

PART II

REALISING THE OPPORTUNITIES OF WASTEWATER

Reducing unregulated discharge of wastewater and securing safe water are among the most important interventions for improving global public health and achieving sustainable development. Part I demonstrated the enormous impacts and high cost to the environment, society and thus to economies, that wastewater can have when inadequately or inappropriately managed. Part II provides another perspective. Where are the opportunities for using wastewater? How can wise investment and appropriate management of wastewater reveal a resource, a tool that can help tackle the global water crisis, urgent health issues, food security and economic productivity, and maintain or improve environmental integrity?



It is critically important how investment is made. Inappropriate financing that does not produce results can have serious knock-on effects, leading to diminished public and political confidence and a lost opportunity to simultaneously tackle a problem and generate capital. The UNGA declared 1981–90 the International drinking water supply and sanitation decade. Approximately US\$700 billion was spent, yet absolute numbers of people without safe drinking water stayed static (Elimelech, 2006; Mintz *et al*, 2001). The task in hand is not a small one, but the technology and know how exist. It can be done.

RECOGNISING WASTEWATER AS A RESOURCE

As its name implies, wastewater is grossly undervalued as a potential resource. All too frequently wastewater is ignored and left to drain away. Smart and sustained investment in wastewater management will generate multiple dividends in society, the economy and the environment. It can involve both private and public sectors, fulfilling public needs as well as social equity and enhance food security. Immediate, targeted and sustained investments should take multiple forms. They should be designed to (i) reduce the volume and extent of water pollution through preventative practices; (ii) capture water once it has been polluted; (iii) treat polluted water using appropriate technologies and techniques for return to the environment; (iv) where feasible safely reuse and recycle wastewater thereby conserving water and nutrients; and (v) provide a platform for the development of new and innovative technologies and management practices. If investments such as these are scaled up appropriately they will generate social, economic and environmental dividends far exceeding original investments for years to come.

It is acknowledged that water is a limited resource for which demand is growing. Managing wastewater is intrinsically linked to management of the entire water chain. How we use and reuse water is the key to successfully meeting the vast water requirements of an urban population twice its current size, expanding agriculture to feed another three billion people and satisfy rising demand for meat, while coping with increasing food waste.

Climate, geography and healthy ecosystems together control the initial supply of water in the water chain, maintain water quality and regulate water flow. Forests and wetlands, including salt marsh and mangrove forests, have an important natural role to play in wastewater management, capturing water, filtering out nutrients and other contaminants and releasing water into lakes, rivers and coastal seas. Worldwide, these ecosystems are being lost and with them the services they provide for buffering extreme weather and assimilating wastewater.

Developing strategies to improve environmental governance, including improving watershed, coastal and riparian management, irrigation efficiency and the greening of agricultural practices, provides an enormous opportunity for maximizing the benefit derived from natural ecosystem processes, greatly reducing the negative impacts of wastewater, and increasing the availability of water to cities.

Climate conditions and watershed management, particularly with regard to deforestation, cropland development and inland aquaculture, are crucial factors in determining the quantity and quality of the water which will eventually be available for irrigation in food production, processing in industry, human consumption and recycling.

Worldwide, water tables and aquifers are declining (IWMI, 2006). With climate change, rainfall patterns are likely to become more variable and extreme rainfall events more frequent.

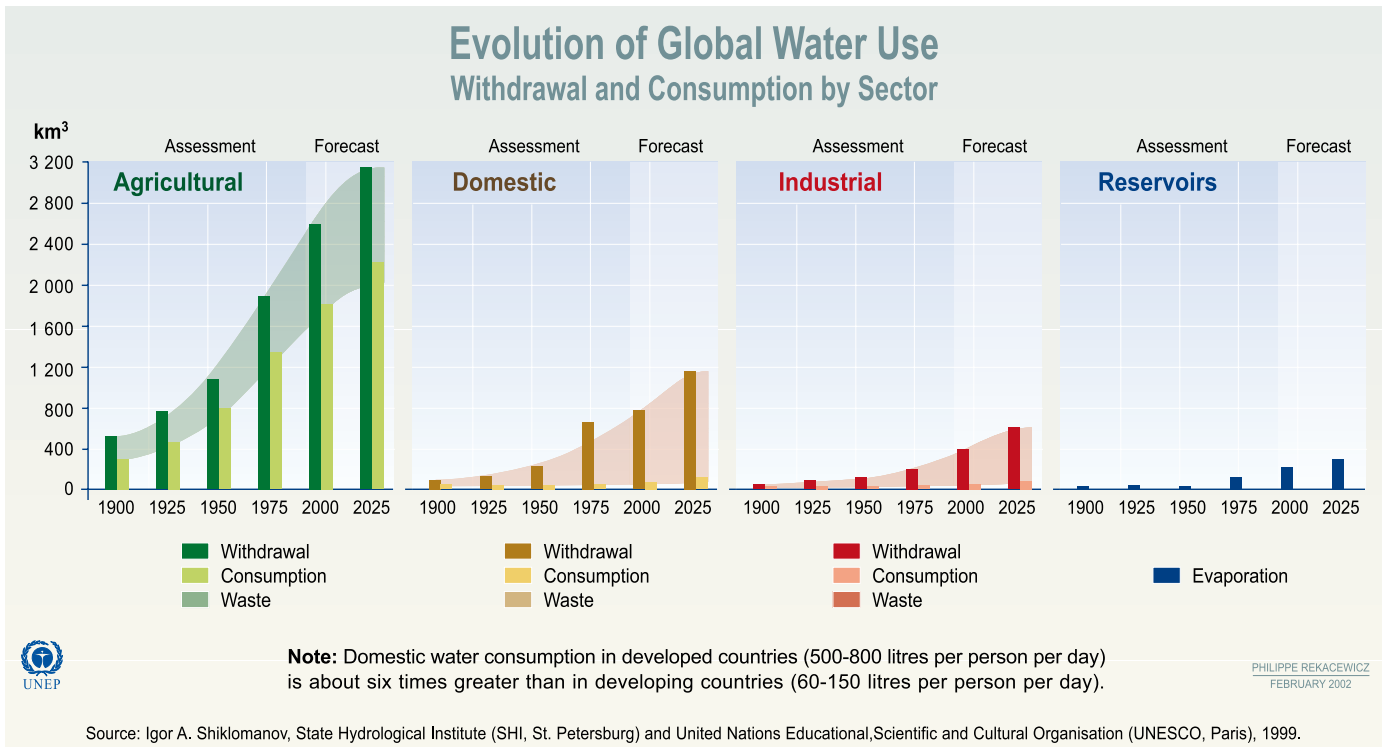


Figure 22: Global water withdrawal and waste over time.

Improving watershed management will be crucial and finding ways to reduce, optimize and recycle water will become increasingly essential in the future. Wastewater is already being used for irrigation and fertilization and can continue to expand this role, particularly for peri-urban or urban agriculture and home gardens. But maximizing water efficiency in the entire water chain including before water enters the cities, and reducing production of wastewater should be a primary goal throughout the entire management scheme.

WASTEWATER AS A MANAGED RESOURCE FOR IRRIGATION AND FOOD PRODUCTION

With proper management, wastewater can be an essential resource for supporting livelihoods. Wastewater treatment and reuse in agriculture can provide benefits to farmers in conserving fresh water resources, improving soil integrity, preventing discharge to surface and groundwater waters, and improving

economic efficiency. In the US state of California, 31 per cent of reclaimed water is used for crop or landscape irrigation. In Mexico, most of the wastewater from Mexico City is used in irrigation districts surrounding the city, notably the Tula valley. Untreated wastewater is often used in the informal, unregulated sector and directly benefits poor farmers who would otherwise have little or no access to water for irrigation. Even untreated wastewater can improve soil fertility and reduce water contamination downstream, since the wastewater is not fed directly into the water flow but is first filtered through soil during irrigation. Through FAO's Farmer Field Schools in developing countries, training in risk-reduction and management strategies in safe food production and crop selection have been implemented from International Guidelines (WHO-FAO 2006) to simple and adoptable 'farm-to-fork' techniques. Safe reuse of untreated and partially wastewater for agriculture production has been tested in Ghana and Senegal where various options at farm, markets, and food-vendor

levels were operationally monitored, farming adjustments and management measures trained and verified on the effectiveness in reducing health risks. In many countries, farmers prefer wastewater for irrigation due to economic benefits in fertilizer savings. Typical concentrations of nutrients in treated wastewater effluent from conventional sewage treatment processes are as follows: 50 mg/litre of nitrogen; 10 mg/litre of phosphorus; and 30 mg/litre of potassium. Assuming an

application rate of 5 000 m³/ha/year, the fertilizer contribution of this effluent would be 250 kg/ha/year of nitrogen, 50 kg/ha/year of phosphorus and 150 kg/ha/year of potassium. Thus, the effluent would supply all of the nitrogen and much of the phosphorus and potassium normally required for agricultural crop production. Other valuable micro-nutrients and the organic matter contained in the effluent would also provide benefits.



Community-based project in Cambodia addresses water supply and wastewater treatment challenges

The project was initiated under the Joint Communiqué of the UNDP GEF Small Grants Programme and PEMSEA. More than 600 families are located in Stung Hav. Most of the families derive their income from fishing, with supplemental income derived from agriculture. The Reservoir Utilization and Community-based Sustainable Ecotourism Development project was implemented to: (1) rehabilitate a 5.9-hectare water reservoir to abate the impact of climate change on water levels and recharge the dried wells in the surrounding area; and (2) provide a water source for other supplemental livelihood activities, particularly agricultural production.

The project resulted in the rehabilitation of a community reservoir with holding capacity of 40 550 m³. Community members

estimated monthly savings of up to US\$34 on water-use fees. The rehabilitated reservoir also serves to recharge groundwater in nearby water wells, thereby reducing the time and effort by family members – mostly women and children – in accessing water for household use.

A wastewater garden was created as a natural water treatment system to prevent water contamination from household wastewater discharge for irrigation. Planting of about 380 trees around the reservoir was also done to prevent soil erosion, maintain the reservoir's water-holding capacity and improve the landscape.

(Source: Personal communication, Adrian Ross, PEMSEA, 2010)

DEFUSING THE CRISIS: MANAGING WASTEWATER EFFECTIVELY



Historically water has been viewed as a common resource – for the people – a public good. “Water controls all geological and biological processes necessary for life’s sustenance” (Narasimhan, 2008). In 2002, the UN Committee on Economic, Social and Cultural Rights declared that: “The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights.” The European Union has declared that: “Water is not a commercial product like any other but, rather, a heritage which must be protected and defended...,” EU Water Framework Directive.

These positions pose questions as to how the right to water can be achieved, how this affects how water is managed and who takes responsibility for managing supply and the water itself once it has been used, in other words wastewater. And critically, who should pay?

This section looks at different tools, strategies and technologies that have been employed to manage wastewater, using case studies to illustrate various instruments, and the opportunities and challenges of implementation.



Defusing the wastewater crisis is achievable and measurable, but will require an entirely new dimension of investments. Currently, most of the wastewater infrastructure in many of the fastest growing cities is either non-existent, inadequate or outdated and therefore entirely unable to keep pace with the demands of rising urban populations. Experience has shown that substantial investments done in the right manner can provide the required returns. However, finding a solution will require not only investment but also carefully integrated national to municipal water and wastewater planning that addresses the entire water chain – drinking water supply, production and treatment of wastewater, ecosystem management, agricultural efficiency and urban planning.

UNDERSTANDING THE COSTS AND BENEFITS OF WASTEWATER MANAGEMENT

Wastewater management has many associated environmental benefits, enabling ecosystems within watersheds and the productive coastal zone to thrive and deliver services on which healthy communities and economies depend. Inadequate management in turn incurs heaving costs, threatening to undermine these ecosystems. However the value of these benefits is often not calculated because they are not determined by the market, due to inadequate property rights, the presence of externalities, and the lack of adequate information. Valuation of these benefits is nevertheless necessary to justify suitable investment policies and financing mechanisms (Hernández-Shancho *et al*, 2010).

THE ROLE OF ECONOMIC VALUATION IN UNDERSTANDING THE COSTS AND BENEFITS OF WASTEWATER MANAGEMENT

In order to develop effective policies and instruments in the management of water and water quality, it is necessary to understand the total value of the resource needs to be measured and incorporated into policy design (Hernández-Shancho *et al*, 2010). Economic valuation is often used as a tool to understand the costs and benefits of different choices. It can be applied in the context of sustainable development to show how dependent the economy is on an ecosystem (Lange and Jiddawi, 2009). The economic valuation of non-market ecosystem services (e.g. gas regulation, waste assimilation) is still very much in development. Despite limitations and caveats on this tool, a benefit is that it uses a common language – money. This can help overcome fragmentation in cross-sectoral decision making and build a broad alliance of stakeholders by quantifying the common interests and mutual dependence of different stakeholders, and providing a scientific basis for assessing tradeoffs among options for development (Lange and Jidawwi, 2009).

Valuation of wastewater assimilation by ecosystems can be looked at in terms of costs or damage avoided by reducing the amount of wastewater (Lange and Jiddawi, 2009). There is an increasing entrepreneurial interest developing for investing in private ecosystem markets such as carbon and nitrogen trading – although these are still emerging, there is evidence to suggest that the total values derived from the services of intact

The story of Xiamen – when wastewater management becomes part of the plan, investments can have many returns

Decades ago, Xiamen pursued economic development with little regard for the environment. The surrounding coastal waters were heavily impacted by aquaculture ponds with pollution from excreta and excess fish food. Nearly all the domestic and industrial wastewater was also discharged untreated into the coastal waters and there was a history of industrial and shipping accidents spilling oil and chemicals into the area.

The situation was especially bad in Yuandang. By the early 1980s, the bay had been cut off from the sea by a causeway and untreated industrial and domestic wastewater was being discharged into the bay. The water body shrank to just one-fifth of its original surface area. The foul smell repulsed would-be investors and red tides often occurred in the poorly flushed water body. Residents began leaving the area (PEMSEA, 2006b). In 1988, Xiamen began the Yuandang rehabilitation. Infrastructure was built to capture and treat the waste. The city government dredged silt out of the bay and built tidal channels to increase water exchange with the West Sea. They also enforced regulations on the disposal of waste more strictly. Dissolved oxygen rose from 0 to 5.2 mg/litre and water quality met the national standards. The public and the national government praised the government achievements in Yuandang. High-rise buildings rapidly increased in number

around Yuandang and attracted big business. Fifty-three per cent of 173 investors cited the good environment as a reason for locating around Yuandang. Despite the estimated total rehabilitation cost of more than US\$43.75 million, Yuandang's central location helped it yield a benefit-cost ratio estimated at 9:1! This helped convince Xiamen's leaders that good environmental management could return social and economic benefits.

The city government generated funds by levying fees for the use of sea areas, waste disposal, and exceeding waste standards. Landscaped areas were developed into business parks and property sold or leased for large sums. Funds generated from use of the sea area were allocated to marine management and helping support the cost of the management programme. Xiamen has invested a total of US\$2 billion in sewage treatment over the last 20 years (XOFB, 2009). Treatment of industrial sewage rose from 20 per cent in 1994 to nearly 100 per cent in the 2000s while treatment of domestic sewage rose from 28 per cent in 1995 to 85 per cent in 2007 (Zhang, unpublished; PEMSEA, 2006a). Xiamen has not only become more sustainable, its beauty has also attracted immigrants, tourists, and real-estate development. A sense of pride in the beauty of their city has also grown in Xiamen's people.



Learning from past mistakes: unsustainable investments in wastewater management

During the decade from 1970 significant investments in wastewater management were made in several African countries, in particular Côte d'Ivoire and Senegal. Schemes were financed by bilateral and multilateral donors, but despite political good-will few of these investments survived. Little attention was paid to the arrangements needed to sustain the effectiveness and sustainability of these investments. The following examples from Saly Portudal and Louga in Senegal and Daloa in Côte d'Ivoire illustrate how good intentions can turn into white elephants.

Senegal: The village of Saly Portudal experienced a tourist boom in the 1970s. This resulted in a significant increase in wastewater production, justifying the construction of a sewage treatment plant. The chosen system was based on stabilization ponds, designed to treat a flow equivalent to 6 000 hotel guests. The project was funded by the World Bank in 1977 for a total cost of 270 million XOF (ca. US\$0.54 million). In 1984 the State of Senegal, through the National Company of Sanitation (ONAS), financed the construction of a similar treatment facility in the city of Louga, with a capacity of 200 m³ a day for nearly 7 000 households. About 20 years later a review (Maiga *et al*, 2002) revealed the following:

- No dedicated institution was established to manage the facility in either of these two cities. The plant of Saly Portudal was managed by the ONAS office in Rufisque, located 205 km away, while that of Louga was run remotely by the ONAS office of Saint-Louis at 60 km.
- At each site, only one staff member, a guard without relevant technical qualification and virtually no supervision, was supposed to ensure the maintenance of the service.
- No monitoring of the quality of the treated water was carried out
- Many cases of non-functioning equipment were reported but there were no financial resources, staff or equipment dedicated to follow up.

Côte d'Ivoire: In 1994 the African Development Bank financed a sewage treatment plant in Daloa to treat wastewater from the regional hospital complex. A follow-up review in 2002 (Maiga *et al*, 2002) noted that the plant was no longer operational. It had been left to fall into disuse and vegetation had invaded and covered the ruins of its basins and dams.

(Source: Personal communication, Dr. S. Kenfack, CREPA and R. Bechtloff, UNEP, Maiga *et al*, 2002)

ecosystems, e.g. wetlands, salt marsh, mangroves, could equal or surpass the current opportunity costs to individuals and society, if for example land-owners change from an agricultural regime to restore wetlands. For this to succeed, requires sufficient economic incentive for the land-owners to participate, and if subsidized, sufficient societal benefit for tax-payers to fund it.

In an assessment of the restoration of the wetlands of the Mississippi alluvial valley, a valuation exercise was undertaken using existing market values. The total value of the wetlands was assessed at just US\$70 a hectare – significantly lower than the anticipated opportunity costs of the land owners. However when a broader range of ecosystem services was incorporated (e.g. social welfare, GHG mitigation, nitrogen mitigation, waterfowl, recreation, etc.) the estimate rose to US\$1 035 a hectare. This market potential was higher than the land-owner opportunity costs, and provides a viable incentive to land owners to consider joining the wetlands restoration programme (Jenkins *et al*, 2009). The challenge however remains in developing these potential markets for ecosystem services. The developing Nitrogen Credit Trading market is described by Jenkins *et al*.



The use of economic valuation as a tool for prioritizing investment

Shadow pricing is a valuation methodology that can be used to assess choices regarding activities discharging by-products which, although they have no market value, may have significant environmental impact, such as wastewater (Hernández-Shancho *et al*, 2010). This method is useful for helping to prioritize management options relevant to wastewater management and treatment, taking into account both the economic and environmental aspects. Table 2 shows the price of water, and the average shadow prices for the

five undesirable outputs of wastewater treatment. The negative value reflects the environmental value of damage avoided, or in other words, environmental benefit. Here, for example, action to reduce phosphorus levels would have the greatest environmental benefit per unit volume, followed by nitrogen (Jenkins *et al*, in press). The overall environmental benefit resulting from the treatment of wastewater can be shown in the volume removed per year and its shadow price (Table 3) (Jenkins *et al*, in press).

Table 2: Reference price of water treated (€/m³) and shadow prices for undesirable outputs (€/kg). (Jenkins *et al*, in press)

Destination	Reference price water €/m ³	Shadow prices for undesirable outputs (€/kg)				
		N	P	SS	BOD	COD
River	0.7	- 16.353	- 30.944	- 0.005	- 0.033	- 0.098
Sea	0.1	- 4.612	- 7.533	- 0.001	- 0.005	- 0.010
Wetlands	0.9	- 65.209	- 103.424	- 0.010	- 0.117	- 0.122
Reuse	1.5	- 26.182	- 79.268	- 0.010	- 0.058	- 0.140

Table 3: Environmental benefit of treatment in €/year and €/m³ (Jenkins *et al*, in press)

Pollutants	Pollutant removal (kg/year)	Environmental value pollution (€/year)	Environmental value pollution (€/m ³)	%
N	4,287,717	98,133,996	0.481	59.6
P	917,895	50,034,733	0.245	30.4
SS	60,444,987	448,098	0.002	0.3
DOB	59,635,275	2,690,421	0.013	1.6
COD	113,510,321	13,364,429	0.066	8.1
Total		164,671,677	0.807	100.0

The greatest environmental benefit is associated with the removal of nitrogen because it represents nearly 60 per cent of the total profit. The next most important factor is phosphorus with a percentage weight of 30 per cent. It is important to note that the removal of these nutrients creates most of the environmental benefit (90 per cent) resulting from the treatment process. This is because these pollutants have the highest shadow prices. Even though large vol-

umes of suspended solids are removed from wastewater during treatment, their low shadow price means that their removal contributes a very low percentage (0.3 per cent) of the total environmental benefit. The share of the environmental benefit accounted for by organic matter (COD and BOD) is only 9.7 per cent because, despite the fact that a great deal is removed during the treatment process, their shadow prices are comparatively low (Jenkins *et al*, in press).



POLICIES AND INSTRUMENTS – MIXING POLICY COCKTAILS

To succeed in the face of some of the largest threats to environmental degradation, human health, and productivity, it is not sufficient to address only urban contamination or wastewater, we also need to consider water supply. Governance frameworks should clarify and link the roles of central and local authorities and communities, including rural areas and industry; promote public responsibility; and where appropriate, facilitate private investment and involvement in wastewater processes, particularly with regard to operational quality, maintenance and upgrading. The use of environmentally sound technologies including green technologies and ecosystem management should be used more actively and encouraged, particularly in

rural areas, both with regard to water supply and wastewater production and management.

Wastewater management must address not only urban but also rural water management throughout the watershed and into the coastal zone. It must also look to the future and be able to meet the needs of a growing population under changing climatic conditions. Meeting these challenges requires long term, coordinated and integrated national plans and organization as this cannot be dealt with alone by municipalities, individual sectors and rarely individual nations. It will require a much stronger role for good governance and an active public sector working across sectors and perhaps international boundaries to solve these challenges drawing on a range, or cocktail of possible strategies, policies and instruments.

THE ROLE OF PARTNERSHIP BETWEEN THE PRIVATE AND PUBLIC SECTORS IN SANITATION AND WASTE-WATER MANAGEMENT

Governments facing challenges of water and wastewater management are always confronted by the issue of attracting investments and the need to achieve broad public and national benefits with improved water management.

Water privatization is the outsourcing of central public water management services and responsibilities to the private sector, such as in drinking water or wastewater management. Privatization can range from management contracts, lease contracts to direct concessions, in which the latter gains responsibility for the entire water system, or even asset sale, where the government actually sells the entire water rights. Because these water services are often viewed as a key public service and human right, privatization is often met with heavy resistance. The Cochabamba Water Wars are an example of a series of protests that took place in Cochabamba, Bolivia's third largest city, between January and April 2000, when the municipal water supply was privatized, due to fears of increased prices (Laurie, 2005).

Currently at least 84 per cent of all water and sanitation systems are publicly owned and managed, with more than 93 per cent in some developing countries (World Bank, 2009). Only an estimated seven per cent of the urban population in the developing world is served by private companies (World Bank, 2009). While the population served by privatized water utilities increased from six million to 94 million in developing or transition countries from 1991 to 2000, and the number of countries involved in such schemes from four to 38, the outsourcing of water management to private contractors has decreased in the last decade (World Bank, 2009).

There are many cases where privatization has led to improved water services by generating cheaper loans and higher investments, while bringing in expertise. However, it is also clear that unless the process is guided and under the close supervision of government agencies there is a risk that the wider public interest will not be served and only wealthy customers will receive services. Impoverished communities are unlikely to be the primary target for companies operating under a cost-benefit investment-return scheme.

Following a move to privatization in the 1990s, there has been a high return of wastewater services from private back to public management (World Bank, 2009). The critical factor seems to be how far privatization goes, with full control or concessions to private companies proving the most controversial. Whilst experience has shown that privatizing water management as a means to gain more investments rarely results in positive results, the private sector has demonstrated improvements in operational efficiency and service quality. Hence, rather than outsourcing management, integrated partnership models where the private sector is given responsibility not for the full water management, but mainly for certain operational segments, can work best.

USE OF ECONOMIC POLICY INSTRUMENTS

Economic development is an important factor in environmental quality (Lee *et al*, 2010). As countries develop their economies, their citizens obtain higher living standards, yet during this process of economic development and industrialization, levels of pollution increase to a point at which citizens begin to demand a higher environmental quality – when measures come in to manage the polluting waste products of many goods (Lee *et al*, 2010). The construction and operation of waste

The role of multinational corporations in wastewater management

Multinational companies dominate the private water, energy and waste management business, many of which have a close relationship to the public sector. Two French multinationals – Suez and Vivendi – control 70 per cent of the world's privatized water concessions, with an Anglo-German company, RWE-Thames, a distant third. (Hall, 2002), and the five largest operating some 80 per cent of all the privatized water concessions (World Bank, 2009). The same companies dominate the waste business – Suez and Vivendi are the largest two waste management multinationals in the world, having bought up the overseas operations of the former USA global giants, Waste Management Inc and BFI. RWE is number three in Europe (Davies, 2001). Many multinationals have changed names or merged with one another. In 2007 Veolia Environment (ex-Vivendi) reported US\$47 billion revenue with a workforce of about 300 000 people (MSE, 2010).

treatment facilities, including those for wastewater requires a huge amount of capital – acting as a barrier to wastewater management in many regions. Creative solutions are required to finance management over the long term (Rammont and Nurul Amin, 2009). Economic Instruments (EI) are tools which can be used to support regulatory frameworks by recovering some of these costs. They generate market-conforming incentives, both positive and negative, that are directed to bring about behavioural change (Rammont and Nurul Amin, 2009). There are challenges in the implementation of economic

policy instruments, in particular that they tend to require a high level of institutional capacity (Russell and Powell, 1996), other challenges include administration, politics, inconsistencies, need for enforcement of legislation and flaws in design (O'Connor, 1998).

ECOSYSTEM-BASED MANAGEMENT AND WASTEWATER

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including

Challenges of applying economic instruments to finance wastewater management in Thailand

Following a period of economic growth and environmental degradation in 1987–96, Thailand started to give priority to environmental issues in the early 1990s when increased economic performance allowed for environmental protection and management. In 1992 Thailand reinvigorated its environmental acts of 1975 and 1978 as the Enhancement and Conservation of the Environmental Quality Act (NEQA 1992), which featured the implementation of two Economic Instruments – the polluter-pays principle (PPP) and the establishment of an Environmental Fund (EF) (Rammon and Nurul Amin, 2009).

Thailand focused on the use of EIs for central wastewater management. Capital investment for basic infrastructure was managed by central government (Ministry of Natural Resources and Environment). Once constructed, responsibility was handed over to local government for operation and management. In 1999 the government established the Determining Plans and Process of Decentralization to Local Government Organization Act. Local government organizations were then handed responsibility for environmental management, including wastewater management – guided by the National Economic and Social Development Plan which focuses on improving water quality, reducing water pollution, applying the PPP and promoting the involvement of the private sector in water pollution management. However due to the high costs in dispensing this responsibility, LGOs needed the continuing support of central government.

This support was provided through two main channels: (1) budgetary allocation, and (2) grants and soft loans through the Environmental Fund. This fund provides financial support for both government and the private sector for provision of control, remedial and disposal systems, and to support the implementation of

activities on enhancement and conservation of environmental quality. Fees collected under the PPP contribute to the EF. Authority for making the charges under the PPP also falls to the local government authorities.

Rammon and Nurul Amin, 2009 identified a number of challenges to the uptake of these EIs in Thailand:

- Failure to follow up with concrete laws and regulations to support charge implementation
- Lack of willingness by local authorities to charge under the PPP.
- Lack of cooperation between water and wastewater authorities (water supply is administrated by two centralized authorities; wastewater under local governments as part of their mission to provide environmental management).
- Willingness of local government to charge and residents' acceptance to pay.
- Complexities in accessing the EF: long process of approval, lack of active public relations, lack of contributory fund, personnel problems and loopholes in the law and regulations are commonly cited problems related to accessing the EF
- Within Thailand, different cities and districts have different waste management approaches.

Thailand's two-pronged strategy of providing financial support from EF and levying charges to implement the PPP for use of EIs in WWM is far from being a success. Even if the subsidy part of the strategy works, the PPP part does not. The confusion between willingness to pay and willingness to charge has resulted in a deterioration in water quality. It is suggested that greater efforts to explain the benefits of wastewater management to local populations would result in greater acceptance to pay charges, and therefore make it easier for local authorities to ask.



humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. Specifically, ecosystem-based management emphasizes the protection of ecosystem structure, functioning, and key processes. It is place-based, focusing on a specific ecosystem and the range of activities affecting it. Ecosystem-based management explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species. It acknowledges interconnectedness between systems, such as air, land and sea, and it integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences (COMPASS, 2005).

Tackling the broad and cross-sectoral nature of wastewater and its management successfully and sustainably requires an ecosystem-based perspective, applied to integrated natural resource management approaches. To those working in water management, the concept of Integrated Water Resource Management (IWRM) is familiar. To those working in the marine environment, it would be Integrated Coastal Zone Management (ICZM), or a variant of this. There is a need for the bridging of these communities to ensure that the entire water supply chain and wastewater impact can be addressed coherently. These approaches are based on natural ecological boundaries and have strong merit. However, it is very much an ideologi-

cal construct as often political and administrative boundaries do not align, and this makes implementation and governance challenging. Additional challenges are social pressures and power over the management and interests of water resources and usage (Molle, 2009).

Nutrient credit trading

Farmers are able to earn nitrogen-reduction credits when they go beyond legal obligations to remove nitrates from the watershed. These credits can then be traded. This can be achieved by changing fertilizer application rates; by changing production practices; by growing different crops, or retiring cropland. (Restoring wetlands is not yet included as a mitigation option because, it has been demonstrated (Ribaudo *et al*, 2001) that wetlands restoration is currently more expensive than fertilizer management and therefore a less attractive alternative for farmers, Jenkins *et al*, in press).

Although there are more than 40 nutrient trading programmes on the books in the United States as well as the development of online tools such as the Nitrogen Trading Tool (<http://199.133.175.80/nttwebax/>), very few trades have taken place to date (Ribaudo *et al*, 2008). As such, the market value under existing markets is essentially zero for N mitigation. Nevertheless, there is some interest in nutrient trading and it is possible that nitrogen mitigation will gain a market value in the future. One estimate puts the annualized potential market value at US\$624/ha/year for nitrogen mitigation (Jenkins *et al*, in press).

Pesticide management in Sri Lanka

Pesticides used in agriculture, public health, industrial, veterinary and domestic use can potentially end up in the water, either through seepage into groundwater, run-off into streams or via the municipal wastewater collection systems. On their way they often threaten human and environmental health. Balancing the desired benefits of pesticide use, whilst minimizing the potentially harmful side effects of these potent chemicals primarily remains the responsibility of governments.

Sri Lanka's high yielding crop varieties, such as tea and rice, are susceptible to pest damage, resulting in a need for safe and effective pest control. Sri Lanka has prohibited a large number of highly toxic chemicals without affecting its agricultural production and today produces one of the world's cleanest teas with regards to all persistent organic pollutants (POPs) and WHO hazard class Ia and Ib chemicals. How was this achieved?

The Office of the Registrar of Pesticides, established within the Department of Agriculture looks at product registration, provides laboratory analysis for monitoring programmes and coordinates enforcement of the Control of Pesticides Act No 33 of 1980, guided by a multi-disciplinary and multi-sectoral Technical Advisory Committee. One of the keys to pesticide management is chemicals registration. Prerequisites are the conformation to international standards such as those of FAO and WHO; and the registration status in other countries. The Rotterdam Convention is one of the key international instruments providing governments with guidelines and detailed information on product use and risk profiles.

The adoption of international standards and cooperation is cost-effective in countries with limited financial and laboratory capacity. Some challenges remain, but given that most of Sri Lanka's pesticide control only started a little over two decades ago, the progress that has been made thanks to the institutional arrangements, legislation, and enforcement, has been remarkable.

(Source: Manuweera, 2007; Manuweera *et al*, 2008)

APPROPRIATE TECHNOLOGY AND INNOVATION

There are numerous examples where attempts to transfer technologies from one place to another fails. Different approaches to wastewater management are required for different regions, rural and urban areas, with different population sizes and different stages of economic governance depending on capacity to manage wastewater and capacity for governance. Approaches can also vary depending on the quality standard required for end users or end-point disposal. The sanitation ladder provides a useful instrument to assess the local status of sanitation in a community, municipality or region, pointing to optimal wastewater management strategies.

Cradle-to-cradle – can we do away with wastewater?

The cradle-to-cradle philosophy suggests a new form of production using processes that rely on reusable, biodegradable or consumable materials. No waste, as we know it at all and in fact the possibility of using production methods to improve the environment, for example water going out cleaner than it came in. With cradle-to-cradle there is no end, as discarded products once they have served their purpose should provide food for the biosphere or be completely recyclable in the technosphere. Examples include carpets that are made of a polymer that is completely recyclable – it can be depolymerized and used again and again or textiles that are made from completely non-toxic material, tested down to parts per million, that are completely biodegradable and nutritious for the environment.

Why is it currently acceptable, even in developed countries with environmental guidelines, for manufactures and consumers to demand products whose production and or disposal damage the environment? We tolerate products that are inherently poisonous, are poisonous to make and have a toxic legacy. We need international regulations to drive innovation so that cradle-to-cradle becomes the norm. Companies are now starting to adopt cradle-to-cradle production and finding that it is economic to have design principles, that are “good” rather than “less bad”.

(Source: McDonough and Braungart, 2002)



Reducing wastewater impacts in the Coral Coast, Fiji

On the Coral Coast of Fiji it was estimated that 35–40 per cent of the anthropogenic nutrients entering the fringing reefs resulted from local pig-rearing. The nearby tourist hotels give leftover food to workers for their pigs, which encourages people to keep pigs. Pigs produce three times as much nitrogen waste per unit weight compared to humans and many of the pig pens are near or over water. Luckily the community found a simple low-cost system to manage pig waste and reduce contamination of the surrounding reefs.

The technique of using sawdust beds to assimilate and stabilize piggery wastes is generally known as shallow bed composting. This technique has the potential to offer pig farmers some real advantages in both economic and waste management terms. For example, the capital and maintenance costs of this system are significantly lower than the original piggery. Additionally, as liquid

waste from washing pens is eliminated, the waste management of the unit is dramatically simplified.

The sawdust must be raked and renewed weekly and kept dry. It is replaced and taken to the farm about every three months to fertilize crops. With good management of these systems foul odours are not a problem, with the final composted product having an earthy smell. The system was initially trialled at one piggery at the National Youth Training Centre in the Sigatoka valley. The manager noted bigger, healthier pigs in the sawdust pens and has since applied this in all the centre's piggeries. If sawdust is not readily available other high-carbon, high-absorptive material can be tried.

(Source: UNEP/GPA and UNESCO-IHE, <http://www.training.gpa.unep.org/content.html?id=199&ln=6>)



It is important that management approaches form part of the planning and development process, reflecting regional realities and cultural differences as well as externalities such as exposure to natural hazards or extreme conditions. Incremental approaches to wastewater management can contribute to long-term success.

Innovation is important to continue to address evolving challenges in a changing world – to reduce the energy demands of wastewater management, and encourage solutions that promote using raw materials that do not contaminate, rather than focusing on end of pipe solutions.

THE ROLE OF EDUCATION, AWARENESS AND STEWARDSHIP

Wastewater is everyone's concern in the home and at work and using education to help change behaviour to both reduce wastewater discharge and also see the opportunities of managing wastewater is part of the solution. Increased understanding of the links between wastewater and health, ecosystem functioning and the potential benefits of wastewater reuse in contributing to development and improved wellbeing can increase uptake of initiatives.

It is vital that education in wastewater management and engagement of stakeholders in all sectors should include access to solutions and be culturally specific. Education, awareness, advocacy and stewardship should be addressed at multiple levels, including the development of professional skills for improved inter-sectoral collaboration and multi-year financial planning.

No one size fits all – wastewater treatment in Bali

As an internationally famous tourist destination, protecting the environment, maintaining natural beauty, and conserving the natural resources of the area are consistent priorities in Bali. Faced with the threats of environmental pollution and deterioration that comes with rapid tourist development, the government and various stakeholders have recognized the critical importance of wastewater treatment and sanitation for the sustainability of Bali.

This was a key consideration in the development of the 300-hectare Nusa Dua Tourist Resort, which has integrated a wastewater treatment system that not only treats wastewater from the hotels and other establishments in the area, but also provides water for maintaining hotel gardens, public gardens and the golf course. The system was also designed to blend with the natural physical surroundings and socio-cultural setting of Nusa Dua. The final wastewater station, called the Eco Lagoon, attracts various species of birds and further adds to the charm of the area. The wastewater treatment system is operated by the Bali Tourism Development Corporation in local government, hotels, and commercial and tourism establishments.

In Denpasar City, one of the focal areas for coastal recreation and tourism in Bali, the three-phase Denpasar Sewerage Development Project (DSDP) is now on its second phase. The first phase of the project completed a sewerage treatment system with a capacity of 51 000 m³ a day, which currently serves around 9 000 homes in Denpasar. The second phase of the project will expand the treatment facility to the other areas in Denpasar all the way to the Sanur area, with additional pipe connections to 8 000 homes. The project is a collaboration between the Government of the Republic of Indonesia, Bali Province, Denpasar City, Badung Regency and the Japan Bank for International Cooperation (JBIC).

For areas that could not be served by the centralized sewerage system, a community sanitation programme called Santasi oleh Masyarakat, or SANIMAS, which involves construction of community wastewater treatment systems with a capacity of 60 m³ a day has also been implemented in Denpasar City and other areas in Bali. The system was set up through a multi-financing scheme with contributions from central and local government and the beneficiary community. Ecological and low-cost wastewater gardens have also been developed in various areas in Bali.

(Source: Personal communication, Adrian Ross, PEMSEA; 2010)



Political and public support for change – Salmon in the Rhine

The Rhine is Western Europe's largest river basin and one of the world's most important trans-boundary waterways, flowing 1 320 km through Switzerland, Austria, Germany, France, Luxembourg and the Netherlands. Established as a navigable river in 1816, the Rhine has seen several major engineering projects proceed without prior bilateral agreement or environmental concern. The river became the "sewer of Europe" in the mid 1900s when large amounts of liquid waste from towns, industry and agriculture were increasingly discharged into the river. Salmon and most other fish species vanished, phosphorus reached alarming levels and it had become difficult to draw drinkable water from the river.

The need to set up a basin-wide body to deal with pollution issues in the Rhine became clear, leading to the formation of the International Commission for the Protection of the Rhine (ICPR) in 1950. However, it took another 20 years to see significant results, partly due to the loose set-up and lack of authority of the commission. The final catalyst came in 1987, when an accident at a Basel chemical plant led to the discharge of tonnes of toxins into the river, an environmental disaster causing the deaths of more than half a million fish.

After the 1987 accident, environmental awareness rose and the affected population and their representatives demanded much tougher measures against polluters. The 15-year Rhine Action Plan – also known as Salmon 2000 – was adopted as a result, one of its goals being the return of salmon and other fish by the end of the century. With an active water-quality monitoring regime, the plan also deployed pollution patrols to industry and communities, penalties for polluters and flood control and bank restoration measures.

Since 1987 point discharges of hazardous substances have decreased by 70 to 100 per cent, the fauna has almost completely recovered, including salmon, and accidental toxic discharges have been greatly reduced. However, several challenges remain, including fish passages, the release of toxic mud from the port of Rotterdam and pollution from farm fertilizers. On completion of the Rhine Action Plan, the Rhine 2020 Plan was adopted in 2001 for further sustainable development of the river.

(Sources: UNEP/DEWA/GRID-Europe, 2004; ICPR, 2010; UNESCO, 2000)



UNEP's response to capacity building needs in developing countries

The UNEP/WHO/UN-HABITAT/WSSCC Guidelines on Municipal Wastewater Management propose sustainable wastewater management based on an approach that integrates water supply, sanitation, and wastewater treatment. http://www.training.gpa.unep.org/documents/guidelines_on_municipal_wastewater_english.pdf

These guidelines also reflect needs for capacity development in this field and in response to these needs, UNEP/GPA jointly with the UNESCO-IHE Institute for Water Education and in the framework of the UN/DOALOS Train-Sea-Coast Programme offer training courses on wastewater management to municipal staff.

The Train Sea-Coast programme trained 1 800 experts from 67 countries between 2003 and 2009. It aims to increase the ability of participants to identify and formulate sustainable and financially viable proposals for the restoration of existing municipal infrastructure. It also develops capacities for new projects to either collect and treat wastewater, or to use alternative technologies to reduce or recycle nutrients from human waste.

Post-training evaluation for 2007–9, demonstrated that the UNEP-UNESCO-IHE training programme was delivering results, providing participants with knowledge and skills that they

were able to apply in their work. It identified a further training need for senior management and high level policy makers of municipalities and utilities providers of wastewater management services.

The evaluation also identified areas of the course that can be strengthened. There are few practical examples and little data on wastewater management solutions that have been implemented locally under the guidance of the course materials. It was proposed that UNEP/GPA and its partners embark on a new phase of the programme to link institutional capacity building with demonstration projects, which should be documented and shared. In addition, the lack of multi-year financial planning for municipal infrastructure projects in many countries severely undermines, and sometimes even prevents, the operation and maintenance of already existing infrastructure, such as sewerage systems and treatment plants. The capacity building needs of lifecycle budgeting processes have not yet been met.

More information about the UNEP wastewater management training programme is available at: <http://www.training.gpa.unep.org>, it is supported by the governments of Belgium, Ireland the Netherlands and the United States, the European Union ACP Water Facility and UNDP-GEF.

Building capacity and stewardship for environmental management of the Iraqi marshlands

The Iraqi marshlands are the most extensive wetland ecosystem in the Middle East and Western Eurasia. The marshlands of the Tigris and Euphrates delta are spawning grounds for Gulf fisheries and home to a wide variety of bird species. By 2002 the 9 000 km² of permanent wetlands had dwindled to just 760 km², drained by the former Iraqi regime and contaminated by sewage and chemical waste. With poor water circulation and low flows, salinity had also increased. The weak management sent the marshes into serious decline, and this impacted the surrounding communities. UNEP's Iraqi Marshlands project is contributing to restoration and sustainable management of the area, through the identifica-

tion and implementation of suitable mitigation options, particularly for provision of safe drinking water, but also for sanitation systems and water quality management. Implemented by the International Environmental Technology Centre, the Marshlands project includes training of Iraqi partners, coordination with Iraqi and other stakeholders, communication and data sharing through the Arabic-English Marshlands Information Network, and pilot projects to introduce environmentally sound technologies for safe water and sanitation to marshlands communities.

(Source UNEP and UNESCO: <http://marshlands.unep.or.jp/>)

