treatment plants[20].

It should be noted that several institutions are involved in implementing these policies at the national, provincial and local levels, the Department of Water and Sanitation (DWA) as a leader authority in the formulation and implementation of public policies on water resources management and the owner of the major water infrastructures, while Catchment Management Agencies, Catchment Management Committees intervene at the regional level on a specific water management area and Water boards, water authorities and water services providers are more oriented on water utilities and sanitation management and wastewater treatment works operation.

Additionally, there are non-institutional stakeholders actively involved in the sector, Water Users Associations and private sector especially in providing water services to population in specific areas and under specific legal conditions. Private sector is now playing an increasingly larger role through the development of major PPP contracts relating to wastewater infrastructures implementation such as the Durban water recycling project in 2001, the first PPP of its kind in South Africa or the eMalahleni Water Reclamation Plant implemented in 2007.

Conclusion

South Africa is a model of a developing country that realized significant achievements in terms of implementing innovative technical solutions regarding wastewater treatment at a large scale, but what specifically characterizes this country is its capacity to design a comprehensive and progressive legal framework and a participatory policy focused on human rights and sustainable development. This led to substantial improvements in terms of accessibility to basic sanitation services both technically and economically, even if further efforts need to be made in order to guarantee this human right for everyone. Concerning environmental protection as well, there are things to be done especially relating to the renovation and the operational improvement of the wastewater treatment plants. There is a general awareness around these issues as well as serious initiatives to advance change.

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Chapter 4. Lessons Learned and Recommendations

1. Effectiveness of the legal framework

It is clear that wastewater raise various challenges for environment and ecosystems as well for human beings that need to be urgently addressed. While it would be tempting to mainly consider wastewater as a technical issue and to focus on technological solutions to wastewater treatment, one should never forget however the crucial importance of legal frameworks even when dealing with issues that appear to be essentially technical. Laws provide behavioral norms, and guidelines/standards in support of effective wastewater management.

Since wastewater do not stop at borders and raise transboundary issues, international law provides with various conventions (such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes[1], the UN Convention on the Law of the Non-Navigational Uses of International Watercourses[2], the Convention on Persistent Organic Pollutants[3]…etc.) but also with various principles (such as the precautionary principle, the polluter pays principle) setting forth the parameters for inter-State – and also for intra-State - behavior in relation to wastewater management. Without denying the importance of international law, domestic legislation plays a most critical role in wastewater management not only as the instrument of State compliance with international obligations, but also as a powerful facilitator of action "on the ground" by governmental, other public and all private actors engaging with the management of wastewater.

a. Legislation responsiveness

The first quality of any legislation is its responsiveness. In regard to wastewater issues; it essentially means that domestic law has to evaluate and take into account the specificity of the national context especially regarding environmental threats, public health issues and water security and then propose legal solutions adapted to these context, instead of trying to simply transpose solutions applied elsewhere. A special attention has to be devoted as well to the status of implementation of relevant human rights relating to wastewater management such as the right to water and sanitation, the right to housing, the right to food, the right to a healthy environment… etc.

i. A legislation tailored to the national context

Each State faces its own national reality that affects its approach to wastewater treatment. These diverse factors/constraints such as water scarcity, rapid urbanization, previous existing water contamination, economic crisis/difficulties, health threats, size of the country, administrative structure of the country etc., are crucial elements that need to be preliminary identified and then assessed in order to develop effective legal frameworks.

The cases examined in this study (Argentina, Australia, Finland, Jordan, Singapore, South Africa) provide some good legal responses to specific national challenges. A country like Australia faces several constraints such as the scarcity of water worsening with growing population and climate change effects but also such as the size of the country and the dispersal of the population. As a consequence, the wastewater management and recycling is of crucial importance, is decentralized and under the responsibility of each state. A good legal practice developed by the State of Victoria to reduce the administrative burden is to provide adapted procedure for wastewater treatment plants establishment according to their daily capacity of treatment (Environment Protection Act, State of Victoria[4]): on site treatment that cover less than 5 M^3 a day can be installed following local government approval, most important wastewater treatment plants that have a design capacity of greater than 5 M^3 a day are to be approved by the Environment Protection Authority (Victoria) while the large scale wastewater treatment plants, greater than 1000 M^3 per day, require approval by the Environment Protection Authority and the department of Health and Human Services (Victoria).

This classification and progressive staggering of levels of control according to the volume of wastewater treated or to the destination of wastewater treated reduces the burden of administration on government, by focussing attention on a limited and selected number of cases posing incremental levels of challenge.

If wastewater management and treatment are obviously a national challenge, this does not necessarily imply that solutions need to come only from the State: national legal frameworks can also encourage private /individual initiative, *a fortiori* in States facing a large and dispersed rural population, through appropriate incentives mechanisms. For instance, the Finnish Water Services Act[5] provides that there is an obligation for municipalities to make sure that appropriate measures are taken to establish a water supply plant to meet the need and secure the availability of sufficient water services in places with a large number of population or where health or environmental protection need to be specifically addressed. In other cases, in more scarcely populated rural areas, water co-operatives in charge of sewerage and wastewater treatment services are encouraged (see the Finnish Co-operatives act[6]).

In countries facing large rural population and dispersed settlements, sewerage and wastewater treatment services can be developed at individual level or on the co-operative model through appropriate incentives mechanisms. This decentralization of the services favours in addition the participation of the citizens in the wastewater treatment process.

The South African Integrated Coastal Management Act N°.24 of 2008[7] is a good example of a legislation developed to respond to the national challenges regarding marine pollution and coastal environment protection in general, also from wastewater discharges, for a country having around 2500 Km of coast. This law established a system of integrated coastal management, including norms, standards and policies promoting the conservation of the coastal environment and the use of natural resources in a way socially and economically justifiable and ecologically sustainable. Additionally, this act was the result of a long process of consultations and policies initiated by the government and involving the different stakeholders in order to move from a fragmented approach regarding coastal management to an integrated one.

Wastewater treatment can entail very high financial investment; that is even truer for developing countries with high public debt ratios and forced to import technologies from abroad. As seen in Jordan, a country facing a severe water scarcity and forced to exploit non-conventional water resources, the As-Samra wastewater treatment plant[8] upgrading in 2008 requiring USD 169 million was made possible through a Public Private Partnership due to the existence of legislation that allows this kind of investments[9]. Since then a PPP Unit has been established within the Jordanian Ministry of Finance and a new law on PPP has been passed in November 2014 in order to strengthen the existing legal framework.

Developing wastewater treatment infrastructures through PPPs can be facilitated by legislation regulating this kind of complex ventures. A dedicated PPP Unit in the structure of government can be useful to expedite the administration of PPP ventures.

ii. Standards adequacy

Global standards relating to wastewater have no mandatory effect on governments and the different actors, they have the value of indicators and guidelines. That is why regulations are needed at the national level to prescribe bidding rules and standards applicable to the different stakeholders in wastewater management and reuse. Standards deserve a specific attention since they eventually form the benchmarks in order to deliver permits/licences, but also to then monitor and assess water quality and processes related to wastewater management (notably by the elaboration of a list of

hazards that need to be controlled in order to then obtain a safe water recycled). As a consequence, they also need to be previously evaluated in the national context since they will respond to specific national challenges. Wastewater treatment standards should be based on a demand-driven approach, very stringent standards can be an obstacle to the valorisation of reclaimed water for further reuse especially in a context of water scarcity. Moreover, on the international level the WHO guidelines for the safe use of wastewater in agriculture have changed their approach and indicators in order to encourage reuse. In Egypt for example, the law 48/1982, about the protection of the Nile and waterways from pollution impose very stringent standards, especially regarding the COD value which is significantly lower than the European Union standards[10], preventing farmers especially in the Nile Delta from using wastewater.

The Jordanian case can be seen as a good practice to follow as it specifies a range of standards according to the different reuses of wastewater adapted to the national policy on water resources management considering wastewater as a resource. The treated effluents to be discharged in watercourses or for reuse in agriculture require not more than a secondary level of treatment.

It is necessary to establish different standards for wastewater treatment depending on the destination of the water: the quality of recycled water doesn't have to be the same when the final destination is direct potable reuse, groundwater recharge, agriculture or the irrigation of non-food crops. These standards have to comply with the national policy around wastewater management and to fit to the national targets, but to comply at the same time with the guidelines recognized at the international level, however they are not binding.

The differentiation of standards of treatment according to the final destination of the recycled water is desirable as it [a good practice to follow that] permits to reduce the costs of wastewater treatment, while encouraging uptake by the end-users.

The Australian case also represents an interesting approach since the new 2006 National Guidelines for Water Recycling has a strong focus on Managing Health and Environmental Risk. This approach implies the necessity of identifying risks to human health and environment in a proactive way and to adopt a risk-based approach to standard-setting. It involves the identification of all hazards in the recycled water that could potentially affect human or environmental health and then assess the risk involved for each hazard, thus providing means to identify the hazards that represent most significant risks for human and environment health. This approach permits to identify preventive measures in order to control such hazards.

The risk assessment-based approach to the setting of wastewater treatment standards (?) permits to preventively protect human and environment health so that States do not only react when problems arise. In any case, even if the risk assessment-based approach is not adopted, a progressive and a continuous evaluation of standards should be encouraged by the law since threats to health and environment do evolve.

iii. Human rights based approach

Promoting good practices in wastewater treatment would not be totally effective without taking into consideration the human rights standards. Considering human rights related to wastewater treatment and management, one need mainly to refer to the right to water and sanitation, the right to housing, the right to food and the right to a healthy environment. Respecting these human rights has obviously implications for water quality management: as for the right to water and sanitation, it implies that water has to be safe and consequently that water resources are protected from pollution and free from any kind of hazards threatening human health. As for the right to a healthy environment, it implies that States shall assess environmental impact of projects but also to make sure that information is public and ensure public participation in environmental decision making. As

for the right to food, it implies that food production cannot be supplied by polluted water affecting the quality of the final product.

The legislation of South Africa is a particularly good example for a human rights based approach, also because South Africa has been one of the first countries to constitutionally recognize the right to water and sanitation in 1996. Among the various progressive measures, one can find in the Municipal Systems Act N°.32 (2000) the fact that local governments have to ensure universal access to essential services. Similar provisions can be found in the Singaporean laws requiring that all Singaporeans shall have access to an affordable, high quality water for the long term. Indeed all the countries that have ratified the international conventions recognizing these human rights recognize them as binding and are committed to introduce them in their national legislation. Consequently, governments have the obligation to respect, protect and fulfil the implementation of these rights.

Water supply as well as wastewater collection and treatment do not have to be necessarily free of charge or provided by government. However, in order to favor a human rights based approach, the legal framework should specify that these services have to be accessible for all, without any kind of discrimination (financial, gender, racial etc.). The price of water should not be excessively increased because of expensive wastewater treatment technology.

Another important aspect of a human rights based approach to wastewater management is public access to information and participation in decision-making. In Finland, transparency and easy access to environmental information is a guaranteed principle. It also includes that regarding environmental issues related to the industrial sector (such as the sector of wastewater treatment), industry but also all stakeholders have the right to take part and to be consulted for the preparation of new legislation or sectorial programmes. While in Jordan, the national water strategy also involves stakeholders from the civil society, as the agricultural water users associations, in order to protect water resources from pollution.

Public participation and universal access to information are an important adjunct to legal frameworks related to wastewater management. This is all the more important since these transparent processes will raise general awareness and will then permit to achieve a commitment of all parties to policy implementation.

The Argentinian *Matanza-Riachuelo* case shows that a human rights-based approach can prove effective in forcing [, one can also understand the importance of encapsulating human rights standards in legal frameworks related to] wastewater management on a recalcitrant government. The Government of Argentina, the City of Buenos Aires, and the Province of Buenos Aires, were found by a federal judge equally negligent and responsible for not controlling the degradation of the Matanza-Riachuelo Basin, notably on the basis of Article 41 of the Constitution ensuring the human right to a healthy environment.

b. Legislation comprehensiveness and enforcement

The second main quality of legislation related to wastewater management is its comprehensiveness since many other related thematic areas of legislation such as public health, environment, planning…etc. need to be taken into account. It is also true that legislation, even comprehensive or responsive, could never be effective without enforcement mechanisms, including the implementation of monitoring systems.

i. An integrated and sustainable approach

A sectorial approach to wastewater management would be in most of cases ineffective. Wastewater management is indeed so deeply interrelated with the protection of human and environmental health but also with various sectors such as agriculture, energy or planning that an integrated

approach is required in order to be efficient, effective and sustainable. All relevant factors related to these sectors have to be taken into consideration in order to produce a comprehensive, efficient and sustainable wastewater management legal framework. If Singapore case happened to be so successful, it is also because the legal frameworks and public policies integrated many sources, covering many dimensions such as urban management, industrial regulation, public housing and public education. In a country facing such territorial constraints as Singapore, solutions to wastewater treatment have to be efficient at the first try; a holistic approach appears then to be the proper tool.

South Africa also could be cited as an example of a country having a comprehensive, progressive and updated legislation regarding the legal arsenal that has been put in place after the apartheid relating to wastewater management, from the approval of the National Water Act in 1998, to the Integrated Coastal Management Act passed in 2008.

Not only an integrated approach involves the comprehensiveness of legal frameworks related to wastewater management, it also favours the sustainability of the answers given to wastewater challenge. Legal frameworks should take into consideration the various sectors and dimensions involved, directly or indirectly, with wastewater management in order to provide sustainable and consistent solutions.

A consistent approach also implies coordinated and integrated decision-making. As a consequence, an integrated approach to institutions is also relevant. Always in the case of Singapore, the institutional coordination between the ministries and agencies across various sectors has been crucial in order to design and then implement laws and regulations related to water and wastewater.

It belongs to each country to identify which ministries (for instance health, environment, agriculture etc.) or agencies are relevant in order to design and implement laws and regulations for wastewater management. However, the long-term success of these laws/regulations is highly dependent on institutional coordination both at the level of decision-making or at the level of implementation.

ii. An effective system for the control of wastewater discharges

Permitting and licensing of wastewater discharges involve *a priori* assessment of the impacts of discharging wastewater. The case of Finland is especially relevant as it developed also an integrated approach to the permitting of industrial activities (including the permit to discharge wastewater) centralized in one agency, the Environmental Permit Offices. The South African Integrated Coastal Management Act N°.24 of 2008 as well includes a chapter dedicated to “Marine and coastal pollution control”, with a specific article concerning “Discharge of effluent into coastal waters”. This article prohibits explicitly effluent discharge that originates from sources on land and describes in great details the procedure for exceptional permissions and authorizations.

Legal frameworks for wastewater management should encourage integrated permit systems for wastewater discharges, preferably administered by a central authority.

Sanctions are also useful to ensure compliance with legislation for wastewater management. Most countries have developed a system of sanctions because of its dissuasive effect. For instance, Singapore, because of its vulnerability due to its territorial specificities, has a well-developed system of sanctions against discharging toxic substance into any inland water causing environmental hazard, ranging from fines to imprisonment. However, a notable fact is that the Singaporean legislation not only prohibits or sanctions but also provides that industries facing difficulties can receive, if needed,

technical support from the government. Sanctions should indeed be accompanied by "softer" inducements to compliance. One such "soft" practice developed by South Africa is the system of certification aimed at measuring and comparing the results of the performance of Water Service Authorities and their providers relating to wastewater management. These kinds of systems constitute positive incentives to respect legal framework and thus create a virtuous cycle.

If sanctions are necessary and have to be credible enough in order to discourage violations and non-conforming behaviours, they should be accompanied by incentives such as assistance from government, or certification of good performance.

In case of repeated violations, and notably when public authorities appear reluctant to take measures in order to sanction/stop the responsible stakeholders, an independent authority like an Ombudsman can be instrumental to rectifying the situation, as shown by the Argentinian case. Facing the massive industrial pollution by wastewater discharges in the Matanza-Riachuelo river basin, it is the national Ombudsman who, on the petition of affected stakeholders, filed a complaint that led to the condemnation of the state government, provincial government and the City of Buenos Aires to establish a clean-up plan.

National Human Rights Institutions, on the basis of their human rights jurisdiction, should be encouraged to monitor the wastewater management situation, and to report violations of notably the human right to water or to a healthy environment for action by the competent authorities.

2. Policy Effectiveness

Public policy can be defined as a series of "political decisions for implementing programs to achieve societal goals" [11] (Charles L. Cochran and Eloise F. Malone, 1995). In its chapter 8 entitled "Integrating environment and development in decision-making guidelines for an effective public policy," Agenda 21[12] recommends adopting "a domestically formulated policy framework that reflects a long-term perspective and cross-sectoral approach as the basis for decisions, taking account of the linkages between and within the various political, economic, social and environmental issues involved in the development process."

Applied to wastewater management, the main objectives of a cross-sectoral policy can be summed up as follows: Environmental protection, public health, water security and food security[13]. Obviously, the order of these objectives will be determined in the light of each State's challenges and priorities, and should be regularly updated according to the emergence of new priorities or risks.

i. Updated strategic vision

Concretely, a comprehensive policy relating to wastewater management should be based at least on the realisation of the Millennium Development Goal relating to ensuring environmental sustainability[14] and, more specifically, the targets around ecosystem protection and access to basic sanitation. New global goals will be officially set by the UN assembly by the end of 2015 through the adoption of the Sustainable Development Goals (SDGs)[15], and it should be noted that Goal 6 as proposed by the Open Working Group is entitled "Ensure availability and sustainable management of water and sanitation for all" and includes targets relating to water aiming to achieve global access to sanitation by 2030 and reducing wastewater pollution.

In addition to these goals, Integrated Water Resources Management (IWRM), as a concept based on the Dublin Principles[16], must be included in every national policy. IWRM emerged in 2002 during the

World Summit on Sustainable Development[17] as part of the international policy framework. A first goal was set for countries to establish national IWRM policy goals by 2005 with the understanding that for regions of the world where water scarcity levels are highest, the use of wastewater and greywater is an important component of IWRM[18]. Indeed, reclaimed water henceforth has to be considered as part of IWRM.

In addition, general principles admitted internationally, such as the precautionary and the prevention principles, as well as the polluter-pays principle, should be clearly integrated in the policies and guidance as seen in the South African Operational Policy for Disposal of Land-Derived Water Containing Waste to the Marine Environment adopted in July 2004[19]. Also the polluter pays principle has to be applied and enforced in a proper way, for instance supported with subsidies scheme where its application is deemed not feasible (for poor peri-urban areas for instance).

A comprehensive policy should be based at least on the realization of the development goals in the national level, respectful of the Integrated Water Resources Management concept and integrates the general principles of precautionary, prevention and the polluter-pays.

A public policy for wastewater management should be the expression of a strategic vision of the national needs over the medium and long term, with specific deadlines. It should clearly identify the challenges and draw up a series of goals and targets from the perspectives of the various stakeholders, describing a series of actions to achieve these targets. The Jordanian "water for life" strategy for 2008-2022 and its chapter 6 relating to wastewater is a clear example of this.

The targets must be achievable according to the available means of the country and be in total concordance with the national development plans and other development strategies at the national and regional levels to ensure that every action will be budgeted. In South Africa, the MDG targets with respect to sanitation backlogs had been reached since 2008, but achieving universal access to sanitation by the end of 2014, as mentioned in the National Water Resources Strategy of 2013, proved to be too ambitious.

As seen in the South African case study, developing a national strategy for water resources management can be incorporated in the legislation as a statutory obligation of government which provides these policies more authority. Indeed, the National Water Resources Strategy is provided for in chapter 2 of the National Water Act as a binding instrument designed to ensure that water resources are protected, used, developed, conserved, managed and controlled in an efficient and sustainable manner. Articles 5, 6 and 7 of the Act describe the content and the procedural aspects of the strategy.

Ensuring the design and the regular update of a strategic vision with achievable targets in terms of both means and time, including a series of concrete actions as well, is absolutely necessary for achieving satisfactory results.

Wastewater management policies should be based on a demand-driven approach instead of a supply-driven approach[20]. This means adapting technical and managerial means to the real needs of the population and the potential reuse of reclaimed water. In Jordan, one of the 10 countries most affected by water scarcity, the Wastewater Management Policy of 1998 has ensured that treated effluent be considered as a water resource, not separated in policy or thought from other water resources. This differs from the majority of South Mediterranean countries facing similar threats, where there are no official strategies for an extensive reuse of wastewater [21].

Bottom-up approaches regarding wastewater reuse have proved their effectiveness in comparison to top-down ones. National strategies must take into account the areas of implementation reality, the

users' expectations, and the level of acceptability among the population. Regulations, standards and the means implemented will not be the same for every use (i.e. if reclaimed water will be used for agriculture, aquaculture or industrial purposes).

Wastewater management policies should be based on demand-driven and bottom-up approaches, adapting to the real needs and expectations of the different stakeholders.

ii. Enabling adapted technical solutions

The UNEP/UN HABITAT report « Sick Water » stresses that technologies in wastewater should be multi-faceted and reflect the needs and capacity of local communities, and that sector policies should encourage innovative and adaptable approaches[22].

Extensive wastewater treatment technologies such as constructed wetlands have proven worldwide not only their effectiveness but also their profitability. Indeed this kind of infrastructure does not require high qualifications in terms of operation and maintenance and consumes no energy at all. In China, 450 wetlands have been constructed since 1987 and they have proven successful [demonstrate their proper functioning], especially in warm areas and where there are large areas of wetlands [23]. In the Middle East and particularly in Tunisia, a filter of planted reeds has been successfully experimented recently in the rural region of Jougar[24].Consequently, governments especially in developing countries should introduce financial and administrative incentives for the implementation of such technologies in rural areas.

Extensive wastewater treatment technologies can currently also be used at a large scale as seen in Melbourne (Australia) where 52% of the city's wastewater (500 million m³/day) is treated in 11,000 ha of lagoons[25]. However this requires sites sufficiently large available at a reasonable cost and close enough to the urban areas, and these elements need to be taken into consideration when developing public policies.

Other solutions could be easily implemented in rural areas such as waste separation at the source or dry toilets. In addition to being more environment-friendly, these solutions are less costly in terms of implementation. Nevertheless, fecal sludge collection and treatment have to be included in the cost.

The choice of technologies around wastewater management should be adapted to the national/ local context. Low-cost natural treatment technologies should be encouraged especially in the rural areas of developing countries.

In the industrialised country of Switzerland, which has numerous lakes and watercourses, a new law was passed in 2014[26] encouraging wastewater plants to be equipped with additional treatment processes in order to remove micro-pollutants. Such costly and innovative equipment is well adapted to a country like Switzerland, and will reflect positively on the environment, but would be inappropriate for countries that do not yet have the same financial means and technical capacities.

As another example of a high-income country which was able to get the best out of technology thanks to a well-conceived policy, Singapore can be cited through the development of its own brand of recycled water –NEWater. Four plants currently produce 547,200 m³/day of reclaimed water, covering 30% of the country's freshwater needs and the ambition is to increase this figure to 55% by 2060. This was possible due to the awareness of water scarcity threats and the willingness of the national authorities to ensure water security and reduce dependence on water deliveries from Malaysia.

High-income countries have to invest in innovative technical solution for a better environmental protection and to reduce the impact of water scarcity.

Some technical solutions are not adapted to the national or the local context of certain countries. South Africa's Green Drop assessment initiated in 2011 has shown that the majority of small wastewater treatment plants located outside metropolitan areas were facing problems of maintenance and operation. Indeed, in many developing countries, wastewater treatment plants situated in rural areas and using intensive processes are often facing these types of problems due to challenging cost recovery schemes, poor governance and lack of regulated support at the time of choosing a technology.

Additionally, the issue of acceptability should be addressed by public policies when choosing a technical solution for sanitation or options for wastewater reuse. Experience from different countries has shown that the population will reject a solution that would be considered un-adapted to the local customs or religious beliefs despite obvious health or financial benefits.

Public policies should anticipate issues of cost-effectiveness, sustainability and acceptability before implementing a certain technical choice.

iii. Multi-level scheme

Public policy regarding wastewater management should be comprehensive in the sense that it has to include a range of measures addressing the issues relating to the sector from the international level down to the local level.

In many cases wastewater management is not only a national issue, as the impact on environment could affect several countries in a context of transboundary watercourses or aquifers, as well as the marine environment. There are 276 transboundary river basins in the world and 200 transboundary aquifers, involving no less than 148 countries[27]

Consequently, transboundary cooperation should be included in wastewater management policies whenever relevant, and reflected in international cooperation agreements as seen in the Finland case study. Also national legislation can reflect attention to transboundary water cooperation, as seen in the South African National Water Act containing a chapter on International Water management[28], recommending the establishment of bodies to implement international agreements.

The International Commission for the protection of the Lake of Geneva (CIPEL), a Franco-Swiss Commission responsible for monitoring the quality of the water in Lake Geneva, in the Rhône and in their tributaries[29], is a good example of international cooperation as seen in the different action plans it developed. The 2011-2020 action plan, in particular, prioritizes the reduction of micro-pollutants from wastewater discharges to the Lake and its basin.

Transboundary cooperation is essential for addressing wastewater issues, permanent international river basins institutions are needed for implementing common and effective policies.

Depending on the level of decentralisation, adapted strategies and actions should be implemented at the regional and local levels according to needs and priorities. In Jordan, regarding the context of water scarcity and the need for irrigation, especially in the Jordan Valley, the major agricultural area of the country, reclaimed water was included as part of the water resources available in order to contribute to the global development of the region. The Jordan Valley Authority (JVA) has among its responsibilities the coordination of actions contributing to the valorization of wastewater with the other concerned agencies.

Decentralized wastewater treatment plants could be better-adapted to the specificities of the rural areas in different developing countries, as observed in Egypt and especially in the Nile delta[30]. It is characterized by dispersed dwellings over a large area. Public policies have to take into account these parameters and push for the implementation of solutions, once their economic and technical profitability has been proven. In this case, feasibility studies should compare extensive and intensive treatment options and propose the solution which best suits best realities on the ground.

In other countries the trend is toward centralization. In Switzerland, several municipalities have put their means together for implementing and operating medium- to large-scale treatment plants, but this is only possible with the necessary financial means, the appropriate technical and managerial expertise, and a manageable amount of territory.

As part of Finland's government policy 1,400 water co-operatives have been created in rural areas, playing a central role in providing water and sanitation services.[31] Co-operatives are officially recognized and regulated by the 2001 Co-operatives Act.

Down to the local level, several individual or small-scale solutions can be implemented regarding sanitation and wastewater treatment, such as dry toilets and waste separation at the source. In Finland, there are a variety of small-scale wastewater treatment systems for isolated households containing a pre-treatment stage, combined biological and chemical treatment stage and an offtake for phosphorous. The different types of package-plants include batch plants, active sludge plants, bio-rotors and biological-chemical plants. There are models available for single-family use, but also for use by several households connected to one system. The systems operate either by treating toilet waste and washing waters separately or by treating toilet and washing waters together[32].

Policies at the National and local levels have to take into account the different technical possibilities and develop strategies for their standardisation and dissemination. Fiscal and financial incentives have to be set as well for their implementation given their obvious impact on environment and public health.

To ensure the implementation of these policies, appropriate and functional institutions are obviously needed. Due to the complexity of the issue, different departments and public agencies could be involved, with the ministry in charge of water, the ministry in charge of environment and the ministry in charge of public health being those most directly concerned. Additionally, several government agencies and public companies specialized in environmental protection, wastewater management, sanitation and public works should be consulted. Coordination between all these public institutions, research institutes and the private sector active in this area is necessary[33]. So is coordination between government and the legislature, to translate policies into legislation if necessary and to secure sufficient budgets for their implementation. Ensuring the necessary human and material means for the functioning of these institutions is obviously indispensable.

A proper coordination is needed as well among institutions acting at the national, regional and local levels. Likewise, between federal and state or provincial authorities in the case of a federal State. A multiplicity of institutions might hinder the process of decision-making. As seen in Singapore, a process of institutional integration was initiated in 1972 and completed in 2001 by placing all water-related services, controls and administration in one sole institution, the Public Utilities Board, under the supervision of the Ministry of Environment. This process of institutional consolidation has led to exceptional results in terms of environmental protection and wastewater management.

Assessment and monitoring of implementation of these policies must be rigorous, reliable and transparent. Specific programmes should be designed for this purpose such as the Green Drop Certification for wastewater treatment plants and systems in South Africa. Specialized agencies

acting independently may also prove necessary. This, in addition to the role that could be played by civil society institutions, National Human Rights Institutions (NHRIs), Ombudsmen and other specialized organizations in terms of monitoring. The reports produced and the actions taken by them can be very useful for the evaluation and adjustment of public policies.

Proper coordination between the different public authorities and institutions at the different levels and an efficient monitoring are needed for an efficient implementation of the policies.

iv. Public participation and awareness

To be effective, a policy should be inclusive (e.g., involve not only the institutional stakeholders but also actors from the civil society). This participation will ensure the policy comprehensiveness and a full involvement of interested parties in the implementation phase.

Multi-stakeholder involvement can take the form of public participation in the process of policy-making and in the preparation of related legislation, but also through developing targeted awareness campaigns around subjects related to wastewater management.

Agenda 21, which emerged from the United Nations Conference on Environment and Development[34] identified nine major social groups which should be involved in decision-making 1) Women, 2) Children and Youth, 3) Indigenous People and their Communities, 4) NGOs, 5) Local Authorities, 6) Workers and their Trade Unions, 7) Business & Industry, 8) the Scientific and Technological Community, and 9) Farmers. All these groups can be directly affected by wastewater management policies as parties having special needs or special interests and expertise and should be consulted.

The Convention on access to information, public participation in decision-making and access to justice in environmental matters[35] contains a specific article[36] regarding public participation on policies, encouraging States "to provide opportunities for public participation in the preparation of policies relating to the environment." These rules are obviously applicable to wastewater management and binding for the States that have ratified this convention.

Public policy should be based on a multi-stakeholders approach.

Public participation can be in the form of consultations, public inquiries, establishing permanent structures or any other means that guarantee a meaningful and full consultation of the different stakeholders. A prerequisite to public participation is ensuring access to information to the different stakeholders related to wastewater management and environmental issues.

The extensive consultative campaign that marked the policy-making process in South Africa, leading to the White Paper on Water Supply and Sanitation in 1994 and then to the adoption of the National Water Act of 1998[37], and the consultations contributing to completion of the Integrated Coastal Management Act of 2008[38], are good examples of public participation involving different stakeholders from public authorities, civil society and the private sector.

Public participation can take the form of a permanent structure as seen in South Africa through the Catchment Management Forum (CMF) introduced by the National Water Act, as a non-statutory water management institution facilitating stakeholder participation in water-resources management.

The Jordan Valley Water Forum, established in 2012[39], is a shining example of public participation in water-resources management even if it is still lacking a legal basis. This forum takes place twice per year and give the various stakeholders (government, farmers, development partners, water users associations, private sector) the occasion to meet and make recommendations regarding the sector at the local level, including on the reuse of reclaimed wastewater.

Water-user associations and other local community groups experienced in several countries (South Africa, Tunisia, Senegal, Bénin, etc.) as local water and sanitation service providers based mainly in rural and peri-urban areas, could constitute an essential partner in drinking water and wastewater management issues if they receive the appropriate support and supervision from public authorities and development institutions.

Public participation should be institutionalized and not occasional.

Promoting public awareness around environmental issues is considered one of the means of implementation of Agenda 21's chapter 8, focusing on "highlighting the responsibilities and potential contributions of different social groups." For its part, the Aarhus convention in its article 3.3 exhorts States to "promote environmental education and environmental awareness among the public."

Experimental public initiatives in Bangladesh and India demonstrate how targeted awareness actions can lead to good results and create a dynamic that can be duplicated elsewhere. Initiatives in those countries take the Community-Led Total Sanitation (CLTS) approach[40], where communities are sensitised to sanitation and hygiene issues and encouraged to abandon open defecation and develop their own facilities according to their environment, using technical solutions adapted to their needs.

The case studies cited in this book include some good examples of public awareness campaigns regarding sanitation and wastewater management as seen in Singapore and South Africa. The ABC – Active, Beautiful, Clean- Waters educational and outreach programme launched in 2006 by the Public Utilities Board in Singapore, to bring the population closer to the network of canals, drains and reservoirs through the creation of community spaces close to these drainage and water-storage areas represents a successful and innovative public awareness initiative.

In South Africa, the eThekwini Water and Sanitation Unit, of the eThekwini municipality serving the Durban metropolitan area, initiated in 1997 a successful awareness programme based on a participatory approach with vulnerable communities, women and children. The programme informed people of the proper use and management of the services using leaflets, house visits, street theater, schools programmes, etc. These actions led, among other outcomes, to the reduction in diarrhea incidents and other diseases, reduction in non-revenue water and illegal connections[41].

Public awareness through innovative and smart sensitising campaigns are very useful in terms of policy implementation especially if based on population involvement.

3. Financial and management schemes

Although some progress has been made, in developing countries, most wastewater is still discharged untreated into receiving water bodies[42]. In addition to effective legislation and policies, the financial and management set up for wastewater treatment is a key element to ensure that an effective and sustainable system is in place.

a. Financing wastewater treatment

What is the best approach to finance wastewater treatment so that the system can operate smoothly in the long run? The financing arrangements need to cover not only infrastructure development, but also operations and maintenance costs as well as the development of institutions and human

capacities[43]. Too many wastewater treatment plants have been built without considering, for instance, how operating costs would be covered. Resulting inadequate maintenance of the infrastructure then eventually leads to abandoning the plant, thereby creating the "white elephants" that can be found in many developing countries.

Hereafter, we consider the various approaches to financing wastewater treatment. The three traditional financing sources are usually referred to as taxes, tariffs and transfers (for government, private sector and donors/NGOs)[44], while other innovative approaches are being developed.

i. Public funding

In developing countries, water companies are still mostly publicly-owned[45]. Public funding can take various forms, as explained by Ménard and Peeroo (2001): public management ranges from direct public management, in which the provision of water services depends on the general municipal budget or an independent department of the local administration, to delegated public management, in which the municipality "delegates" the provision to a communal enterprise which operates under company law[46].

In Buenos Aires, the public company providing water and sanitation services, AySA, and the Government of Argentina have responded to the 2008 Court ruling by developing a comprehensive and ambitious wastewater investment program which includes conveying wastewater to two large pre-treatment plants before discharging the wastewater through long outfalls to the La Plata River) with diffusers to dilute the wastewater. To complement this, a number of smaller secondary wastewater treatment plants are also being built in distant urban areas. The financing of such activities

and the larger basin clean-up is supported by a large (USD 838 million) lending programme from the World Bank (from 2009-2016).

In Singapore, to finance part of its investment programme, the Public Utilities Board issued a bond to raise $400 million[47].

In Switzerland, a new tax will be effective starting 2016 to encourage wastewater treatment plants to introduce more advanced processes for wastewater treatment (ozonation, powdered activated carbon treatment). The main goal of this nation-wide tax based on the polluter-pays principle, is to prevent the discharge of micropollutants and reduce the adverse effects these have on the aquatic environment, especially rivers and lakes[48].

Overall, municipal wastewater treatment faces an annual global shortfall in funds (between 2002 and 2015) of an estimated US $ 70 billion[49]. Allocation of funds for sanitation and wastewater treatment are rarely perceived as a priority due to a combination of four factors: such funding is perceived as capital intensive, does not generate important revenue, does not always deliver intended benefits nor much political visibility[50]. To face budgetary constraints, it is not uncommon for small towns to cluster together to reduce costs for services (in France, for example, in 2014, there were more than 12,000 public establishments for intercommunal cooperation[51]).

Tightening public budgets are giving rise to new forms of public funding for wastewater treatment, ranging from the issuing of bonds to the clustering of small centres to finance service provision.

ii. International cooperation

International donors and NGOs are also a crucial source of funding for wastewater treatment.

Most small urban centres in Africa, Asia and South America do not have access to development bank resources, so additional seed funding in capital can be required to get the wastewater treatment system to work and allow to charge for the service. Such seed funding can be provided through international development projects, such as the UN-Habitat project in Lake Victoria region to build capacity for utilities in secondary towns[52].

Similarly, international partnerships are increasingly being developed between private Dutch water companies, which dedicate a small portion (1%) of their budget to international solidarity projects, and local water governments in developing countries, to help leverage additional capital/funds/loans from banks such as the World Bank.

The Global Water Operators' Partnerships Alliance is a network designed to support water operators improve their capacity to provide access to basic water and sanitation services, by encouraging partnerships between water operators. Led by UN-Habitat, it is increasingly playing a financial brokering role between utilities and financial institutions[53].

In Uganda, the Waste to Wealth Initiative of the United Nations University Institute for Water, Environment and Health (UNU-IWEH) is promoting a pilot project whereby the marketing of wastewater products such as fertilizer and soil amendment products, will allow to finance the sanitation service for the 400,000 slum dwellers of the capital city, Kampala[54].

Since 2009, foreign aid from OECD countries has levelled and is predicted to continue declining in the future, due to low growth and prioritization on domestic spending (with aging population) over oversees development aid[55].

Donor resources, which are currently constrained by the financial crisis, can play a crucial role in supporting the leverage of additional financial sources for wastewater treatment. Strategic investments can also help support the development of creative market-based solutions.

iii. Private sector participation

In the water and sanitation sector, full privatization is very rare. Except for the case of England and Wales, in Western Europe, for instance, liberalization has essentially translated into private sector participation. In developing countries, private sector participation occurred mainly in Latin America[56].

Although public-private partnerships (PPPs) started developing in the 1980s, there is still no common definition on which everyone agrees on. According to the World Bank's Public Private Partnership in Infrastructure Resource Centre (PPPIRC), "PPPs are typically medium to long term arrangements between the public and private sectors whereby some of the service obligations of the public sector are provided by the private sector, with clear agreement on shared objectives for delivery of public infrastructure and/ or public services"[57].

Public-private partnerships (PPPs) range from community contractors, service contracts, management contracts, leases, concessions (build-operate-transfer), divestures and public-private companies[58].

The World Bank and donors in general are quite keen on this approach. The World Bank has developed a database on private participation in infrastructure[59], which comprises:

- *Management and lease contracts*: A private entity takes over the management of a state-owned enterprise for a fixed period while ownership and investment decisions remain with the state (with operational risks either remaining with the government or transferred to the private operator, depending whether it is a management or lease contract)
- *Concessions*: A private entity takes over the management of a state-owned enterprise for a given period during which it also assumes significant investment risk. Concessions can include a combination between building, rehabilitating, operating, leasing or renting, and transferring the facility.
- *Greenfield Projects*: A private entity or a public-private joint venture builds and operates a new facility for the period specified in the project contract. The facility may return to the public sector at the end of the concession period. These include arrangements such as: Build, lease and transfer (BLT), Build, operate and transfer (BOT), Build, own and operate (BOO).
- *Divestitures*: A private entity buys an equity stake – full or partial- in a state-owned enterprise through an asset sale, public offering, or mass privatization program.

There are more traditional models of public service delegation (such as the French “affermage”, etc.) and more recent models such as Build-Own-Transfer and BOOO, where it is the investor who finances the project rather than the technology transfer. This allows the State to avoid increasing its public debt so it is a PPP-financing model (the company resorts to banks and contracts with other companies) and brings rigor in the project management (infrastructure contracts of 20-35 years or more, then transfer). For the transfer to be able to take place, the project needs to be maintained, which the proponents of PPPs justify that only the private sector can ensure.

In Singapore, while the first NEWater plants were public, the following ones were developed under Design, Build, Own and Operate (DBOO) contracts[60].

In Jordan, the As-Samra wastewater treatment plant is a “hybrid model” as it was financed through the first public-private partnership in the Middle-East, under a Build-Own-Operate contract and a unique combination of private, public and international donor’s funds. Other such partnerships have developed since, including a number of micro Private Sector Participation contracts at the governorate level, for billing, revenue collection and leakage repairing functions.

The OECD Guidelines on Public-Private Partnerships[61] have been used by many countries to develop their own national legislation on PPPs. In Morocco, for instance, there is a law on public service delegation and in Tunisia, one on concessions. The World Bank’s PPPIRC maintains a database with the main international guidelines, as well as national laws on PPPs[62]. The World Bank also has a database on the legal framework and the types of regulatory systems that exist for the water sector[63].

The United Nations have also recognised the strategic importance of private sector financing for core development topics and recommend the establishment of innovative partnerships to catalyse additional financing[64].

To overcome the current financial crisis and address the global sanitation issue, a new financing approach is being promoted, which mixes two main principles: blending various sources of capital

(public and private) but also shifting the focus from the amount of money invested to financial incentives linked to the delivery of measurable results (also called "financing for outcomes").[65] For example, in Brazil the PRODES programme was initiated in 2001 to encourage utilities to build, enlarge or improve wastewater treatment plants, with financial incentives (12 payments in total) paid out every three months over a three-year period and based on a proven track record of pollutant reduction[66].

Public-private partnerships, which can be declined under a wide variety of arrangements, represent a way forward to tap into important financial resources for wastewater treatment while overcoming public funding shortcomings.

b. Costs recovery/ Tariff structure/Affordability

It is very common that wastewater management services are "undervalued, under-priced and regulations (where they exist) may not be rigorously enforced", resulting in difficult **cost recovery**[67].

In addition to the most common wastewater discharge charges to raise funds, other economic instruments such as taxes or nutrient trading schemes, could be useful to encourage changes of behaviour[68].

According to the UN-Water 2014 GLAAS report, 70% of the countries surveyed reported that their **tariffs** do not cover the costs of operation and maintenance, key to ensuring good quality service provision[69]. Users are usually non willing to pay their wastewater tariffs so these rarely cover the costs (in some case, these are not covered at all – see free basic sanitation for certain portions of the population without resources in South Africa as part of the Free Basic Services Policy).

Tariffs can be used for several sustainability purposes, such as cost recovery or to encourage reduced water consumption, as well as for social protection[70].

In Singapore, for instance, the national water agency (called the Public Utilities Board) increased tariffs several times over the past decades to reflect wastewater treatment costs and to promote more efficient water use. Today, water is priced to recover the full cost of its production and supply, with the monthly water bill including the water fee, water conservation tax and waterborne fee and sanitation appliance fee (contributions to the national used water system)[71]. This conservation approach is combined with targeted assistance from the government to low-income families, and ensures that all Singaporeans have access to an **affordable**, high quality water for the long term[72].

In Nairobi, which faces many of the common problems found in developing country cities –a fast growing water demand which cannot be met by supply, an unreliable supply which leads users to resort to high-priced unregulated service providers (such as water vendors), water pricing should be increased for the biggest consumers to strengthen cross subsidies of the pro-poor Increasing Block Tariff[73].

For sustainability purposes, it is important to aim for cost recovery of wastewater treatment services, but this can be done through a combination of tariff structures allowing to preserve an affordable service for all.

c. Management efficiency

i. Centralization vs decentralization

Two complementary wastewater management systems exist: a centralised system (large-scale, gathering wastewater from many users and treating it on one or very few sites) and a decentralised system (on-site and small-scale, servicing individual users or the neighbourhood/community). When deciding on which option is preferable for a specific site, it is crucial to consider both options without any preconceived preference for any, and in all cases, to ensure continued management through proper staff training and capacity for smooth operation and maintenance[74]. A comprehensive site evaluation process is needed to select the appropriate management strategy, taking into account the social, cultural, environmental and economic context[75].

Historically, government officials in developing countries have given preference to centralised systems, and it is predicted that this may continue despite "continued high probability for failure".

Reasons for this preference include a higher political visibility and perception of modernity, as well as engineering capacity traditionally oriented towards such systems[76].

However, urban wastewater management is expensive due to the transport through drains, so for developing countries, resorting to more simple technologies with higher community ownership can be an interesting option[77]. The Decentralized Wastewater Treatment Systems (DEWATS) approach, which was initiated in the 1990s, resorts to waste and nutrients recycling and includes modules such as constructed wetlands and biogas plants, and has proven to be successful in slums and peri-urban settlements in Africa and Asia[78].

In rural Finland, small-scale wastewater treatment systems are the norm (centralised treatment plants for isolated settlements would incur high costs), covering single families or several households. For the same reasons, also common are the 1400 cooperatives, small private, not-for-profit water organisations which provide water and sanitation services, mostly in the sparsely populated rural areas.

It might very well be that a combination between the two wastewater management systems – centralised and decentralised- might prove to be the most optimal, keeping decentralised systems for big units such as hospitals or refurbished urban areas, especially considering the trend towards wastewater recovery and reuse[79]. In Melbourne, for instance, the city is developing a strategy to combine the largely centralised sewerage system (which conveys 90% of the city's wastewater to the two wastewater treatment plants) with decentralised and on-site wastewater treatment plants[80].

Wastewater management systems need to be adapted to the social, economic, environmental and cultural context. The decision-making process to choose the appropriate model requires an objective assessment to allow for appropriate tailoring.

ii. Wastewater and sanitation systems performance

As seen in our case studies such as Melbourne or Singapore, successful wastewater management requires new holistic and integrated ways of managing the water supply and disposal chain, to include ecosystem management, agricultural efficiency, urban planning and wastewater treatment[81].

Innovative mechanisms for wastewater treatment include the disposal of wastewater sludge and biosolids management technologies and systems[82]. In Finland, a number of wastewater plants use the energy content in the sludge from wastewater to produce biogas. The Viikinmäki wastewater

treatment plant, which serves about 800,000 inhabitants, is run by the Helsinki Region Environmental Services Authority and treats 270,000 m³ of wastewater per day (or 100 million m³ per year), of which about 85% is domestic wastewater and 15% industrial wastewater. With the energy produced from biogas at the plant, the treatment plant is self-sufficient in heating and about 50% self-sufficient in terms of electricity. The plant produces about 60,000 tonnes of dried waste sludge per year, which after processing is used as soil for landscaping.

Other alternative pathways include low-cost technologies such as simplified sewerage -with smaller diameter pipes than conventional sewerage– also called "shallow sewerage" (because pipes can be as shallow as 0.2m). Very common in Brazil, this technology greatly reduces the cost of wastewater collection as the sewerage is much cheaper to construct (while remaining of good quality)[83]. It also offers a pragmatic option for rapidly urbanising centres[84].

To be most effective and efficient, wastewater management systems need to integrate other sectors (urban planning, potential local irrigation needs for treated wastewater, ecosystems…etc.).

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Fact Sheets

Matanza-Riachuelo River Basin, Argentina: Civil Society Commitment

General data:

Surface area: 2,736,690 km^2

Population: 41.45 million with an average growth rate of 0.9% (2013)

Urban population: 37.9 million (91% of total population) (2013)

Country GDP: USD millions 609,889 (2013)

Human Development Index: 0.808 (very high - 49th in 2013)

Climate: Varies in the 7 geographical regions, from tropical (in the north-east) to temperate in the centre and sub-polar (in the south)

Available renewable water resources: 7,045 m^3/year/capita (2013)

Rainfall/year: from 750 mm in the north to 500 mm in central west-1000 mm in central east down to 200 mm in the south

Annual freshwater withdrawals: 37,800 Mm^3, 74% for agriculture, 15% for domestic uses and 11% for industry (2013)

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 97% (2012)

Population connected to the wastewater collecting system: 42.5% (2001)

Wastewater treatment rate: 11.75% of the collected wastewater at national level (2012) but hides wide disparities

Number of wastewater treatment plants for Buenos Aires City (1.4 million inhab.): 1 main plant (Berazategui) treats 1.9 million m3/day; primary treatment only: pre-treatment then dilution into receiving water body (La Plata River). Smaller secondary wastewater treatment plants in distant urban areas: Planta Sudoeste I, Planta Sudoeste II, Norte, El Jaguël, Barrio Uno

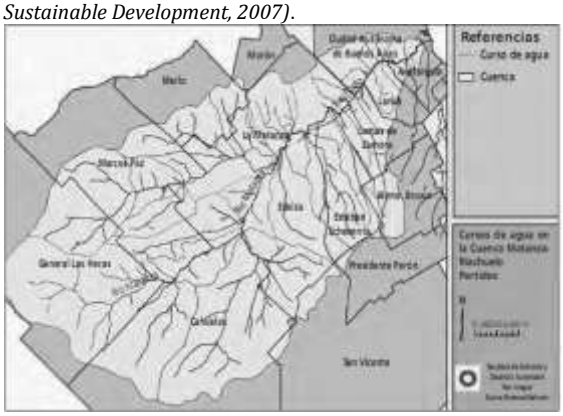
Major institutional stakeholders:

- Ministry of Public Works
- National Agency for Water and Sanitation Works
- Environmental Protection Agency
- Matanza-Riachuelo River Basin Authority (ACUMAR)

Main laws related to wastewater:

- National Law Nr. 25.688 - Environmental Management Regime of Water
- Law Nr. 12.257 - Water Code of Buenos Aires Province

The Matanza-Riachuelo basin spreads over 14 municipalities and the City of Buenos Aires (Source: Componente Cuerpo de agua, ACUMAR, National Secretariat of Environment and Sustainable Development, 2007).



Public hearing before the National Supreme Court (June 2011) © FARN

Major achievement

Over the past few years, some progress has been made towards cleaning up the Matanza-Riachuelo river basin, the most polluted in Argentina and one of the 30 most polluted in the world. Although far from being complete, this is a first step towards reverting a severe environmental deterioration process, which stemmed from intense urbanisation and industrialisation during the 20th century, combined with ineffective wastewater laws and institutional fragmentation. Interestingly, the change has been made possible through a legal framework strongly supportive of human rights.

The 64-km long Matanza-Riachuelo River defines the southern boundary of Buenos Aires federal district and flows into the De la Plata River. The catchment area of 2,240 km is home to 6.1 million inhabitants. Historically, the main sources of pollution were untreated sewage and industrial effluents. Several thousand industries located in the medium and lower parts of the basin –the most polluting of which are slaughterhouses, tanneries and metal-based industries- produce dangerous contaminants such as arsenic, chromium, lead and mercury. The poorest populations living in informal settlements along the river banks were impacted the most. They often lacked basic services such as drinking water, sewage, plumbing, health services and decent housing.

Clean up was initiated after a group of citizens used Constitutional *Article 41 on the right to a healthy environment* to bring the case to the High Court of Argentina in 2004, suing the national, provincial and municipal governments and 44 corporations. Based on the results of several reports prepared by the National Ombudsman (head of the National Human Rights Institution) with neighbour associations, civil society organizations and educational institutions, a Supreme Court Ruling in 2006 requested the government authorities to develop a clean-up plan for the river basin, to be presented in public hearings. The private companies were also requested to define their clean-up measures. In 2008, after several public hearings, the Supreme Court gave a historic ruling known as “the Mendoza ruling,” thereby requiring the three governmental levels to restore and prevent further deterioration of the river basin.

The clean-up plan included seven components: providing public information, controlling industrial pollution, closing unsanitary solid waste dumps, constructing water supply, drainage, and sewerage networks, improving the river banks, addressing the environmental public health crisis and enforcing and monitoring the implementation of the Court ruling. The 2008 ruling also created an inter-jurisdictional basin authority (ACUMAR) to implement the clean-up plan. The National Ombudsman was put in charge of coordinating a Chartered Body composed of the third parties involved in the case to oversee the implementation of the plan, thereby promoting public participation. The Auditor General of Argentina was tasked with supervising the budget allocation for implementation of the restoration plan; and a federal judge was designated to oversee the programme.

In 2012, positive results included an increased number of environmental inspectors in the region (from 3 to 66), creation of 90 sampling points for water quality monitoring water and 4 for air and soil quality. Three new water treatment plants had been built, providing clean water to 1 million people; 11 sewage-treatment plants had been expanded; 186 garbage dumps had been closed; and 177 polluting industrial facilities reconverted. However, efforts and resources are still needed to strengthen the Basin Authority’s inter-jurisdictional power, to improve sewerage services, support the reduction of industrial discharges and improve decision-making for sustainable land-use and drainage planning. These are being addressed through a USD 850 million loan from the World Bank, expected to terminate in 2016.

Australia: Environmental awareness

General data

Surface area: 7 741 220 km2

Population: 23.7 million (2015) with an average growth rate of 1.31% (2010-2015)

Urban population: 20.7 million (about 89% of total population)

Country GDP: USD millions 1,560 372 (2013)

Human Development Index: 0.933 (very high - ranked 2nd in 2013)

Climate: Mostly desert and semi-arid, partly temperate (south-east) and partly sub-tropical/tropical (south-west and north-east)

Available renewable water resources: 21 270 m3/year/capita (2013)

Rainfall/year: below 600 mm for 80% of the country and below 300 mm for 50%

Annual freshwater withdrawals: 22,600 Mm3, 74 % for agriculture, 16 % for domestic uses and 11 % for industry (2013)

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 100%

Population connected to the wastewater collecting system: 87%

Wastewater treatment rate: 92% of the collected wastewater

Number of treatment plants: 580 municipal plants treating 2,000 Mm3 of wastewater/year

Principal technologies: Pre-treatment (Screening); Primary treatment (sedimentation); Secondary treatment (biological treatment, chemically assisted treatment, lagoons); Nutrient removal (biological, chemical precipitation); Disinfection (lagooning, ultraviolet, chlorination); Advanced wastewater treatment (sand filtration, microfiltration)

Major institutional stakeholders:

- Minister of the Environment / Department of the Environment
- National Water Commission
- State Environmental Protection Agency
- State Department of Health and Human Services
- Public water companies such as Sydney Water, Melbourne Water, Brisbane Water
- Councils/local government

Main laws related to wastewater:

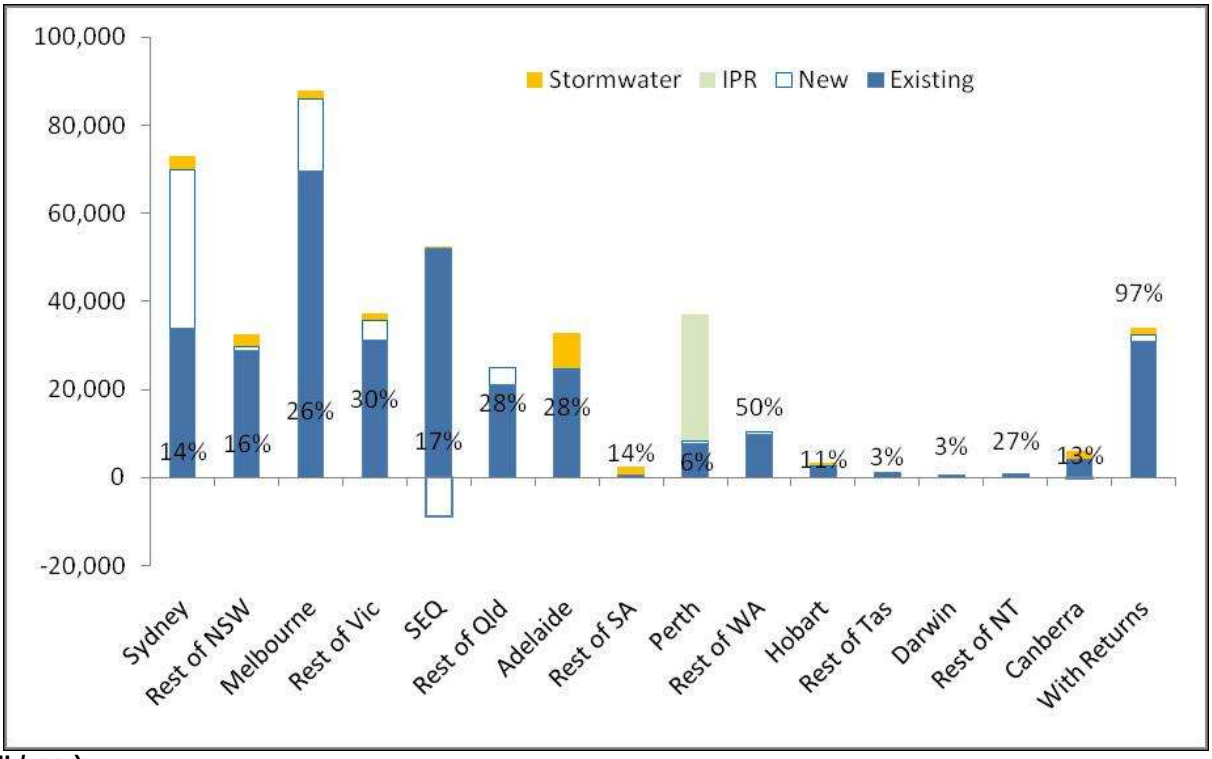
- Environment Protection Act 1970
- Health (Amended) Act 1977
- Health (Use of Waste Water) Regulations 1978
- Water Act 1989 and 2007
- Australian Guidelines for Water Recycling: Managing Health and Environmental Risks 2006

Recycled wastewater in major Australian cities (2005-06 and projections 2015)

City	Total waste-water treated (GL)	Total waste-water recycled (GL)	Percen-tage recycled in 2005-2006	Target (%)	Percentage recycled in 2015 (national target: 30%)
Melbourne	312	46.5	15%	20% by 2010	26%
Sydney	437	22	5%	16% by 2015	14%
Adelaide	70	14	20%	43% by 2025	28%
Brisbane/ SEQ	107	5	4.8%	20% by 2010	17%
Perth	117	6.2	5.3%	20% by 2012	6%
Canberra/ ACT	32	2.2	6.7%	20% by 2013	13%

Sources: Mekala G. D. et al (2008) *Wastewater reuse and recycling systems: A perspective into India and Australia*. Colombo, IWMI Working Paper 128: p.8 and Marsden Jacobs Associates (2012*) Progress against the national target of 30% of Australia's wastewater being recycled by 2015*: p.3

2009/10 recycled wastewater volumes and augmentations to 2015 by capital city and rest of jurisdiction



(ML/year)

Source: Marsden Jacobs Associates (2012) Progress against the national target of 30% of Australia's wastewater being recycled by 2015: p.3

Major achievement

Following regular episodes of droughts in the previous decades, from 2002 to 2010 Australia suffered from a significant decrease in rainfall known as the “Millennium drought”. This resulted in an urgent need to secure water supplies across jurisdictions. Significant investments in wastewater recycling were made at all levels of government, encouraged by the National Water Initiative of 2004 which promoted a variety of water-saving measures for cities.

As a result, over the past two decades, most inhabitants of big cities across the country have operated a shift in mindset due to the droughts, allowing them to realize the need to protect the limited water resource. Between 2000 and 2009, the country managed to reduce per capita consumption by 40%. As a consequence, Australia now joins those water-scarce countries in recognizing wastewater as a valuable resource, from the effluent disposal issue it was limited to just a few decades ago. In 2010, the Australian Water Recycling Centre of Excellence was established to undertake research and broaden the use of recycled water. Since then, and despite the end of the drought in the eastern States, water conservation and non-potable recycling initiatives are now embedded across the country, and have become mainstream in most new urban developments. Although historically, agricultural represented the biggest demand for recycled water, with increasing urban population, future projections show a dominating demand for municipal, industrial and commercial use, as well as for environmental protection.

The City of Melbourne, one of Australia’s largest and driest cities, provides a good illustration of this evolution, with large scale wastewater reuse and natural treatment, which has led to better environmental protection.

Since 2005, Melbourne has developed large-scale wastewater reuse for two important peri-urban irrigation schemes. Together, the city’s two main wastewater treatment plants produce 50 million m3 of recycled water yearly, thanks to large investments to upgrade both plants. This recycled water is used mainly for agriculture irrigation and also increasingly for non-potable domestic uses, as shown by the boom in dual pipe connections for housing developments in the area. Strong community support for increasing the use of recycled water for non-drinking purposes is the making of effective awareness-raising programmes.

Melbourne met its target of 20% of recycled wastewater by 2010 and is expected to reach 26.1% by 2015 (against the national target of 30%). As such, it is ahead of all other major cities apart from Adelaide (expected to reach 28%) and remains the leader city in terms of quantity of recycled wastewater. The city’s large-scale water recycling scheme was prompted in 2005 by a legislative measure taken by the State of Victoria’s Environmental Protection Agency: the amendment of the waste discharge licence law to protect the health of Port Phillip Bay, into which the Western Treatment Plant discharged its effluents. Although twenty years later, this reflects the country’s key driver to improve wastewater management in the 1970s and 1980s: the impact of wastewater discharges on receiving waters’ quality (mostly inland waterways and the ocean).

Melbourne also showcases one of Australia’s commonly developed approach to wastewater treatment, being home to one of the world’s largest lagoon-based treatment plants. The city treats 52% of its wastewaters in the 11,000 ha of lagoons which constitute the Western Treatment Plant. This world leader in environmental and technical innovation is listed as a wetland of international significance under the Ramsar Convention since 1982, hosting thousands of birds and receiving thousands of visitors each year for educational purposes.

Finland: Regional Cooperation

General data:

Surface area: 338,145 km^2

Population: 5.427 million in 2014

Urbanisation: 83.7% of the population lives in urban areas

Urban population: 4,538,130 (World Bank, 2012)

Country GDP: USD 267.329 billion (World Bank, 2013)

Human Development Index: No. 24 of 49 of the category Very high human development.

Climate: Cold temperate; potentially subarctic, but comparatively mild because of moderating influence of the North Atlantic Current, Baltic Sea, and more than 60,000 lakes.

Available renewable water resources: 110 km^3 (2011)

Annual rainfall: 600-700 mm

Water demand: 408 Mm³/year

Water Use: 1.63 km^3/year
domestic (25%), industrial (72%), agricultural (3%)

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 100%

Population connected to the wastewater treatment system: 80% (2013)

Wastewater generation: 251.06 million m^3 (2011)

Wastewater treatment rate: 84.25% of the collected wastewater

Number of treatment plants: 550 (10 large)

Main treatment plants: Viikinmäki (Helsinki region) Viinikanlahti and Rahola treatment plants (Tampere)

Principal technologies: Activated sludge, process with chemical and biological filters, primary mechanical and tertiary treatments, aeration.

Major institutional stakeholders:

The Ministry of Environment

The Ministry of Forestry and Agriculture

The Finnish Environment Institute (SKYE)

The Finnish Water Utilities Association

The Ministry of Foreign Affairs (international cooperation)

Main national laws:

1961 Water Act (last amended 2011)

2000 National Environmental Protection Act (last amended 2014)

2004 Act on Water Resources Management

2006 Decree on Hazardous and Harmful Substance on Aquatic Environment

2006 Urban Waste Water Treatment

EU directives:

1991 Urban Waste Water Treatment Directive

2000 Water Framework Directive

2010 Directive on industrial emissions (integrated pollution prevention and control)

1991 Nitrates Directive

The Viikinmäki plant run by the Helsinki Region Environmental Services Authority, which participates in a twinning programme for training and technology with the wastewater utility, Vodokanal in the City of St. Petersburg.

Major achievement

A large portion of the Baltic Sea's 8,000 km coastline is shared by a population of nearly one hundred million people. Many of the urban areas on its shores are active commercial ports. The biggest city is Saint Petersburg (5 million inhabitants). Other large cities include Stockholm, Copenhagen, Helsinki, Gdansk-Sopot-Gdynia, Riga and Tallinn. Excessive nutrient load and the resulting eutrophication are the Baltic's most serious problems. As one of the largest brackish-water basins, the limited water exchange with the Skagerrak and the North Sea results in long residence time of water and is one of the main reasons for eutrophication in the Baltic Sea to. To control this problem, the Finnish Ministry of the Environment created a programme from 2012–2015 to reduce and recycle nutrients and improve the status of the Archipelago Sea in collaboration with other Baltic states.

Maritime traffic in the Baltic Sea is increasing, which is causing emissions and increasing the risk of oil and chemical spills. The status of the eastern part of the Gulf of Finland has improved, in part due to wastewater treatment in Saint Petersburg with assistance from Finland. Finland has also improved preparedness for oil and chemical spill responses. These measures include the implementation of the EU Marine Strategy for the Baltic Sea, the Baltic Sea Action Plan of the Baltic Marine Environment Commission (also known as the Helsinki Commission or HELCOM) and the EU Strategy for the Baltic Sea Region. Finland has invested 38 million euros in St. Petersburg's wastewater projects since 1991, from the neighbouring area cooperation funds. The City of St. Petersburg has also invested over one billion euros; these investments have helped reduce its wastewater discharges into the Baltic Sea. By 2011 about 93% of St. Petersburg's wastewater was treated and future targets aim for 98%. One of the cornerstones of the cooperation is the twinning programme between the wastewater treatment plants of Helsinki and St. Petersburg with training in modern wastewater utility operations. Today, Vodokanal in St. Petersburg is one of the best water and wastewater utilities in Russia. St. Petersburg shares its know-how with other Russian cities through the International Advanced Water Technologies Centre, with Finnish assistance in training. (Finland Ministry of Environment: http://www.ym.fi)

In transboundary cooperation, Finland has three commissions dealing with transboundary waters and corresponding bilateral conventions regulating transboundary water cooperation:

- The Border River Commission between Finland and Sweden regulated by The 2010 Agreement between Finland and Sweden Concerning Transboundary Rivers (replacing the 1971 Agreement).
- The Finnish-Norwegian Commission on Border Water Systems regulated by The 1981 Agreement between Finland and Norway on a Finnish-Norwegian Transboundary Water Commission and the Agreement on the Finnish-Norwegian River Basin District of 2014 (to implement the EU WFD).
- The Finnish-Russian Joint Commission regulated by The 1965 Agreement Between the Finnish Republic and the Soviet Union Concerning Frontier Watercourses.

The three commissions work together with the municipalities, business entrepreneurs, public authorities and other actors in the region. Wastewater management is important to each basin and joint monitoring systems help to survey the status of the waters under the EU Water Framework Directive and the EU Waste Water Directive. Wastewater from industries like steel mills and pulp and paper, as well as nutrient loading from municipal wastewater plants and agriculture, are some of the issues affecting transboundary waters in the region. Finland has also ratified the 1992 UNECE

Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses.

Jordan: Policy Effectiveness

General data:

Surface area: approximately 90,000 km2

Population: 7 274million (2013) with an average growth rate of about 2.16% (2010)

Urbanization: about 73% of the population lives in urban areas

Urban population: 6. 459 million (2013)

Country GDP: $33.68 billion (2013)

Human Development index: 0.745 (high-ranks 77th in 2013)

Climate: Semi-desert

Available renewable water resources: 130 m3/year/capita

Rainfall: varies from 100 mm in the south and east to 600 mm in the north-west

Water demand: 1512 Mm3, 64 % for agriculture, 31 % for domestic uses and 5 % for Industry (2006)

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 98%

Population connected to the wastewater treatment system: 65%

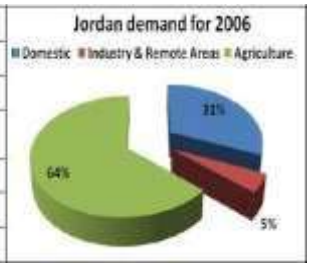
Wastewater generation: 115 Mm3/year

Wastewater treatment rate: 98% of the collected wastewater

Number of treatment plants: 28

Main treatment plants: As-Samra wastewater treatment plant: average daily capacity: 267,000

	[M m^3]
Water supply	925
Domestic	290
Industry & Remote Areas	46
Agriculture	589
Water Demand	1512
Deficit	-587



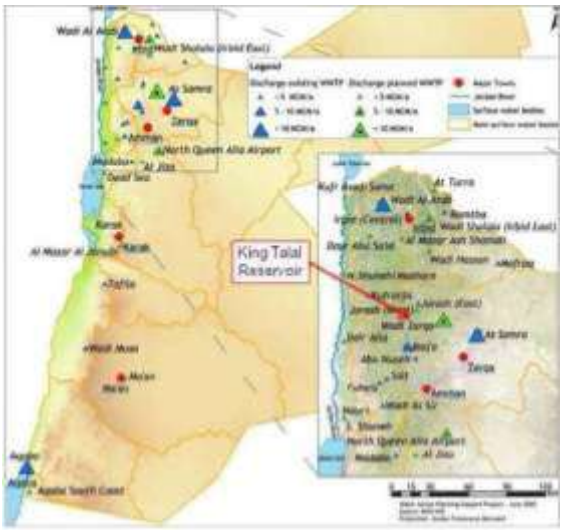
Principal technologies: Activated sludge, biological filters, aerate waste stabilization ponds, mechanical.

Major institutional stakeholders:

- The Ministry of Water and Irrigation (MWI)
- The Water Authority of Jordan (WAJ)
- The Jordan Valley Authority (JVA)
- Public water companies : Miyahuna, Aqaba Water Company, Yarmouk Water company

Principal legal texts:

- Water Authority of Jordan Law No. 18 of 1988 and its amendments,
- Ministry of Water and Irrigation By-Law No. 54 of 1992 and its amendments,
- Jordan Valley Development Law No. 30 of 2001,
- Groundwater By-law No. 85 of 2002 and its amendments,
- Environmental Protection Law No. 85 of 2006,



Water consumption for irrigation, in Jordan

Region	Total irrigated area (dunum)	Water resources	Quantities of consumed water (MCM/ Year)
North JV	89,835	KAC (freshwater)	38
Middle-south JV	212,525	KTR, Kafrain, and Shu'aeb dams (reclaimed water)	120
		Wells (brackish water)	62
Southern Ghors	56,560	Surface (freshwater)	37
Highland	701,814	Wells (freshwater)	245
Total	**1,060,754**		**502**

Source: JVA and MoA, 2010.

Major achievement

What specifically characterizes Jordan is its well-designed and effective policy meeting the specific challenges of the country. By the early 1980's and during the International Drinking Water and Sanitation Decade (1980-1990), the Jordanian Authorities have been conducting comprehensive plans with regard to the different issues of wastewater management: sanitation utilities improvement, a better addressing of public health concerns, and strengthening pollution control of water resources. Then in 1998, the Government has initiated a **Wastewater Management Policy** as a global strategy for the wastewater sector articulated around 4 key issues, adding to those already targeted by the previous plan, consideration of treated effluents as a source for irrigation reuse and the improvement of the socioeconomic conditions in the areas to be served by the proposed systems. This exhaustive policy includes 67 points regarding the future use and management of wastewater covering several aspects such as legislation, standards, financing and investment, pricing, research and development…etc. The key point of this policy is that treated effluent has to be considered as a water resource and not separated in policy from other water resources.

This was followed by the **National Water Strategy** for water and sanitation for the period (2008-2022) "Water for Life Strategy" with as main priority "to achieve national water security and to serve the overall development objectives" and a particular attention to the development of land and water resources in the Jordan Rift Valley, among other things by increasing the use of treated wastewater in agriculture. This strategy contains a chapter around wastewater and among the goals set in this strategy we have:

- All the major cities and small towns in Jordan are provided with adequate wastewater collection and treatment facilities,
- Public health and the environment, in particular groundwater aquifers, are protected from contaminated wastewater in the areas surrounding wastewater treatment plants,
- Treated wastewater is used for activities that provide the highest return to the economy.
- The quality of treated wastewater from all municipal and industrial wastewater treatment plants meets national standards and is monitored regularly,
- Tariffs for wastewater collection are rationalized,
- All treatment plants are operated according to international standards

Additionally, Jordan has set up multi-level institutions capable to put into practice this policy in particular, the Ministry of Water and Irrigation, the Water Authority of Jordan, the Jordan Valley Authority and 3 major public water utilities. This, without omitting the role played by international cooperation (especially with US and Germany), civil society and private sector in the implementation of these objectives, and the impetus given by the Performance Management Unit (Part of the Water Authority of Jordan), responsible of promotion, monitoring and auditing private sector participation in water sector.

All these strategies and the effective cooperation between the different stakeholders have led to the construction and renovation of 28 wastewater treatment plants across the country, in the view of the fact that in the 1960's there was only one plant. These plants are currently treating 98% of the collected wastewater and providing secondary high quality reclaimed water with about 90 % reused in agriculture. This, in addition to one of the highest sanitation rates in the region, indeed 98% of Jordanians have access to improved sanitation facilities with no significant differences between urban and rural areas.

Singapore: Innovative water and wastewater management

General data:

Surface area: 718 km^2

Population: 5.5 million (2014) with an average growth rate of 1.6% (2010-2015)

Urban population: 5.5 million (100% of total population)

Country GDP: USD millions 297,941 (2013)

Human Development Index: 0.901 (very high - ranked 9th in 2013)

Climate: Tropical

Available renewable water resources: 111 m^3/year/capita (2013)

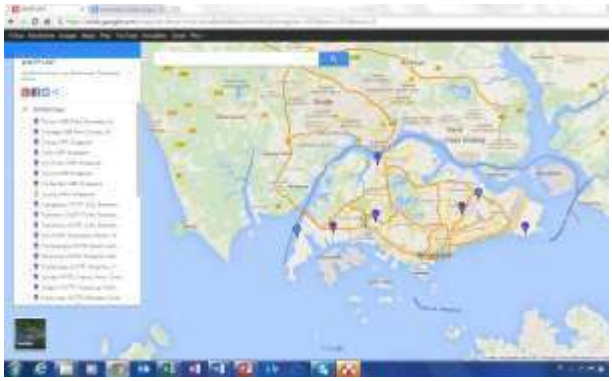
Rainfall/year: 2497 mm

Annual freshwater withdrawals: 666 Mm^3, 4% for agriculture, 45% for domestic uses and 51% for industry (2013)

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 100%

Population connected to the wastewater collecting system: 100%



Wastewater treatment rate: 99.5% of the collected wastewater

Number of wastewater treatment plants: 7 treating 582.2 Mm^3 of wastewater/year (2013), including 4 to produce NEWater (547,200 m^3/day in 2013)

Direct use of treated wastewater: 194 Mm^3 [1]

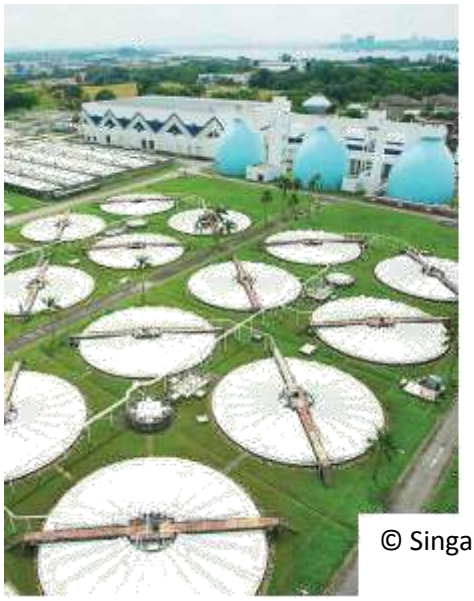
Principal Technologies: Secondary treatment, stability control and chlorination, as well as more advanced dual membrane (via microfiltration and reverse osmosis) and ultraviolet disinfection

Major institutional stakeholders:

- Ministry of the Environment and Water Resources
- Public Utilities Board (national water agency)
- National Environment Agency

Main laws related to wastewater:

- Environment Public Health (Amendment) Bill 1970
- Environmental Public Health (Prohibition of Discharges of Trade Effluents into Water Courses) Regulations 1971
- Water Pollution Control and Drainage Act 1975
- Environmental Protection and Management Act 2008



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Singapore's NEWater brand

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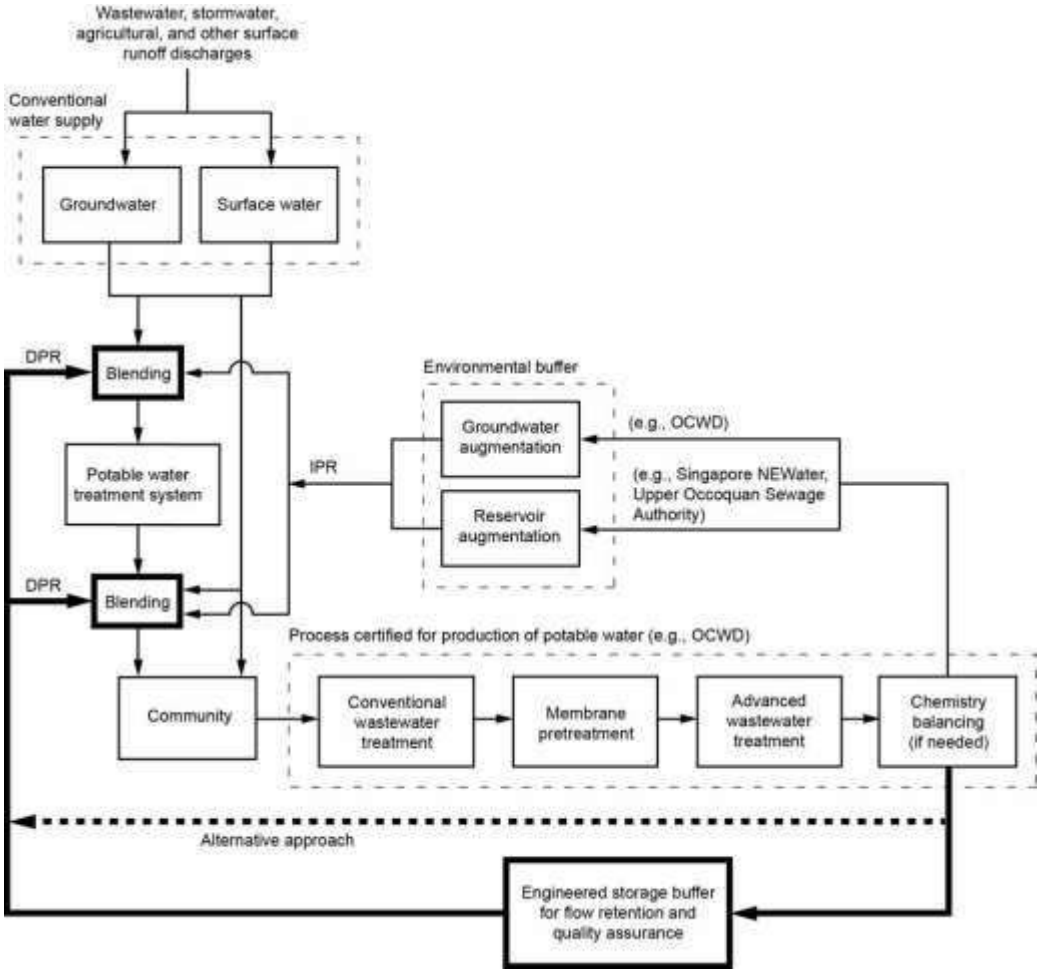
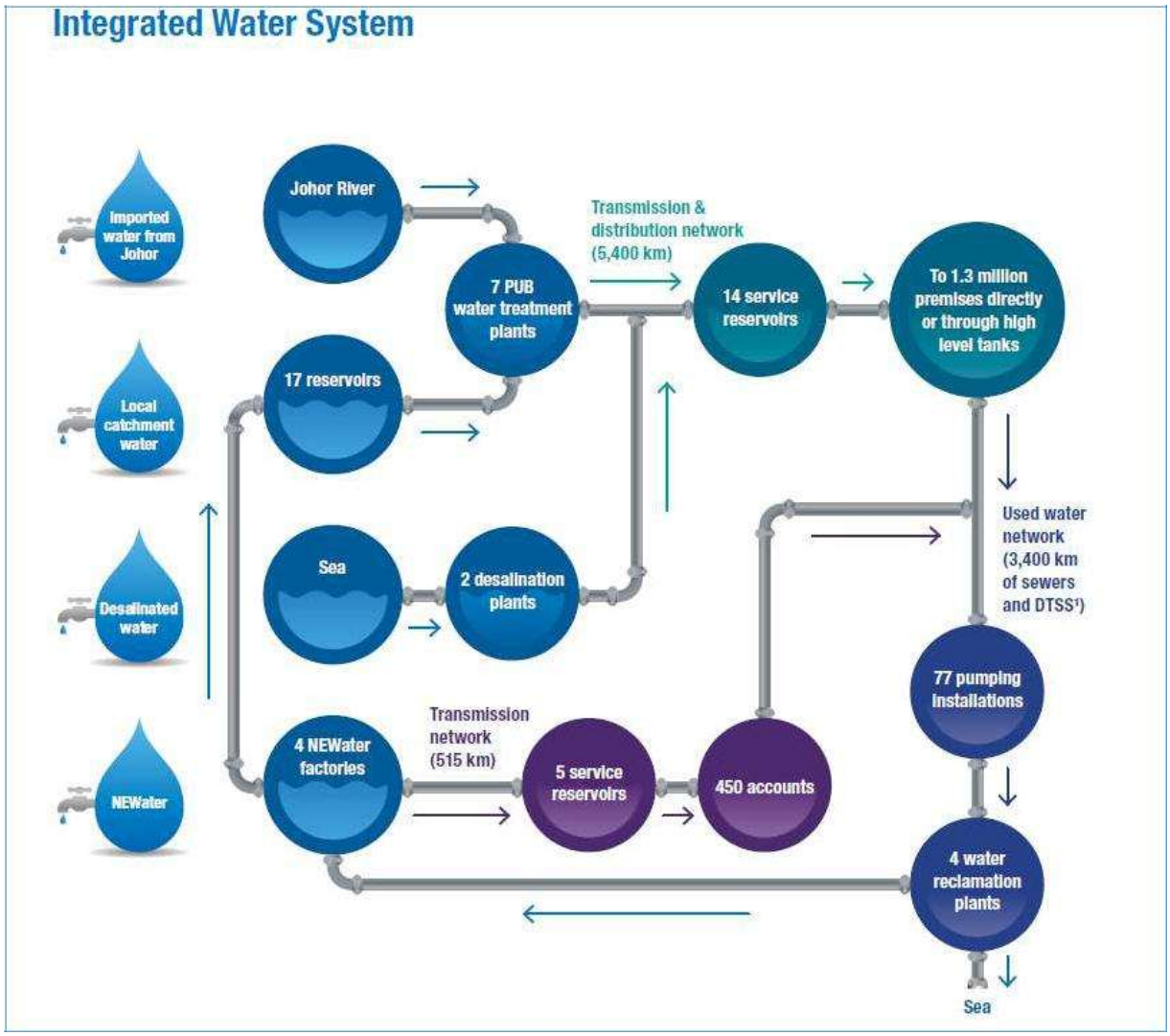
Definition of planned indirect and direct potable reuse (IPR/DPR)



Source: Tchobanoglous G., 2012 NWRI Clarke Prize Conference Research and Innovations in Urban Water Sustainability



PUB (2013) Our Water, Our Future: p.6

Major achievement

Despite its tropical climate, Singapore is a small city-state with limited catchment area to store rainfall and no natural aquifers or lakes. With the second highest population density worldwide and in view of growing population and GDP (3-fold and 30-fold increase respectively since 1965), this water-scarce country has managed over the past five decades to overcome water shortages, by developing a strategy based on the "Four National Taps". These include, along with water imports from neighbouring Malaysia, rainfall storage and seawater desalination and the world's first large-scale wastewater reuse system for potable water production, operating since 2003.

Today, Singapore has its own brand of recycled water: NEWater. Four plants currently produce 547,200 m^3/day of reclaimed water, covering 30% of the country's freshwater needs. The ambition is to increase this figure to 55% by 2060 to achieve water independence from neighbouring Malaysia, by building new recycling plants with bigger capacity and by increasing seawater desalination (two reverse osmosis desalination plants have a capacity of producing 454,500 m^3/day of water). Currently, the reclaimed water is mainly used for industrial purposes, and, in a small proportion, for indirect potable reuse (re-injected into reservoirs, it is treated and used as tap water, suitable for drinking purposes, as it surpasses World Health Organization requirements).

Behind this success lies a strong and stable political will and vision, which orchestrated what is now frequently recognised as a unique holistic approach to water resources management since water was identified as a national priority in 1971. This strategic approach combines several ingredients:

- Policy axis: long-term planning and integrated public policies –from public housing and urban management to industrial regulation- keeping in mind the overall economic development of the country; water pricing to cover full production and supply costs; technological research to develop very high quality treated wastewater; and public education and involvement to develop ownership and gain support for water conservation.
- Legislation axis: strict laws (regularly amended and enacted according to needs), regular monitoring and enforcement.
- Institutional axis: restructured and coordinated institutions allowing for an integrated management of the whole water loop (the Public Utilities Board –in charge of all water and wastewater-related services, controls and administrations- and the National Environment Agency- overseeing the implementation of environmental policies- both under the Ministry of the Environment and Water Resources).

Over the past few years, the Public Utilities Board has received more than 20 international awards – including the 2014 UN-Water "Water for Life" Best Practices Award, the 2013 Global Water Awards and the 2007 Stockholm Industry Water Award- recognising its outstanding performance in water and wastewater management. Singapore is on its way to becoming the "City of Gardens and Water" it envisions.

South Africa: A Human Rights-based Approach

General data:

Surface area: 1.219.090 km^2

Population: 52 million (2014)

Urbanization: 33 million (2012)

Country GDP: $350.6 billion (2013)

Human Development Index: 0.629 (2012) (medium – ranks 118th in 2013)

Climate: Subtropical

Available renewable water resources: 968.2 m^3/year/capita

Rainfall: 464mm/year

Water withdrawal: 12.500 Mm^3 (2013), 60% for agriculture, 27% for domestic uses 23% for urban needs, 4% to rural, mining and bulk industry 6%, afforestation 3% and power generation 2%.

Wastewater and sanitation data:

Population having access to improved sanitation facilities: 74%

Population connected to the wastewater treatment system: 57% (2007 UNSTATS)

Number of treatment plants: more than 1000

Main treatment plants:

Durban wastewater treatment plant

eMalahleni water reclamation plant

Principal technologies:

Activated sludge

Bio-filters

Ponds

Major institutional stakeholders:

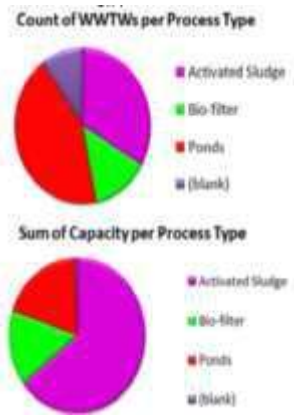
South African Department of Water Affairs (DWA)
Water Boards (12 in all the country)
Water Services Authority (Municipalities 152)

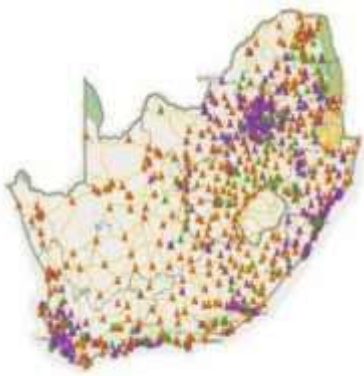
Principal legal texts:

Constitution of the Republic of South Africa (1996)
Water Services Act (1997)
Housing Act (1997)
National Water Act (1998)
National Environmental Management Act (Act n° 107 of 1998)
Municipal System Act (2000)
Integrated Coastal Management Act (2008)

	1994 Population (million)	2001 Population (million)	2011 Population (million)
Population	38.9	44.8	51.77
People below RDP	20.4	19.5	16.1 (4.5 mil HH)
% People below RDP	52%	43%	31%
People equal to or above RDP	18.5	25.3	35.8 (10.0 mil HH)
% People equal to or above RDP	48%	57%	69%
% Improvement since 1994		9%	21%

information is based on Stats SA Census 2011 results





Major achievement

For decades until 1994, public policy and the legal framework in South Africa were based on racial segregation affecting all spheres of life, with the result that up to 20 million South Africans, the majority belonging to the black community were living without adequate sanitation. With the fall of the apartheid regime, a new policy was implemented based on a democratic system without racial discrimination, which also extended to the legislation and policies relating to sanitation and wastewater management in terms of health and safety, environmental protection, wastewater utilities and human rights to water and environment.

Currently the South African policy regarding wastewater management is based on a human rights approach, a process of human development in accordance with international human rights standards and directed to promoting, protecting and implementing them. This is manifested first in the Bill of Rights of the Constitution of the Republic of South Africa promulgated in 1996, which recognized not only the right to water, but also the right to environment in very clear terms emphasizing health, well-being, sustainability and economic and social development (Section24). This was followed by the legislative recognition of the right to sanitation through the Water Services Act promulgated in 1997, in which water services institutions had obligations to take concrete measures for the realization of this right and the right to water as well.

Additionally, the National Environmental Management Act of 1998, provides for clearly that "development must be socially, environmentally and economically sustainable" and emphasizes the concepts of environmental justice and non-discrimination particularly against vulnerable and disadvantaged persons. From a human rights perspective, this law is considered as a model of an environmental framework placing people at the center of development that is environmentally, socially and economically sustainable.

It should be noted, that the recognition of the human right to water and sanitation in South Africa occurred before these rights were officially recognized by the UN General Assembly in resolution A/64/292 of 28 July 2010 and even before the General Comment No 15 of the UN Committee on Economic, Social and Cultural Rights in 2002 on the right to water. South African authorities have translated these principles into policies for the sector with the purpose of implementing them. An example is the Free Basic Sanitation Implementation Strategy, approved by the Minister of Water Affairs and Forestry in 2009 as a part of the Free Basic Services Policy adopted in 2001. This strategy enabled a number of municipalities for providing essential and basic sanitation services free of charge for poor households.

Additionally, this human rights-based approach consecrated in the South African legal framework and policies relating to wastewater management also appears through the right to information and public participation. These rights were demonstrated by the extensive consultative campaigns which led to the approval of the 1998 National Water Act and the drafting of the White Paper for Sustainable Coastal Development. A significant development to facilitate public participation is contained in the National Water Act, which is the establishment of the Catchment Management Forum (CMF), a non-statutory water management institution, which can assist in setting up statutory water management institutions. A chapter is dedicated to the Water User Associations (chapter 8) as well and several provisions in the National Water Act and the National Environmental Management Act assert the right to access to information.

In terms of outcome, access to improved sanitation increased by 30% in South Africa compared with 1990, reaching the Millennium Development Goal targets with respect to sanitation backlogs since 2008. The South African Government is aiming to achieve universal access to sanitation very shortly.

At a local level, eThekwini Water and Sanitation, a unit of the eThekwini municipality serving the Durban metropolitan area was named the winner of the Stockholm Industry Water Award in 2004, for its transformative and inclusive approach to providing water and sanitation services (in the past 14 years, 700.000 people have been provided with access to toilets additionally to some pioneering solutions to convert urban wastewater challenges to agricultural opportunities).