



COMPENDIUM OF GLOBAL GOOD PRACTICES

Urban Sanitation





**SANITATION
POLICY REFORM
WASTE WATER
TREATMENT,
RECLAMATION AND
REUSE**

**GENERATING
VALUE FROM
WASTE**

**PARTNERSHIPS
FOR SANITATION**

**PRO-POOR
SANITATION
STRATEGY**



an initiative of



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PREFACE

The National Institute of Urban Affairs is the National Coordinator for the PEARL Initiative (Peer Experience and Reflective Learning). The PEARL program ensures capacity building through cross learning and effective sharing of knowledge related to planning, implementation, governance and sustainability of urban reforms and infrastructure projects – amongst cities that were supported under the JNNURM scheme.

The PEARL initiative provides a platform for deliberation and knowledge exchange for Indian cities and towns as well as professionals working in the urban domain. Sharing of good practices is one of the most important means of knowledge exchange and numerous innovative projects are available for reference on the PEARL website. “Knowledge Support for PEARL” is a program supported by Cities Alliance that aims to qualitatively further this initiative. One of its key components is to carry out a thematic and detailed documentation of good practices in various thematic areas related to planning, governance and service delivery.

In an effort to fill the critical knowledge gaps for efficient service delivery in Indian cities, a number of good practices from across the globe have been compiled to address specific issues in the areas of water supply, sanitation, solid waste management, urban mobility, and the incorporation of information & communication technology in service delivery processes. Each volume examines case specific processes, activities and results to garner ways of improving operational efficiency – integrated water management, increasing customer base, corporatization of supply, reducing NRW etc. for efficient *water supply*; waste water treatment programs, pro-poor sanitation policy formulation, reclamation & reuse initiatives and public private partnerships for better *sanitation*; comprehensive waste management strategies, at source reduction and segregation, municipal capacity building, recycling, reuse and resource recovery for effective *solid waste management*; integrated land transport systems, travel demand management, pedestrianisation for EcoMobility and integration of informal systems for enhanced *urban mobility*; and finally e-Government development models; GIS mapping for municipal functions and intelligent service delivery systems using *ICT*.

The compilations assemble good practices from countries like Burkina Faso, Senegal, Ireland, Japan, Cambodia, Bolivia, Brazil, Kenya, Netherlands and Mongolia (Water Supply); South Africa, Denmark, Singapore, Thailand, Indonesia, Pakistan, Uganda, Mauritius, Philippines (Sanitation); Australia, USA, Brazil, Bangladesh, Egypt (Solid Waste Management); Nigeria, Mexico, UK, South Korea, Colombia (Urban Mobility); Germany, China, Peru, UAE (ICT). Cases are examined from the perspective of increasing operational efficiency, enhancing systemic capacity, creating efficient public private partnerships and building long-term sustainability into urban management activities. Priority has been given to cases from developing countries in order to increase adaptability and replicability of key concepts and practices.

Jagan Shah
January 2015

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The compendium of global good practices focusing on “Urban Sanitation” is an outcome of a collective contribution of several individuals. NIUA acknowledges their contribution and thanks them for their support.

Firstly, we wish to sincerely thank the Cities Alliance and World Bank whose grant support and knowledge partnership for PEARL has made the documentation possible at a time when urban infrastructure development is one of the main agendas of the Government of India.

We would like to thank Deeksha Matta, Apurva Bajpai, Shoma Mathew and Shilpi Madnawat of the PEARL team, who have contributed in putting the compendium together; and Deep Pahwa and Kavita Rawat for designing and formatting the compendium.

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Special thanks are due to Ajay Suri, Regional Adviser-Asia, Cities Alliance and Prof. Jagan Shah, Director NIUA for their support, guidance and inputs. NIUA has been enriched by the experiences gained in this process and sincerely hope that the report will contribute towards strengthening sanitation services in Indian cities.

Dr. Debjani Ghosh
Project Coordinator



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INTRODUCTION

URBAN SANITATION

Sanitation, along with clean water and food security, is a primary driver for improving public health. It is a hygienic means of promoting health by prevention of human contact with the hazards of wastes through services such as excreta management, garbage collection, storm water management, treatment and proper disposal of sewage wastewater, etc. Apart from these, eliminating open defecation, a practice strongly associated with poverty and exclusion, is critical to achieving sanitation.

In order to be sustainable, a sanitation approach must be socially acceptable and economically viable. Thus, sustainable sanitation is a loop-based approach differing from the current linear concepts of wastewater management, and that does not only recognize technology, but also social, environmental and economic aspects suited to local conditions. Improved sanitation, apart from promoting human health, also reduces environmental burdens and increases sustainability of environmental resources.

Access to adequate sanitation is a basic human right. To address the challenges in improving public health, most of the world's governments and international agencies have committed

themselves to the Millennium Development Goals which arose from the United Nations Millennium Declaration adopted in September 2000. The most relevant of these for sanitation is the **Millennium Development Goal 7**: Target 10 is to halve, by 2015, the proportion of people without sustainable access to improved sanitation¹.

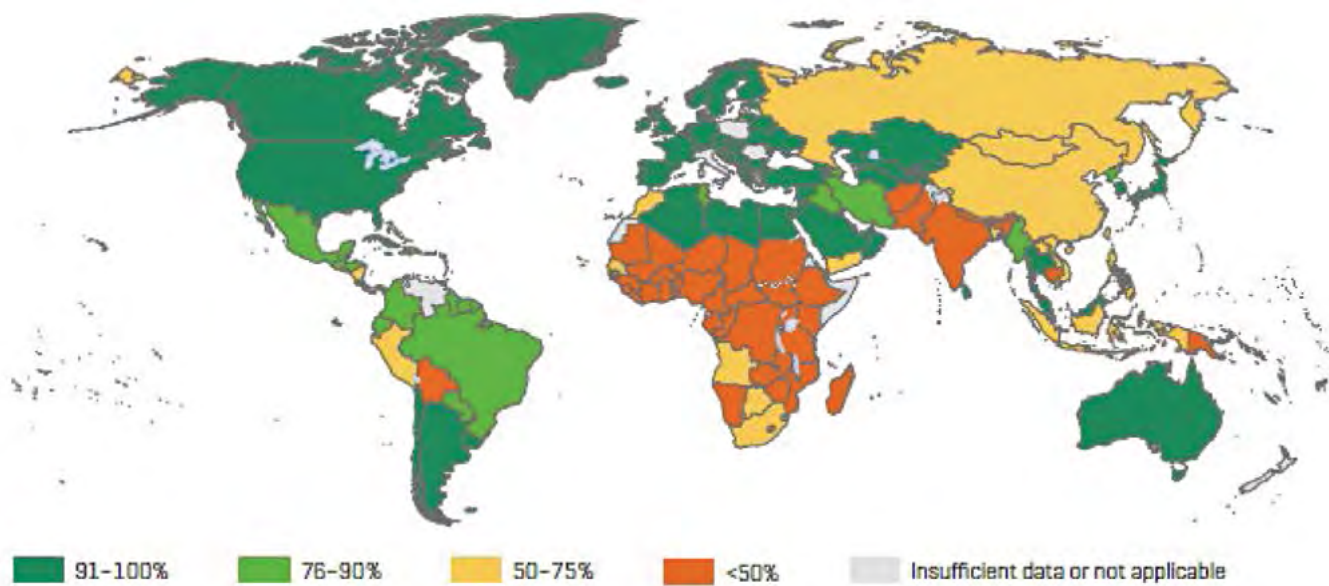
Despite significant progress on sanitation, in 2012, 2.5 billion people world-wide did not have access to an improved sanitation facility, down from 2.7 billion in 1990, a decrease of only 7%. There are still 46 countries where less than half the population has access to an improved sanitation facility. Among the world's regions, Southern Asia and sub-Saharan Africa continue to have the lowest levels of coverage. A large majority (70%) of those without access to an improved sanitation facility live in rural areas. Over the past 22 years, the number of people practising open defecation fell by a remarkable 21%, from 1.3 billion in 1990 to 1 billion in 2012. 9 out of 10 people who practise open defecation live in rural areas, but the number in urban areas is gradually increasing².

According to the **Census of India 2011**, 72.6% households in urban areas have availability of water closets, 7.1% households have pit latrine, 1.7% households have other latrine and 18.6% do not have latrine facility. Whereas 49.8% households in India

¹ UN-HABITAT, *Water and sanitation in the world's cities: Local action for global goals*, Earthscan Publications Ltd: London, 2003
² World Health Organization and UNICEF, *Progress on drinking water and sanitation - 2014 update*, WHO Press, Switzerland, 2014



MAP SHOWING PROPORTION OF THE POPULATION USING IMPROVED SANITATION IN 2012 WORLDWIDE



Source: WHO and UNICEF, Progress on drinking water and sanitation - 2014 update

defecate in the open, this figure is lower in the urban areas, at 12.6%. Similarly, 44.5% households in urban India have connection to closed drainage facility, 37.3% to open drainage facility and 18.2% have no drainage facility. A large proportion of households which are unconnected to the waste management system discharge their waste in the storm water drains. This waste, when discharged untreated in the rivers, leads to the pollution of water bodies.

Sanitation in India is a State subject. State-level steering committees and urban departments play the role of guidance and support to Urban Local Bodies (ULBs) which are responsible for final implementation of sanitation at the local level. ULBs are mandated to undertake planning, design, implementation, operation and maintenance of water supply and sanitation services in cities and towns. Currently various stakeholders are playing distinct roles in providing sanitation to urban India. The stakeholders include the Central and State government, Urban Local Bodies (ULBs) such as municipalities and municipal corporations, development agencies and foundations, social businesses, corporates, Microfinance Institutions (MFIs) and non profits.

In spite of being a key cause for poor health, sanitation as a sector has and continues to be hugely neglected and underfunded. There is no single development policy intervention that brings greater public health returns than investment in basic sanitation and hygiene practices. Five cornerstones have been identified that are crucial in providing universal sanitation - developing a **Gendered approach**, improving **Hygiene**, **Government's involvement**, nurturing **Community ownership** and **Customising solutions**.

Key Application Areas

This report is a documentation of case studies that address the challenges in the sanitation sector faced by the cities today, including open defecation, untreated sewage, management of human excreta, sanitation services for the poor, among others. It also describes the initiatives taken by the cities to implement certain solutions aimed at improving public health and hygiene through enhanced sanitation services. Before replication, the strategies and programs have to be tailored and contextualised specifically to the needs of the city. The key initiatives to improve the sanitation sector in each city have been discussed under the following five thematic areas:

THEME 1 - SANITATION POLICY REFORM The case study selected under this theme has illustrated a comprehensive sanitation policy framework with a focus on environmentally sustainable development.

Port Louis, Mauritius - Environmental sanitation project: Mauritius has adopted an integrated approach to wastewater management, enforced by a Wastewater Management Authority and comprises a portion of the National Sewerage Program.

THEME 2 - WASTE WATER TREATMENT, RECLAMATION AND REUSE: Under this theme, three cases highlighting three different waste water treatment technologies have been selected as case studies.

Denmark - Sustainable urban infrastructure: The project demonstrates a decentralised sewage treatment system based on

limiting the use of non-renewable resources, and has alternate uses as a greenhouse and space for fish cultivation.

Singapore - Sustainable water management: A centralized approach for wastewater treatment, water reclamation and also recycling of treated water for drinking purpose.

Udonthani city, Thailand - Restoring and rehabilitating natural creeks: The initiative involves a low cost approach to treat wastewater by turning existing waterway from municipal sewers into natural treatment systems or wetlands.

THEME 3 - GENERATING VALUE FROM WASTE: The two initiatives chosen under this theme are case studies that incorporate reducing, reusing and recycling the waste generated by converting a part of the waste to energy.

Naivasha, Kenya - Public toilet with biogas plant and water kiosk: This case is an example of providing safe and environmentally-friendly sanitation solutions with a focus on the reuse of the human waste as a resource.

San Fernando City, Philippines - Ecological Sanitation: This case is an example of how waste can be sustainably managed through community empowerment.

THEME 4 - PARTNERSHIPS FOR SANITATION: The theme covers best practices in the provision of sanitation services implemented by means of a partnership between the government and other entity, which could be the community, the private sector or a non-government organisation.

Denpasar, Bali Province, Indonesia - Community participation: This case demonstrates the success of a community based sanitation program (SANIMAS) to provide sanitation services for 840 people in a densely populated area of Denpasar city.

Orangi, Karachi, Pakistan - Non-government organisation: This case study showcases self-funded, self-administered and self-maintained grassroots movement involving large-scale provision of sanitation for the urban poor.

eThekweni Municipality, Durban, South Africa - Private sector participation: Public-private partnership was used as an instrument to treat domestic and industrial wastewater near to potable standards, and sell the same for industrial use.

THEME 5 - PRO-POOR SANITATION STRATEGY: Under this theme, the successful international initiatives undertaken to provide affordable sanitation services to the poor have been discussed.

Kampala, Uganda - Comprehensive program for informal areas: A comprehensive program incorporating sewer network expansion, complemented by improved collection of sludge from pit latrines, septic tanks & sewage treatment, was adopted in 2010 for the informal & unplanned areas of Kampala.

Nairobi, Kenya - Community toilets: This case study demonstrates an initiative to provide financially sustainable and affordable sanitation to the bottom-of-the-pyramid customers through the provision of community toilets.



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THEME 1

SANITATION POLICY REFORM

Governments across the globe realise the need for a nationwide sanitation strategy in the form of policy and legal framework to provide comprehensive, sustainable and accessible sanitation services to all. A sanitation enabling framework can be developed through strengthened policies, regulations, legislations and standards relating to sanitation, institutions, strategies and action plans. This along with the law enforcement and coordination among the institutions responsible for sanitation improvement (especially between the central government institutions and local governments) can bring about safe sanitation services.

Initiatives in India

Water supply and sanitation were added to India's national agenda during its first five-year plan period. Yet until 1979, relatively negligible investment was made within the sector. Since 1980 the government substantially increased its financial commitment to the sector, but mainly to rural sanitation. India's

first comprehensive **National Urban Sanitation Policy (NUSP)** was developed in 2008 by the Ministry of Urban Development (MoUD) to transform Urban India into community-driven, totally sanitised, healthy and livable cities and towns. Developing hygienic and affordable sanitation facilities for the urban poor and women were given special focus. The Policy provides a framework for all Indian States to approach urban sanitation in an integrated manner and mandates each state and city to formulate its own sanitation strategy and their respective City Sanitation Plans in overall conformity to the NUSP. Funding options through direct central and state support including through existing schemes (JNNURM, UIDSSMT and BSUP), public-private partnerships, and external funding agencies are available. NUSP directs at least 20% of the funds to be earmarked towards servicing the urban poor. The success of NUSP demonstrates that national level prioritisation of policies is the key to help states and cities take appropriate action in achieving comprehensive sanitation.

ENVIRONMENTAL SANITATION AND GOOD GOVERNANCE, MAURITIUS

Location	Port Louis, Mauritius
Region	Africa
Year	Mid-1990s
Agency	Wastewater Management Authority (WMA)

Project Aim

To contribute to Environmentally Sustainable Development by improving the health and quality of life of urban residents, and by protecting water resources by undertaking a program to connect household and industrial polluters to the sewerage system.

Context

The area developed as a result of bursting activity in the early 1980s as the country moved from an agricultural based economy to a more diverse one. This accelerated economic growth coupled with both residential and industrial development in the mid-1990s resulted in noticeable pollution of rivers and land in Port Louis. The 1990 National Environmental Action Plan (NEAP) identified inadequate disposal of urban wastewater as a growing threat to the quality of groundwater resources and marine and coastal ecosystems.

To check increasing pollution, the Ministry of Public Infrastructure set up the Wastewater Management Authority (WMA) in accordance with the Wastewater Management Authority Act in 2001. The WMA in Mauritius is a good model of an effective organization capable of implementing a national sewerage program, providing wastewater treatment services to consumers, achieving cost recovery through monthly tariffs, successfully

negotiating agreements with industrial plants on pre-treatment systems, and enforcing compliance with the discharge standards and regulations.

Project Description

The WMA initiated the 'Environmental Sanitation Project' to address severe waste water pollution from heavily urbanized areas of Port Louis, the industrial zones, and the affected coastal zones. The proposed project comprises a portion of the National Sewerage Program developed by the Government of Mauritius. The adoption of the National Sewerage Master Plan (NSMP) embodied Government's commitment to the improvement of the environment and to promote sustainable development. The NSMP provided a complete scheme for the development of wastewater sector in Mauritius and targets above 80% population connection to the sewerage system by the year 2033. The main objectives of the Environmental Sanitation Project are:

- To improve health and sanitary conditions of the population in these areas
- To reverse the current trend of environmental pollution on the island and its coastal zone
- To ensure good governance such that the project is a success

The following strategies have been adopted to attain the above-mentioned goals:

1. An institutional strengthening component for capacity building of the WMA
2. Improve wastewater infrastructure and service financing through tariffs for cost recovery
3. Economic incentives for industrial pollution control and reuse of treated wastewater in agriculture



Key Results and Impacts

- The number of household connections to sewage treatment facilities increased on a yearly basis, and this significantly improved the sanitary conditions and public health in Port Louis. By 2006, 30% of Mauritians were connected to the network (a 10% increase) and by year 2033 it is planned to connect 80% of the population (source: Wastewater Management Authority, 2012).
- The institutional performance of the waste water sector improved, with revenues generated through tariffs covering all O&M costs as well as the interest payments for loans.
- Environmental degradation has been reversed. Treated waste water rose from 20.2 million m³ in 1999 to 30.5 million m³ in 2005.

Lessons learnt

- Investing in wastewater management and services is a necessary condition for enabling sustained economic growth.
- Regularly reviewing the organizational effectiveness of im-

Project Implementation

1. TECHNOLOGY OPTIONS

Wastewater Collection:

- A rising main conveys wastewater from Fort Victoria (capacity of 23,000 m³/d) and Pointe aux Sables pumping stations (capacity of 25,000 m³/d) to the treatment plant.
- A number of households and industrial polluters were connected to the sewerage system.

Treatment System:

- Over 150 pre-treatment plants (either individual or jointly installed) treat industrial effluents before discharge to the public sewer.
- *Sewage treatment:* Primary treatment with disinfection, treating over 40,000 m³/d of wastewater.
- The plant was also designed to stabilize and dewater sludge.

Sea outfall: The outfall reaches about 695 m off shore, with six diffusers set at an average depth of 30 m to ensure that the effluent mixes with seawater.



Construction of Sewerage System



Wastewater Treatment Plant

2. FINANCING ARRANGEMENTS

Capital Investment:

- The World Bank financed the sewerage system (\$12.4 million), capacity building for the wastewater authority, and program implementation.
 - The Japanese Bank for International Cooperation (JBIC) financed, with a soft loan (\$33.6 million), two new pumping stations, the 'Montagne Jacquot' wastewater treatment plant, and the sea outfall. The government of Mauritius also provided funds for some aspects of each component. The Montagne Jacquot Sewerage Project consisted transportation, treatment and disposal of 48,000 m³ per day of wastewater.
 - Local industry will make in-kind contributions through pre-treatment of industrial effluents.
- Cost Recovery: Cost recovery was achieved through monthly wastewater tariffs.

3. INSTITUTIONAL AND MANAGEMENT ARRANGEMENTS

- The **Ministry of Environment** is responsible for supervising an environmental audit, consisting of a team set up at the level of the Government to monitor the impact of the wastewater projects being implemented under the national sewerage program.
- The **Wastewater Management Authority** is the implementing and executing agency for this project. The Authority was supposed to operate, maintain, and manage all public sewerage systems and treatment facilities.
- **External experts** will assist WMA to develop and undertake staff training to strengthen planning, financing, management, and enforcement functions in the wastewater sector.

4. PROJECT SUSTAINABILITY

The project falls within the *National Sewerage Program*, developed by the Government of Mauritius (GoM). As such, it is an integral part of the comprehensive program for the sector, and has the full backing of the GoM. Project components to strengthen institutional capacity in the wastewater sector and to establish a cost-recovery system will ensure project sustainability.

plementing agencies, and quickly addressing weaknesses can help ensure that agencies perform as effectively as possible.

- Introducing joint billing for water and wastewater makes cost recovery more efficient, and also reduces costs for administration of the scheme.

Replicability

Government's involvement in the sanitation sector is one of the most important factors behind sustainable and large scale sanitation outcomes. It is important to identify and foster champions for sanitation within all levels of the government – central, state and local – who will enable favourable policy environments. Champions at the national and state level enable policy and institutional arrangements ensuring that sanitation is included in poverty reduction strategies, allocate explicit long-term budgets to the sector and undertake the necessary reforms within and

outside government to improve performance.

Like in the case of Mauritius, the cities can benefit from the establishment of a wastewater management authority for sewerage and storm water management. It is essential for the political leadership to prioritize sustainability in sanitation as a policy issue. In India, the issues which need to be considered while framing policies and legislative framework include 100% safe waste disposal; achieving open defecation-free (ODF) status for towns and cities; the plight of the urban poor, especially the manual scavengers; developing a gendered approach for full participation of women and community ownership. The lack of awareness on sanitation, integrated planning, and the lack of technical know-how and capacity cause most of our infrastructure facilities to not operate efficiently. Thus, the policy should focus not on infrastructure development alone but also on outcomes and behaviour change.

THEME 2

WASTE WATER TREATMENT, RECLAMATION AND REUSE

Given the pressure on water resources and the gap in water demand and supply, the emergence of wastewater reclamation, recycling and reuse is becoming a vital component of Sustainable Water Resource Management in urban and rural areas all over the world. Wastewater reuse has been associated with the earliest Minoan Civilization dating back to 2700 B.C. The development of programs for planned reuse of wastewater within the U.S. began in the early 20th century. The State of California declared the first wastewater reuse regulations in 1918. In the later part of the 20th century, the concept of promoting wastewater reuse as a means of supplementing water resources spread to the European Union. Post 1960 was marked by an era of wastewater reclamation, recycling and reuse with the publication of 'U.S. Clean Water Act' to restore and maintain water quality, 'WHO Guidelines for Agriculture and Aquaculture Reuse', and 'Guidelines for Water Reuse' by the U.S. EPA and Office for International Development (1992), etc.

The potential benefit of reclaiming water from wastewater instead of disposing it to the environment has been recognized in many industrialized countries. Reclaimed or recycled water finds application in agricultural and landscape irrigation, industrial reuse, groundwater recharge and surface water replenishment, environmental and recreational use such as development of lakes and golf course ponds, non-potable urban uses such as fire protection, construction activities and flushing of sanitary sewers. Treating water for reuse is an important part of water conserva-

tion efforts and has great environmental and economic value, as listed:

- Wastewater reuse enables municipalities to generate revenue by selling their sewage
- Wastewater reuse contributes to National Development
- It provides a strong motivation for effective O&M, thus controlling the Environmental pollution
- It provides opportunities for privatization

Initiatives in India

In India, only 13% of all wastewater is treated and less than that is reused, thus it is important to harness this resource to meet the demand of water. About 71% of waste water in Class I cities and 96% in Class II cities remain untreated (www.indiawaterportal.org). One of the major issues regarding this is cost recovery, which is very crucial to invite private players, therefore the objective should not be just 'recycle' of wastewater but also to get 'revenue' from it. Bangalore started reuse of water in 1990s, which is first in the country in municipal sector. The country's first recycling project came up in Chennai where the city's sewage was sold to Chennai Petroleum Company Limited (CPCL), which in turn used RO technology to filter the sewage and turn it into water for its use. Delhi Jal Board uses treated water in irrigation department, garden and for supplying water to Delhi Common Wealth Village through dual pipeline.

SUSTAINABLE URBAN INFRASTRUCTURE, THE KOLDING PYRAMID, DENMARK

Location	Denmark
Region	Northern Europe
Year	1994
Agency	Municipality of Kolding, Ministry of Housing and Urban Affairs, Danish Town Renewal Company and Byfornyelse Danmark, a Consulting Company

Project Aim

To build a sewage treatment system based on reclaiming resources specially designed to target geographical areas with insufficient wastewater treatment infrastructure and/or scarce supplies of water.

Context

Urban ecology to create more sustainable cities was emerging in Denmark in the late 1980s. During the 1990s, new standards for building and living in the cities were introduced based on 'Sustainability'. Most of the initiatives to such project were taken by private persons and NGOs. These small scale initiatives were based on simple technology with great symbolic value. However, these were not integrated with other sectors and lacked documentation and evaluation of results. This gap led to a series of spectacular projects in the field of Ecological Urban Renewal. The Kolding Pyramid Project can be seen as a reaction to what was lacking. It is a top-down, large scale, integrated project with emphasis on documentation. The Pyramid, carried out from 1993 to 1997, is one of the pilot/ demonstration projects.

Project Description

The decentralized wastewater cleansing Pyramid is situated in the courtyard of Hollændervej/ Fredensgade block in Kolding, a mid-size Danish town. The basic idea with the project was to establish a wide range of possible ways of showing consideration for the environment and limiting the use of non-renewable resources. The projects were based on:

- reduced consumption of energy and water
- reduction of waste through sorting for recycling and composting
- use of environmentally friendly materials in the construction involved

Key Results and Impact

- The Pyramid project treats wastewater less expensively than the municipal wastewater treatment plant. In the process, it reclaims nutrients for the fertilization of plants (98% of the organic material is reclaimed) and the production of fishes.
- It has greatly contributed to raising awareness and giving inspiration to decision makers, technicians and private people

DECENTRALIZED WASTE WATER TREATMENT

Decentralized Wastewater Treatment System (DEWATS) approach is an effective and affordable wastewater treatment solution for both small and medium sized enterprises (SME) and un-served (rural and urban) households in developing countries, especially South Asia. It can be managed as a stand-alone facility or be integrated with centralized sewage treatment system. Up to 1,000 m³ of domestic and non-toxic industrial sewage can be treated by this locally organized and people-driven system. Several such systems have been running successfully in various parts of China, Germany, Indonesia, Sri Lanka and Philippines. These include treatment systems ranging from individual houses to hotels, hospitals, small industries and small townships.

In India, small-scale decentralized composting plants are found frequently at community level. Numerous initiatives have developed particularly for treatment of solid waste in residential areas. Such initiatives have also been taken at city level, e.g. the cities of Pune and Mumbai have adopted promising composting approaches at community level (together with primary waste collection), which are actively promoted by the city authorities.

in Denmark and abroad.

- Impact on sustainability areas:
 - Environmental - High (if placed on the right locality)
 - Social - Medium (no direct involvement, but basis for local network)
 - Economic - Unknown (the prototype rather expensive)
 - Institutional - High (creating platform for discussions between departments)

Lessons learnt

- The project has to be seen as a demonstration project, demonstrating a technology that could be used in other places - places without possibilities of connection with a central sewage treatment plant, for instance remote villages and villages on small islands.
- There could be a conflict between visions of sustainability and health hazards. As the pyramid houses both STP and a greenhouse, health authorities would not permit any edible crop to grow there due to the risk of epidemics.
- Other important lesson learnt, is about transferability. Some urban infrastructure technologies are rather sensitive to the specific local conditions. Not only the climate, but also the sunlight conditions in wintertime and the soil structure are quite important in such projects.

THE KOLDING PYRAMID LOCATED IN COMMON AREA OF THE BLOCK CONTAINING 129 DWELLINGS WHICH LATER INCREASED TO 143 WITH A TOTAL OF 250 RESIDENTS



On the common use areas, projects were developed in less cooperation with the tenants and house owners because new technologies were introduced. The project on the common use areas concerned:

- sewage water treatment (from kitchens, bathrooms, and toilets) in a local biological sewage treatment system
- recycling of rainwater for use in toilets
- filtration of treated sewage water and surface water to the groundwater
- recycling and composting of garbage
- environment friendly landscaping
- environment friendly planting to support diversity of species
- local responsibility and ownership among the residents for administration and taking care of the common activities, including the wastewater system

Project Implementation

1. INSTITUTIONAL FRAMEWORK

The project was born in 1993 as the result of a co-operation among these parties:

- **Municipality of Kolding** is a mid-sized Danish town of approx. 60,000 inhabitants with a strong political interest in supporting sustainable development in accordance with the principles of Agenda 21 from the Rio conference in 1992. The Municipality of Kolding was among the first to adopt the Aalborg Charter from 1994 concerning the responsibilities of local authorities to take action to strive for sustainable development
- **Ministry of Housing and Urban Affairs** was responsible for both legislation and development in urban renewal and new building. The Ministry had the power to set new standards in building regulations and in social housing schemes promoting the reduction of the use of energy and other resources. In addition, the Ministry had substantial funding for development projects at its disposal. A considerable part of the funding was allocated to projects supporting the development of sustainable solutions. The second energy crisis and a general recession during the first half of the 90s provided an incentive to encourage and stimulate these special efforts.
- **Danish Town Renewal Company**
- **Consulting Company Byfornyelse Danmark** had 25 years of experience in urban renewal. The company had a great interest in setting new standards for their work in accordance with the principles of sustainability. The municipality of Kolding and Byfornyelse Danmark had carried out a series of successful large-scale urban renewal projects in close interaction with the residents involved. This gave the credibility necessary to make the ministry count on this project as one of their flagships in the programme of new ecological urban renewal schemes.



The Glass Pyramid

2. PLANNING AND DESIGN

The Form: The form was chosen for functional reasons and also fits in with the surroundings. Lack of space in the block's courtyard forced the team to build a greenhouse in several stories, ending up with the pyramid shape. The Glass Pyramid contains basins for wastewater treatment on the ground floor. On the upper three floors are plant beds for pot plants. This is a combined greenhouse and wastewater treatment plant.

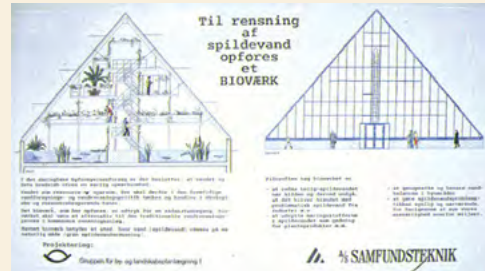
Material: since the pyramid also functions as a greenhouse, glass was needed to protect plants against cold in the winters, and also with glass, the light conditions are good on all floors.

3. INFRASTRUCTURE SERVICES

- **Pyramid 'green' sewage treatment plant:** It is the most spectacular element in the entire project. Wastewater from kitchens, bathrooms and toilets is directed for biological treatment. All sewage in the block is collected, pre-treated in a small underground mechanical-biological sewage treatment plant, sterilized in a uv-ozone filter, pumped to the Pyramid, where the sewage is further cleaned by algae and plants. The total surface of the tanks is 840 m² and the total tank volume is 460 m³. From the Pyramid, the sewage is 'polished' in a reed-bed and infiltrated in the ground. In principle, no wastewater leaves the block. The plant treats approx. 11000 m³ of wastewater per year.
- **Rain water harvesting:** Rainwater is gathered from the roofs, and is led to a lake and an underground storage tank in the gardens. Stored rainwater is constantly circulated in a watercourse running through the common gardens. This oxidises the water and keeps it fresh, but it also adds quality to the gardens. Water from the lake/tank is led to the toilets in the flats.
- **Functions as a Greenhouse:** the greenhouse is on the upper three floors. Plants are being irrigated with the sewage and thus reducing the content of nutrients. Fern, ivy and bamboo grow in the Pyramid. A total of 15000 potted plants are produced per year only using 10-15% of the water available.

The project also comprises of:

- **Energy savings in the dwellings**
- **Passive Solar Heating**
- **Photovoltaics**
- **Water saving installations**



Principle of the Pyramid 'green' STP



Phytoplankton, zooplankton, crayfish and fish play a decisive role in WWT



Greenhouse on the upper floors of the pyramid

- Ownership issues – the plant was a local initiative, meant to be taken care of by the users as the system required little skill to be maintained. From the users’ point of view, the project was far beyond the scale of a private compost heap. So the original idea of having the residents taking over the administration and operation failed.

Replicability

There is a need for capacity building of community institutions and participation by urban local bodies in order to scale up and replicate such innovative approaches in the future. A single wastewater treatment technology would be inappropriate for a country like India which has several different geographical and geological regions, varied climatic conditions and levels of

urbanization. It is more appropriate to address the potential of identifying appropriate solutions for different regions. A significant opportunity available in India is to introduce decentralized systems through which the resources generated from the wastewater, including recycled water and manure etc., can be utilized locally at much lower costs.

Given the urban sanitation situation in India, there is a need to promote such initiatives in waste water treatment by providing incentives and a supporting policy environment. Further, there is a need to support implementation of pilots and projects which demonstrate not only the decentralized and low-cost treatment of wastewater, but also demonstrate how communities and local administration can partner to implement the interventions in ways that make the facilities more durable and long lasting.

HOLISTIC APPROACH TO SUSTAINABLE WATER MANAGEMENT, SINGAPORE

Location	Singapore
Region	Southeast Asia
Year	2000
Agency	Public Utilities Board (PUB) and Ministry of Environment and Water Resources
Awards	Stockholm Industry Water Award (2007), Environmental Contribution of the Year Award (2008) and Global Water Awards (2009)

Project Aim

To protect and expand the available water sources by desalination and reuse of wastewater, and use technological developments to increase water availability, improve water quality management and lower the production and management costs.

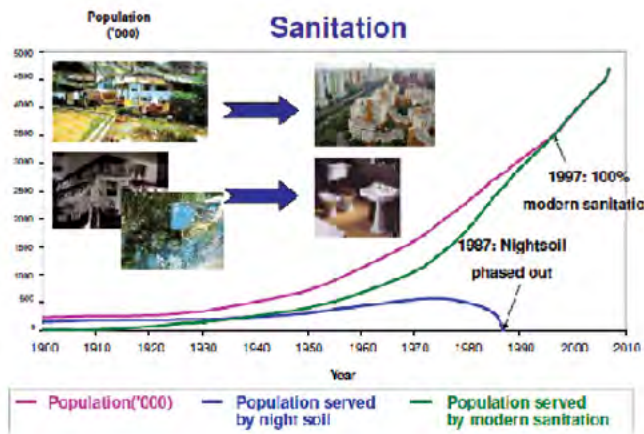
Context

Water has been a critical issue for Singapore since gaining independence in 1965, with the city-state determined to become truly self-sustainable in this area. In order to reduce the country’s dependence on water imported from neighbouring Malaysia, Singapore adopted innovative integrated water management approaches. The Public Utilities Board, created in 1963, embarked on the construction of more water schemes inside Singapore. In 1998, the government initiated a study, the Singapore Water Reclamation Study (NEWater Study), to determine if reclaimed water treated to potable standards was a viable source of water. In order to facilitate the new integrated approach, the Public Utilities Board, which had previously been in charge of water

CENTRALIZED WASTE WATER TREATMENT

Public sewer systems or municipal wastewater treatment plants are centralized systems that have advanced treatment for water reclamation. These are applied on a large scale and usually serve established towns and cities. The system involves long distance transportation of wastewater by a network of pipes and pump stations to a central location for treatment and purified water back to the point of origin. A single centralized system can take the place of several decentralized systems, requiring fewer people to manage it, allows for greater control and produces only one discharge to monitor instead of several. The centralized system gained favour, especially in Europe, following the success of the first modern-day system constructed for Hamburg, Germany in 1843.

However, centralised systems are high-cost, energy and maintenance-intensive systems and are not so suitable for developing countries. In India, the centralised sewage treatment technologies have generally failed to cater to the total wastewater generated. More than 75% of wastewater is not addressed by centralised treatment facilities. The untreated/partially treated wastewater makes its way to the water bodies causing immense degradation of the ecosystem and the environmental health. Also, centralized approaches to wastewater treatment have had limited success to make wastewater management people-centered and effective.



Situation in Singapore: 1900 - 2010

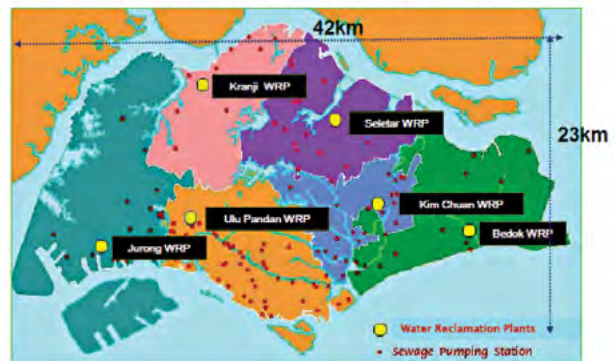
supply only, was given the responsibility for sanitation as well in 2001. Previously sanitation had been under the direct responsibility of the Ministry of Environment. The new policy was called the “Four Taps” strategy aimed at reducing reliance on supply from Malaysia by increasing the volume supplied from the three other sources, or “National Taps”. The first and second taps were local water catchments and water imports. In 2002 Singapore commissioned its first reclaimed water plant, thus opening a “Third Tap”. In 2005 Singapore opened its first seawater desalination plant, the “Fourth Tap”.

In 1965, when the country gained independence, only 45% of its population had access to proper sanitation. A sewerage master plan was developed in the late 1960s and by 1997, Singapore was 100% covered with modern sanitation. Until 2010, wastewater in Singapore was collected through a sewer system that included 139 pumping stations that pumped water to six wastewater treatment plants. These pumping stations and plants were to be gradually decommissioned with the coming up of a new system, the Deep Tunnel Sewerage System (DTSS).

Project Description

Singapore adopted a holistic approach to water resources management through the Deep Tunnel Sewerage System (DTSS), a visionary project by Public Utilities Board (PUB), Singapore’s National Water Agency. The size of the island, the lack of available land and continued growth meant that traditional approach would not work. The basic concept for the project was developed in the late 1990s. Designed to be cost-effective and efficient, DTSS can meet the city-state’s long-term needs in used water collection, treatment, reclamation and disposal for the next 100 years. The system collects waste or used water through a network of underground sewers that leads to Sewage Treatment Plants (STPs) where the used water is a resource to be reclaimed. There is a separate system for storm water collection, comprising of drains that collect and channel storm water and surface run-off to rivers. The treated used water from STPs is piped to the NEWater plants as feed water for NEWater production, Singapore’s own brand of reclaimed water. Remaining treated

3200 km Sewers 116 Pumping Stations
6 Water Reclamation Plants (WRPs)



Used Water Infrastructure before DTSS

effluent is discharged into the sea.

DTSS is an integral part of Singapore’s water management and was selected as the water project with the most significant contribution to water technology and environmental protection. The project has received numerous awards for its innovative approach to sewage management.

Key Results and Impacts

- There have been campaigns to urge people to conserve water, reducing consumption from 165 litres per person per day in 2003 to 155 litres in 2009. The target is to lower it to 140 litres by 2030.
- The tariff structure was modified. While tariffs historically included a cross-subsidy from industries that paid a higher price to residential users that paid a lower price for social reasons, this policy was ended and residential users were charged a tariff that covers the full costs of supply. It is seen that the new tariffs had a notable impact on the behaviour of the consumers, and have turned out to be an effective instrument for demand management. Average monthly household consumption steadily declined during the period 1995 – 2004.
- The level of water losses - more precisely defined as non-revenue water - is one of the lowest in the world at only 5%.
- The completion of DTSS phase-I has reduced the land previously used by the WRPs and intermediate pumping stations from 300ha to 190ha. Phase II is further expected to reduce the land to 150ha. The freed-up land can then be used for other higher-value developments.
- Regular rehabilitation of leaking public sewers minimized incidences of leaks from the sewer network contaminating canals, water-ways. It also intensified sewer maintenance at choke-prone areas, over the years.
- The centralization of used water treatment at two Water Reclamation Plants has allowed for greater economies of scale and has proved more cost-effective.

Lessons Learnt

- For a holistic approach to sustainable water management,

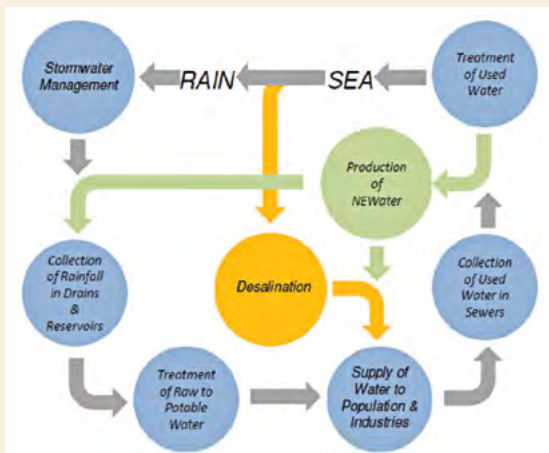
Project Implementation

1. INSTITUTIONAL FRAMEWORK

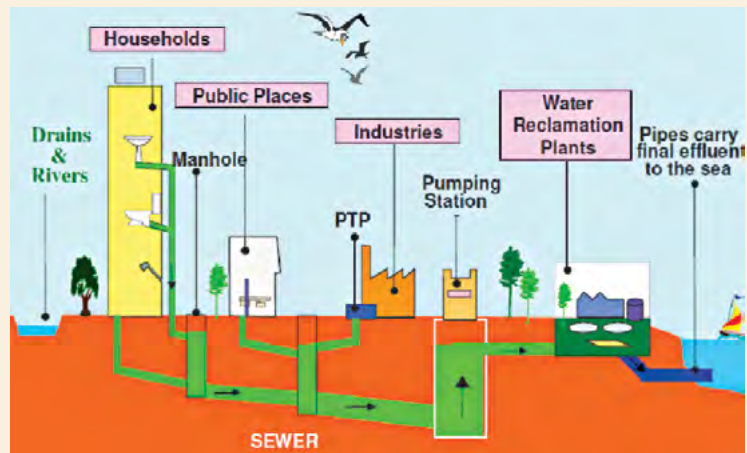
- The project is conceptualized and managed by Singapore's National Water Agency, **Public Utilities Board (PUB)**. PUB is a statutory board under the Ministry of Environment and Water Resources and is in charge of providing water supply, sanitation services and storm water drainage in an integrated and coordinated manner. PUB promotes water conservation, keeping water catchments and waterways clean and taking a sustainable approach to water resources. It also monitors compliance of potential polluters on the basis of the Sewerage and Drainage Act. PUB thus is both a service provider and a regulator.
- **Ministry of Environment and Water Resources**, Government of Singapore is in charge of policy setting for water and sanitation. Setup in 1972, the Ministry is responsible for providing a quality living environment and a high standard of public health. PUB and NEA are its two statutory boards.
- **National Environment Agency (NEA)** monitors PUB's compliance with environmental as well as drinking water quality standards on the basis of the Environmental and Public Health Act. It develops environmental initiatives and programmes through its partnership with the People, Public and Private Sectors.

2. PLANNING

- Singapore had already prepared for greater water self-sufficiency through an integrated water management approach including water reuse and desalination of seawater.
- Water management is closely integrated with land management. The latter is tightly controlled in order to prevent any pollution of water resources through sewage, sullage or other sources of pollution.
- Public education was an important instrument to promote water conservation. For example, a Water Efficiency Labeling Scheme for taps, showerheads, toilets and washing machines was introduced so that consumers could make informed choices when making purchases.



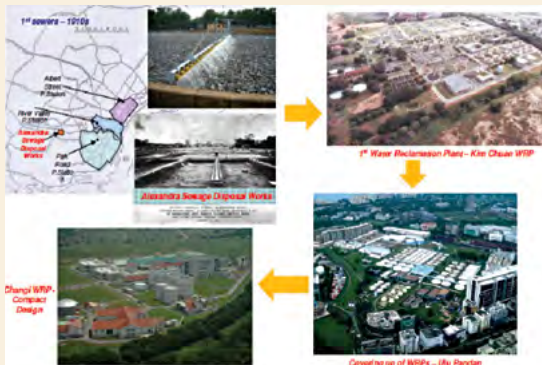
Closing the Water Loop



Used Water System: From sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water



Deep Tunnel Sewer System (DTSS)



Physical Evolution of Water Reclamation Plants



Changi Water Reclamation Plant



NEWater Plants in Singapore

3. INFRASTRUCTURE PROVISIONS

Deep Tunnel Sewer System (DTSS)

- The conceptual plan for the DTSS consists of two large deep tunnels that span the island conveying wastewater to two centralized wastewater treatment facilities. The deep tunnel works entirely by gravity, eliminating the need for pumping stations, and thus the risks of used water overflows.
- With the DTSS, land used to site the existing water reclamation plants and its buffer zones, as well as pumping stations will be freed up for other developments.

Changi Water Reclamation Plant (CWRP):

- CWRP, the heart of the phase I of the DTSS, was first constructed in 2007 to initially treat 800MLD or 800,000 cubic metres (176 million gallons) of used water a day to international standards. In 2010, the plant was operational and expanded to handle a maximum wastewater flow of about 860MLD.
- The Changi Water Reclamation Plant itself is a showcase of an effective water solution for cities, especially those that face water demand and pollution challenges. At one-third the size of conventional plants, the CWRP is designed to be compact to save on the land resource. Centralization of used water treatment at Changi also allows for economies of scale.

NEWater Plant:

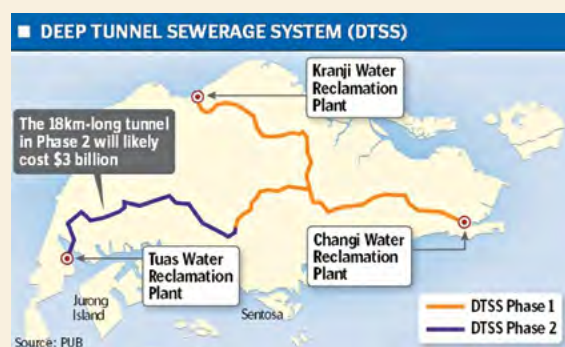
- The effluent from the reclamation plants is further treated in NEWater plants using dual membrane and ultraviolet technologies. NEWater is the brand name given to ultra-pure water that is produced from reclaimed water. The quality of NEWater consistently exceeds the requirements set by USEPA and WHO guidelines.
- Integrating the NEWater plant with the water reclamation plant allows for efficient large-scale water recycling, thus ensuring its sustainability. Most of the NEWater is used by industries for non-potable uses such as water fabrication. The rest is fed into nearby reservoirs. As of 2008, according to PUB NEWater was able to meet 30% of Singapore's water requirements.
- Rest of the treated used water is discharged into the sea through deep sea outfalls.

4. FINANCIAL ASPECTS

Financing: The project is self-financing through retained earnings, debt financing through bonds and project finance for desalination. In 2005 PUB issued for the first time a bond, raising S\$ 400 million, to finance part of its investment program. Since then, bonds have been issued regularly. During the financial year 2010, PUB Group received an operating grant of S\$ 185 million to fund the operation and maintenance of storm water drainage network and operating costs of certain water infrastructure assets such as the Marina, Serangoon and Punggol Reservoir schemes. DTSS cost: \$3.65 billion.

Investment: In 2010 PUB undertook investments of S\$ 411 million (USD 290 million) in its own assets, mainly for water supply and NWater, and S\$ 451 million (USD 319 million) for assets belonging to the Government, mainly for sanitation and storm water drainage. This corresponds to annual investments of USD 117 per capita, which is higher than in the United States where the corresponding figure is USD 97.

Tariffs: Water and sewer tariffs in Singapore are set at a level allowing cost recovery, including capital costs. The sewerage tariff (called "waterborne fee") is S\$ 0.30/m³ for domestic users plus a fixed tariff of S\$ 3 per "chargeable fitting" per month. The water tariff includes a conservation tax set at 30% that increases to 45% for domestic consumption above 40 m³ per month. A general service tax of 7% is added to the bill. Industrial water tariffs are set lower at S\$ 0.52/m³. Water and sewerage tariffs are lower than tariffs in some European countries such as in Germany where the average water and sewer tariff including taxes was Euro 3.95 per m³ in 2004.



Phase-wise layout of the DTSS

5. IMPLEMENTATION MECHANISM

The first phase of the Deep Tunnel Sewerage System (DTSS) was launched in 2000. It conveys wastewater from North and East Singapore to the Changi Water Reclamation Plant, at the Eastern end of the island. The system comprises of a 48 km long deep tunnel sewer, 20 to 55 metres below ground and running from Kranji to Changi, a centralized water reclamation plant at Changi, two 5 km long deep sea outfall pipes and 60 km of link sewer. Phase I was completed in 2008.

Phase II of the DTSS is envisaged to be developed before 2030. In the second phase, the system is to be expanded to the entire island, with a second wastewater treatment plant at Tuas at the Western end of the island.

it needs to be closely associated with a long-term land use planning.

- Effective policy implementation and law enforcements are needed to regulate effluent and solid waste discharges from industrial and commercial activities.
- Instead of just using engineering or hardcore technological solutions, the main target must be to stop the pollution from entering the surface water sources by looking at soft management solutions as well.
- Have an effective institutional management with a comprehensive plan providing all the relevant agencies a framework with their respective targets.

Replicability

Many states in India strike resemblance to the case of Singapore in the dependence on other states for raw water and polluted water sources. To become self-sufficient, the states and cities in India need to adopt an integrated approach to water resource management. Urban wastewater management has

become a challenge in India as infrastructural development and regulations have not kept pace with population growth and urbanization.

In many cities, the wastewater generated is a mixture of domestic and industrial wastewater which makes reuse recommendations a challenge. Wastewater is put to reuse mainly for irrigation, hence possibility of treatment, recycling and reusing it to potable standards should be explored like in the case of Singapore. Public perception about recycling and reusing wastewater is the most important influencing factor for its penetration in the municipal segment. Aversion towards usage of recycled water for potable purposes hampers the efforts of water management in the municipal sector.

The high costs involved in running the centralised systems favour decentralised treatment systems for developing countries like India. The need of the hour is better overall planning & budgeting, lowering production and management costs, maintaining discharge quality into drains and sewers and identifying gaps for R&D.

CONSTRUCTED WETLAND FOR MUNICIPAL WASTE WATER TREATMENT, UDONTHANI CITY, THAILAND

Location	Udonthani, Thailand
Region	Southeast Asia
Year	2010
Agency	Udonthani Municipality and Khon Kaen Universtiy

Project Aim

To revive the existing creeks by developing a natural wastewater treatment system (wetland), improve the surrounding landscape and provide social and economic benefits to the local communities.

Context

The Udonthani municipality covering an area of 5.6 sq km is served by two local creeks - Huay Mak Khaeng and Huay Mang, for the city's natural drainage. As a response to growing population and urbanization, leading to an increase of urban sewage and contamination, Udonthani municipality planned for a large-scale wastewater treatment system enough to cater for the next 20 years. The treatment plant, covering 46 hectares, was located 7 km outside the town requiring transportation of wastewater from town for which the creeks served as a water passage. By 2003, the creeks were in poor condition with high sedimentation loads, pollution and contamination. It was then that the municipality initiated a wastewater treatment system by turning existing waterways from municipal sewers into natural treatment systems (constructed wetland). The model was set up as supplementary system to the existing municipal wastewater treatment.

Project Description

To address water pollution, environmental and public health problems of Udonthani, the then city mayor initiated restoration and rehabilitation of the two creeks. However, there was no appropriate model of water treatment system available locally at the time. A natural-based treatment system was selected as demonstrated by the Royal Department Project in Khao Hin Son in Chachoensao Province. The wetland construction started in 2006 on a small scale, a so-called "showroom", as a pilot project to promote public awareness of its purpose. It became a demonstrative wastewater treatment system based on ecological processes. Initially the project was called "Klong Suay Nam Sai" (meaning beautiful creek, clear water) and took place between 'Prajak Silapakom' and 'Athibadee Street', with a 720 meters long creek. Positive responses were expressed, particularly among the local communities within the vicinity of the constructed wetlands. The municipality then

NATURAL TREATMENT SYSTEM (WETLAND)

Constructed Wetland System (CWS) is an innovative and low-cost treatment approach that has been implemented for treatment of wastewater from a range of sources - municipal wastewater, agricultural wastewater, industrial effluents, storm water run-off, acid mine drainage and landfill leachate. Constructed wetlands are passive systems for wastewater treatment that can also be designed to add aesthetic value, enhance the environment, and provide wildlife habitat and recreational opportunities. These are designed to mimic the filtration processes that take place in the fragile ecosystem of a natural wetland. The design considerations for CWS are varied and site dependent and may be constructed as either Surface Flow or Sub-surface Flow System. The Surface Flow Systems are frequently designed to maximize wetland habitat values and reuse opportunities, while providing water quality improvement, while Sub-surface Flow Systems do not provide benefits other than water quality improvement.

The use of CWS is an emerging technology worldwide. The first operational full-scale constructed wetland for municipal wastewater was built in Europe, in Othfresen, Germany. In U.S. some systems were installed in the 1970's with an increasing number in the 1980's. The 1990's saw a major increase in the number of these systems as the application expanded for use not only to treat municipal wastewater, but also urban storm water, industrial, mining and agricultural wastewaters. The U.S. Environmental Protection Agency (EPA) considers the use of wetlands to be an emerging alternative to conventional treatment processes. The use of CWS in the United States, New Zealand and Australia is gaining rapid interest where most of these systems are used for tertiary treatment from towns and cities. Conversely, in European countries, these are usually used to provide secondary treatment of domestic sewage for village populations.

decided to expand the constructed wetland to cover 9.76 km of Huay Mak Khaeng. During 2009-2010, the constructed wetland was upgraded to be part of the municipal wastewater treatment system.

Currently, wastewater is primarily treated by the municipal main treatment system, goes through the constructed wetlands and is naturally treated in the final stage prior to discharge into creeks. The load comes from 47,828 households, 11 markets, and 400 industries that discharge a total of 50,000 cubic meters per day. The maximum capacity to treat water of the constructed

wetland is 5,000 cubic meters per day, but the intake is currently at 2,000 cubic meters per day. The integrated system does not only treat water effectively, but also provides additional areas for recreation for local communities.

Key Results and Impacts

- The constructed wetlands markedly improved the urban water quality and increased the capacity of the existing municipal wastewater treatment system. The BOD of treated

Project Implementation

1. INSTITUTIONAL FRAMEWORK

Steering Body: In 2005, a Memorandum of Understanding (MoU) was signed for collaboration between the *Udonthani municipality* and *Khon Kaen University* (Faculty of Engineering and Faculty of Architecture), to survey, study and design the constructed wetland as well as carrying out landscaping work.

Coordination Mechanism: The *Sanitary Work Division* of the municipality had the responsibility of coordinating and supervising the works. The work was in collaboration with the Social Welfare Office, which coordinated with local communities, and the *Public Health and Environment Office*, which oversaw health and environmental quality in the municipal area.

Specific Technical Expertise: Different experts have been involved in the project, since a variety of skills were required -

- *Ecosystem experts* understand the natural behaviour of a creek that continues its natural ecological process as well as treats water. They have expertise in selection of plants for cultivation as treating agent. The selection process is concerned with the compatibility of plant to the depth, using local or indigenous species, and seasonal variety in order to make the landscape more attractive.
- *Engineering experts* understand the wastewater treatment system and know how to design a constructed wetland, work together with other experts from various subjects, e.g. agriculture, fisheries and architecture, to calculate the hydrological capacity of the system to operate smoothly and naturally.
- *Architecture experts* designed the surrounding areas of the creeks as recreational areas. The expertise needed was architectural design, material selection for paths and bridges to match the local setting, and landscape design to decorate the project.

2. PLANNING

Construction of the man-made wetland consisted of two parts: 1) The wetland confinement and its ecosystem; its depth, slope and wall, and 2) The landscape surrounding the wetland.

The construction of wetland was envisaged in four phases:

Phase I - Construction of the wetland by **improving the existing creek** to have designated depths and cultivating different aquatic plants as needed. The constructed wetland consists of three ponds:

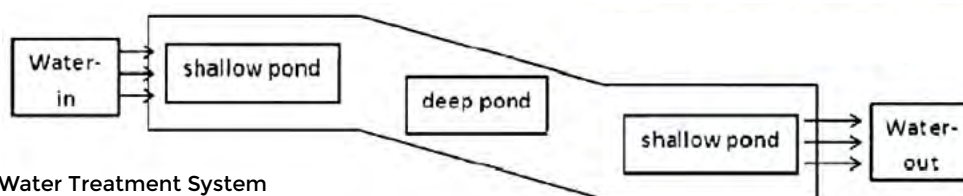


Diagram of Water Treatment System

- 1) Shallow pond (1st pond) is cultivated with sedge, screw pine, cattail, Indian shot, etc. to reduce water speed and get rid of organic matters in the water. Protein compounds are transformed into ammonia;
- 2) Deep pond is cultivated with lotus and submerged plants to transform the ammonia from the previous shallow pond into nitrate (nitrification);
- 3) Shallow pond (2nd pond) is cultivated with sedge, screw pine, cattail, Indian shot, etc. to transform nitrate to nitrogen (de-nitrification) and disperse it into the air. The discharge from this part is used for fisheries purposes.



Diversity of water plants in Constructed Wetland



Water Diversion way in creek for divided wastewater and treated water

Phase II - Carrying out pipe-laying work in order to control the intake from the creek at optimum level to the capacity of the wetland and to control the outflow of treated water in order to retain water for a certain period of time so that the plants can treat it.



Landscape Design for Recreation

Phase III - Landscape improvement in adjacent area to the wetland for easy access and additional benefit, e.g. recreational area for local people. The project was aiming to cater for: 1) horticulture and medical herb reservoir, 2) bridge improvement, 3) exercise ground, 4) playground and 5) civic multipurpose space



Utilization of Open space around Huay Mak Khaeng Area

Although the landscape work is not the essence of the treatment system, a large amount of money was invested by the municipality. This was justified because local communities have expressed appreciation of the great surrounding areas of the creeks, which have been transformed into recreational areas for community benefits. In turn, local residents take good care of their areas to ensure sustainability.

Phase IV - Public relations and information sharing with local people by allowing them to recognize the benefits from having a constructed wetland, the municipality aims for their acceptance and participation in the long-term maintenance. The concept of 'urban wastewater treatment' was new to the local community; subsequently it had taken time to gain understanding and acceptance. Udonthani spent a year providing knowledge and information about the operation and effectiveness of ecological system in treating wastewater.

3. SALIENT FEATURES OF THE PROJECT

Principles of wastewater treatment:

- Nature-based, simple, neat and economical;
- Problem solved in a sustainable way;
- In harmony with the local surroundings;
- Compatible with the existing system.

Sustainability of the Model: Economical and cost effective - The constructed wetland integrated into the existing wastewater treatment system applies natural mechanisms to treat water. It utilizes locally available resources, hence easy to establish. The wetland is a low construction, low-maintenance or nearly a maintenance-free treatment system. Once it gets started, it can naturally operate on its own, not needing any technical assistance or repairs, one only needs to ensure the optimal quantity and diversity of plants to prevent water circulation blockage. This helps to ensure the sustainability of the project.

People's Participation: Some 20 local communities living on both sides of the creeks took part in public hearings conducted before the commencement of the project. People gave inputs to the municipality on landscaping around the constructed wetland and the creeks. A wide variety of suggestions was made - lighting at night, public restrooms, banning of littering into the creek, picking up trash, exercise facilities, provision for social and cultural activities, e.g. Loy Krathong festival, art and music festivals. The local communities even participate in maintaining the system.

Active Role of the Media: The mass media has been helpful in propagating the wetland project from the very beginning, starting with picking up on the press release of the MoU between the municipality and the Khon Kaen University to construct the wetland. This helped to raise awareness of the project among the local residents. Media at the national level also helped propagate the news to a wider audience. The municipality also provided a live model to audiences for easy understanding. Consequently, requests for site visits were well received. Invitations to conferences and exhibitions gave the opportunity to spread the concept.

water came down to 10.08 mg/l from 62.50 mg/l.

- Social Benefits - 1) the project increased awareness on conservation and protection of aquatic ecosystems among the local communities. The benefits of the development have drawn great attention to the need to maintain healthy creeks with good water quality, 2) the system has added an aesthetic value to the place by creating a new green public recreational space for social and cultural events.
- Economic Benefits - the local communities are able to utilize different plant species for their livelihoods and to generate income.
- The project's success made it a replicable model and many other authorities such as Nong Samrong municipality and Ubonrat municipality in Khon Kaen have adopted it. Sakon-nakorn municipality and Phuket municipality have started to study its feasibility and compatibility with their existing systems.

Lessons Learnt

- The challenge would be to increase participation from various stakeholders as pollutants increase such as sewage from houses, shops, markets and factories. With development, more sewage would occur, affecting the water quality in the creeks. Natural mechanisms alone cannot handle the problem, but residents should consider more options to reduce the load at the source. Some measures should be promoted such as grease traps, on-site waste reduction, or water conservation.

- Collaboration between the municipality and the people is highly prioritized.
- Vision of the administrator and continuity of policy, including consistent support has been remarkable. Because the constructed wetland is relatively low-cost and seems insignificant, local authorities in general often neglect it.

Replicability

In developing countries like India, the problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-technology and user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources.

The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to the conventional treatment systems, constructed wetlands need lesser material and energy, are easily operated, have no sludge disposal problems and can be maintained by untrained personnel. Thus, constructed wetlands are an attractive option for a small community with limited funds for expanding or updating their wastewater treatment plants. These are also suited for rural municipalities that have access to adequate land, and wetlands blend well into a natural landscape setting. Site specific designs that carefully consider factors such as hydrology, native plant species, and seasonal temperature fluctuation can lead to efficient removal of contaminants in wastewater.

THEME 3

GENERATING VALUE FROM WASTE

Across the countries, there is a growing recognition of the climate change benefits to be realised from increased recycling, reuse and reduction of waste. Garbage needs to be treated as an opportunity to generate value from what otherwise would be considered as 'waste'. Waste is not just a cost burden but can also be a source of valuable materials that can be recycled. Resources can be recovered from waste if they are separated at the source, and are treated properly. Equal or higher emphasis should be given to "upstream" resource management and waste reduction efforts, as compared to "downstream" waste management options such as treatment and disposal. By reducing

production of wastes, and by maximising the use of reusable and recyclable materials, a city can achieve greater resource efficiency. Such efforts will also help cities to reduce the financial burden on city authorities for waste management.

Partnerships with communities need to be created to manage and reduce waste while recovering valuable resources and creating clean, renewable energy. City leaders should try to encourage a fundamental change in mindsets and attitudes towards waste. Public information campaigns need to encourage urban populations to help reduce the waste stream and to turn what used to be considered as "waste" into "resources."

PUBLIC TOILET WITH BIOGAS PLANT AND WATER KIOSK, NAIVASHA, KENYA

Location	Naivasha, Kenya
Region	Africa
Year	2008
Agency	Water Services Board, Naivasha Water Sewerage and Sanitation Company Ltd. (NAIVAWASS) and Water Services Trust Fund (WSTF)

Project Aim

To provide safe and environment-friendly sanitation solution with a focus on the reuse of the human waste as a resource (ecological sanitation or ecosan), and to find a business-orientated solution that would create economic incentives for the water sector institutions to invest in sanitation and to generate income for private operators.

Context

Naivasha is a small town located at the shores of Lake Naivasha about 80 km north of Nairobi, the capital of Kenya. The town covers an area of 30 sq. km. with a population of approximately 70,000 people. The town relies mainly on pit latrines for excreta management, with less than 5% of households and commercial establishments connected to the sewer system which is connected to a poorly functioning wastewater treatment plant. The public toilets in the town managed by the municipal council were also in an appalling state due to absence of operation, maintenance and management concept and erratic water supply. The municipal council lost interest in the upkeep of these toilets since they failed to generate any revenue that could be used to cover costs for O&M. There was a need to improve the living conditions by providing hygienic and environment friendly sanitation solutions with reuse of the human waste. A need to provide a business-oriented solution that would create economic incentives for the water sector institutions to invest in sanitation was also felt.

Project Description

To deal with the water and sanitation problems in Naivasha, a Water Service Provider (WSP) called Naivasha Water Sewerage and Sanitation Company Ltd. (NAIVAWASS) was formed under the Water Sector Reform Program of the Ministry of Water and Irrigation (MWI). The responsibility for water and sewerage was shifted from the Municipal Councils to the regional Water Services Boards (WSB) who delegates the management to the local WSP. Public toilets were still a responsibility of the Municipal Councils according to the regulations of the local government, but may be handed over as well to the WSB/WSP.

Naivasha Bus Park was selected as the location for a pilot and demonstration public sanitation project combined with a water kiosk. The new facility was to take over the old existing public

WASTE-TO-ENERGY

Given the quantum and rate of waste generation, it is essential to reduce, reuse and recycle the waste by converting a part of the waste to energy. Also, with the fast depletion of the conventional resources and the growing awareness and concern regarding the environmental effects of their utilization, there has been a major thrust in the recent past to identify and develop alternate energy sources. Wastes are increasingly being seen as a resource for generating different forms of energy such as biogas, compressed biogas and pyrofuels. Three processes for conversion of waste to energy, namely i) bio-chemical pathways (anaerobic digestion) or biomethanation ; ii) thermo-chemical pathways, and iii) composting are appropriate. The adoption of technologies for conversion of waste to energy requires consideration of local conditions, waste composition, quality and quantity of waste generated and available and skills for adapting, managing and maintaining the technologies.

Waste to energy technologies have been and are being developed in several highly industrialised countries where about 80% of energy requirements are for heating or cooling buildings and powering vehicles. In developing countries with tropical climates and less developed infrastructure, decentralized options for electricity and heat generation using renewable energy is an attractive option.

toilet used by approximately 200 people per day without any user charges. The technology of biogas sanitation was chosen for this project to demonstrate that biogas production from human waste is possible under Kenyan conditions. The technology was not selected to be the cheapest alternative but to show that sanitation can be "productive". The facility was put in operation after handing over to the WSB in July 2008. It was the first project in public sanitation aimed at developing appropriate procedures for funding and implementation of such facilities.

Key Results and Impacts

- The toilet and water kiosk are delivering convenient, safe and affordable sanitation and water services to approximately 300 users per day.
- The project has drastically improved the hygienic conditions at the Naivasha bus park. It also provides an income to the private sector (operator) and to the WSP.
- The reduction of organic load through the anaerobic treatment process of waste has contributed towards the protection of Lake Naivasha.
- The project demonstrates commercialisation of sanitation

services within the institutional water sector.

Lessons Learnt

- The pay-per-use concept is appropriate to supply convenient services to the user through an operator.
- The management and ownership of public toilets should be linked to the water sector institutions and the privatised water service providers in order to enhance sustainability of service provision.

Replicability

Provision of public toilet complexes at public places such as markets and bus stands and in slums is important for community health, hygiene and environmental sanitation. In India, several public toilet complexes with biogas generation have been constructed in different states and approved by the Ministry of Non-conventional Energy Sources, Govt. of India. Sulabh International Social Service Organisation, a non-profit voluntary organisation founded in 1970 invented an efficient design of

biogas plant linked with public toilet, the first model of which was set up at Adalatganj, Patna. It produced electricity from biogas which was supplied to the 3 kms long Bailey Road, Patna.

Experience in the field suggests that such model is successful through inter-sectoral coordination and partnership of local authorities, NGOs and the community. For the construction and O&M of these complexes, other organizations like 'sulabh' need to be set up to play the role of a catalyst and a partner between the official agencies and the users. Such practices may not be viable in the absence of an enabling atmosphere created by the government's policy intervention. The interventions comprise of policies to promote public toilets on a use-and-pay basis and substantial capital subsidies for their establishment. However, toilet complexes located in less developed areas are generally not self-sustaining and their maintenance can be cross-subsidized from the income generated from such units in busy and developed areas. In India, the psychological taboo attached with biogas usage in some societies, needs to be changed with advancement of education and awareness among the people.

Project Implementation

1. INSTITUTIONAL FRAMEWORK

The project was implemented through the following established institutions of the Water Sector Reform Program under the Ministry of Water and Irrigation (MWI):

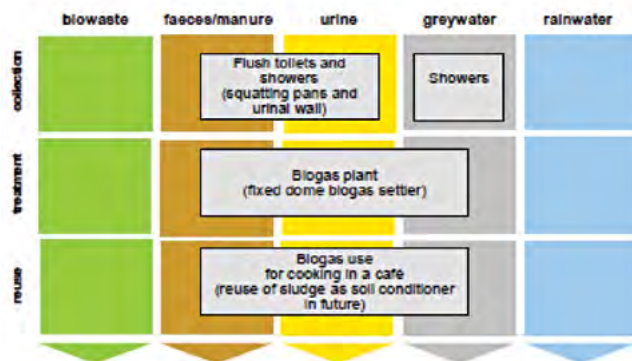
Owner of the facility: Rift Valley Water Services Board (RVWSB)

Implementation/Facility Management:

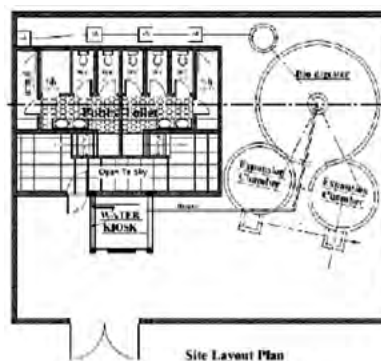
- Naivasha Water and Sanitation Company (NAIVAWASS), the local Water Service Provider (WSP) was given the responsibility to operate and manage the facility. It selected, contracted (for one year) and trained a Community Based Organization called Banda Livestock Self Help Group, a private operator to run the facility on a day-to-day basis.
- Water Services Trust Fund (WSTF)

Technical Planning/Implementation Support: EU-Sida-GTZ EcoSan Promotion Project (EPP) is one of the components of the Kenyan Water Sector Reform Program. The project piloted sustainable sanitation projects in rural households, public places, public institutions and informal settlements. EPP acted as a support organization in project preparation, implementation supervision and training activities.

The EPP, WSTF, WSB, municipal council of Naivasha and the WSP formed a project task force and jointly developed the sanitation concept. A Memorandum of Understanding was signed between the WSB, WSP and municipal council to avail the site for the facility to the WSB. Then a final sanitation project proposal was presented to the WSTF for approval.



Applied Sanitation Components in the Project



Site Layout Plan with Toilet Block & Biogas plant

2. INFRASTRUCTURE PROVISIONS

The **sanitation unit** has 5 toilet cubicles (2 for males and 3 for females), hand wash basins, 2 showers and one wall for urinating. The water is provided through 2 overhead water storage tanks (each 5 m³) placed on the toilet roof.

The **water kiosk** located in front of the toilet building sells water and other commodities. It also serves as the operator's room to serve the toilet customers. The water kiosk has a separate overhead water storage tank (5 m³) on its roof. The water kiosk design was developed by the WSTF and has been successfully implemented in Kenya and other African countries

Biogas plant or biogas settler:

Wastewater generated from the sanitation unit gets discharged into an underground 54 m³ fixed-dome biogas plant where the wastewater is treated through settling and anaerobic digestion thereby lowering the organic content (pollution load) of the wastewater. Biogas is produced in the process. The biogas plant has two outputs: treated effluent (continuous flow) and sludge (emptied once per year and can be used as fertilizer). Settling of solids occurs in the main chamber (or dome-shaped reactor). The treated effluent from the biogas plant is drained into the existing public sewer line. The biogas is piped to a nearby café where it is used for cooking.

Design information:

- The required area for the toilet building and biogas plant is approximately 10 x 15 metres. The underground structure is located about 0.5 m below surface. It is not recommended to build any structures on top of the biogas plant.
- The design of the fixed dome was based on the system implemented for livestock manure in Kenya by the GTZ-PSDA program (Promotion of Private Sector Development in Agriculture).
- The project did not focus on sanitizing and treating the effluent for agricultural reuse since (i) the available space for further treatment was not available and (ii) there was no demand for irrigation water in the area.



New Public Sanitation Facility



Customers at the Water Kiosk



Area of top manhole, above the Biogas Dome



Cafe using Biogas for cooking located adjacent to the Public Toilet

3. FINANCIAL ASPECTS

Capital Investment: The investment costs for the entire facility was approx. 40,000 EUR. The costs included material and labour costs for the ablution block, water kiosk, biogas plant and administrative costs for the supervision work of the Water Service Provider, NAIVAWASS. The infrastructure was funded by EPP. The funds were channeled through the Water Services Trust Fund (WSTF), a basket fund supported by Kenyan Government, donors and development partners for pro-poor service provision of water supply and sanitation. Rift Valley Water Services Board is the designated asset holder of the infrastructure.

Cost Recovery: The Public Toilet charges for the use of the toilet 5 Ksh8 (0.05 EUR), for use of the shower 10 Ksh (0.1 EUR) and for a 20-22 litre jerry can of water 2 Ksh (0.02 EUR). These tariffs were proposed by the WSP. The Water Services Board and the Water Services Regulatory Board (regulator) can adjust these tariffs if required. The operator is not allowed to raise the price of water and sanitation services. The price setting is meant to be pro-poor. The operator pays a subsidised water tariff to the WSP of 0.3 EUR per m³. At the same time he/she makes 1 EUR per m³ from the sale of water thereby making a profit of 0.70 EUR per m³. For the water used in the toilets the operator pays the standard retail price of 0.8 EUR per m³ since he/she collects a toilet user fee to cover his costs for toilet operation. The financial sustainability of the facility depends on the number of users, the water and the toilet/shower tariffs and the other operation and maintenance costs.

URINE DIVERSION TOILETS, SAN FERNANDO CITY, PHILIPPINES

Location	San Fernando City, Philippines
Region	Southeast Asia
Year	2003
Agency	The City Municipality Awards: Netherlands Water Partnership, WASTE, PRACTICA, IRC and SIMAVI

Project Aim

To improve public health by giving access to proper sanitation that does not pollute scarce drinking water resources, of all the citizens.

Context

San Fernando city in the Province of La Union is one of the biggest urban centres in Northern Luzon, Philippines. In 2000, the city had a population of 102, 082 (National Statistics Office, May 2000) which was expected to increase to 127, 708 by 2010. A significant percentage of the city's population lacked access to improved sanitation, mainly in poor coastal barangays (villages) and remote uplands where people practiced open defecation, used unsanitary open pit toilets, or had access to unhealthy communal toilets. These became potential source of disease and groundwater and/or surface water pollution. Thus, poverty, ignorance about the consequences of poor sanitation, lack of awareness about alternatives and scarcity of water to maintain toilets, led to sanitation issues being neglected.

To improve public health by providing access to proper sanitation, the city government in 2003 took the step of accepting to pilot the Ecosan project which promotes waterless urine-diverting dehydration toilets (UDDT).



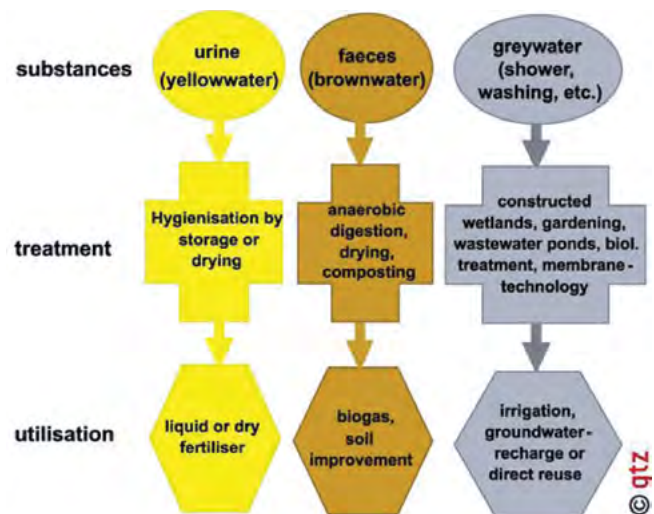
San Fernando city in La Union province

ECOLOGICAL SANITATION

Ecological sanitation or 'ecosan' is a holistic approach to sanitation and water management based on the principle of "minimum resource utilization and maximum resource recovery". It can be characterized as a "closed loop" sanitation system which recognises human excreta and water from households not as a waste but as resources that can be recovered, treated and safely reused. As ecological sanitation system adopts treatment processes that closely mimic the cycles of nature, it is sustainable and has no negative impact on the environment. Ecosan is based on three fundamental principles - preventing pollution rather than attempting to control it, after we pollute; sanitizing the urine and the faeces; and using the safe products for agricultural purposes. This approach can be characterised as 'sanitize-and-recycle'. The ecological sanitation system has two components - Urine Diverting Dehydrating Toilets (UDDT) or Ecosan Toilets and Waterless Urinals.

Ecological sanitation has been identified as an alternative and sound approach to conventional sanitation by many experts and organisations worldwide. Ecosan is preferred for its modular, decentralised partial-flow systems for more appropriate cost-efficient solutions that can be adapted to the local situation. The increasing number of demonstration projects for excreta reuse carried out in Sweden from the 1980s to the early 21st century aimed at developing such sanitation system. Similar lines of research and projects began elsewhere, for example in India, Zimbabwe, Netherlands, Norway and Germany.

VARIOUS ECOLOGICAL SANITATION SYSTEMS



Source: GTZ

Project Description

Three low-income, water-scarce communities in San Fernando City - Barangay Nagyubuyuban (an upland farming village with 1,300 people), Barangay San Agustin (a coastal urban poor village with 1,900 people) and Fishermen's Village (a resettlement coastal village with 450 people) adopted Ecosan in 2004 and successfully improved their health and environment conditions. These communities began to install and use waterless (dry) urine diversion toilets. In 2006, sanitation took center stage in San Fernando City's development agenda and updated its Sanitation Code. The Ecosan project expanded within the City proper and in 2007, 358 units of Ecosan toilets were installed. The city also passed its Sanitation Strategic Plan, which called for the construction of another 1,000 Ecosan toilets by 2010.

The City of San Fernando has served as model and learning example for other municipalities in the Province of La Union. The second phase of the ISSUE Programme (2007-2010) made it possible for CAPS to work with the Provincial Government and reach out to neighbouring towns interested in implementing Ecosan projects.

Key Results and Impacts

- **Better sanitation and health conditions for the poor communities:** With the introduction of Ecosan, the barangay leaders of a pilot community decided to pass an ordinance prohibiting defecating along the seashore and public places.
- **Urban agriculture:** Majority of the households who owned an Ecosan toilet started practicing urban agriculture by reusing urine and faeces as fertilizer and soil conditioner in their gardens and farms.
- **Generation of an additional business:** Ecosan project paved the way for manufacturing local Ecosan toilet design in the Philippines. The project contracted small ceramic makers to develop (design and mould-making) a ceramic urine-diverting toilet. This is again part of the Waste Venture Component to develop related businesses.
- **Ecosan in Government regulations and National laws:** Ecosan was accepted as a viable sanitation option in the Implementing Rules and Regulations of the Clean Water Act. This was achieved through active networking under the Knowledge Sharing Component. Through this, a Philippine Ecosan Network (PEN) is now formed. The city now integrates the concept of dry ecological sanitation into its strategic sanitation planning, under the slogan Sanitation for All = A Healthy Environment for All.

Lessons Learnt

- **Social Preparation:** The main challenge in terms of viability of Ecosan is its social acceptance by the target city stakeholders and partner-beneficiaries. An effective social preparation, information and education campaigns is necessary to overcome this. Though the concept of "dry sanitation" was new and an innovative approach, yet Ecosan became viable because its benefits and advantages were successfully conveyed and concretely shown through knowledge sharing, capacity building and project piloting.
- **Political Will:** The most critical success factor has been the strong leadership demonstrated by the Local Government. The Mayor of San Fernando, realising the applicability, advantages and benefits of Ecosan for the city has been the key

Project Implementation

1. INSTITUTIONAL FRAMEWORK

The Programme is being managed by a Consortium of five organizations:

- 1) **City Government of San Fernando, La Union (CSFLU)**
- 2) **Center for Advanced Philippine Studies (CAPS)** introduced the concept to the city government in February 2004. As Programme Coordinator and implementer, CAPS took care of the capacity building work and community relations as well as community organization to enable them to deal with the radical changes in social and personal behaviour that will be necessary to adapt to the totally different system of sanitation.
- 3) **Solid Waste Management Association of the Philippines (SWAPP)**
- 4) **Foundation for Sustainable Society, Inc. (FSSI)**
- 5) **Institute for the Development of Ecological Alternatives (IDEAS)**

By August 2004, the city government and CAPS, together with SWAPP, FSSI and IDEAS had formed a partnership to mainstream ecological sanitation in the city. Working through its Program on *Integrated Support for Sustainable Urban Environment (ISSUE)*, funded by WASTE, a Dutch NGO, CAPS assisted the City Government from 2004-2006 to establish Ecosan as a sanitation system appropriate for the communities. The ISSUE Programme was one of the prime movers in partnering with the local government and other stakeholders in the City, to support their work for equitable and affordable urban environmental service systems.

At the **City level**, a Technical Working Group (TWG) composed of Department Heads was formed to supervise day-to-day Ecosan activities.

At the **Barangay level**, an Ecosan Committee was formed to carry out coordination and management of the co-operators and the finance schemes and to monitor the household beneficiaries on their use and maintenance of the toilets.



Barangay Level Workshop

2 .PLANNING

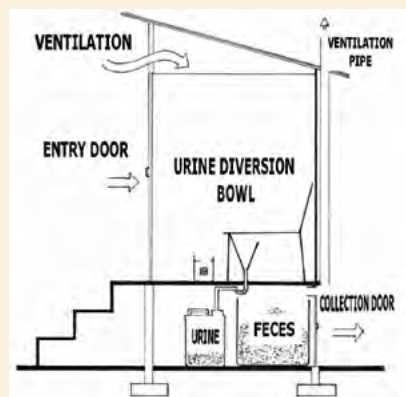
Community Level Orientation: To empower the community as agents of change, the City Mayor adopted a process of capacity building and social preparation that involved workshops and seminars at City, Barangay and Household level.

Before the construction of UDDT, the ecosan co-operators (people installing these toilets in their homes) were given training on careful handling of faeces and grey water and were technically prepared to use and maintain the urine diversion toilets.

Design: The UDDT is sited 60-100 cm above ground level allowing faeces to fall into a collection container and the urine runs off to a separate liquid container. The substructure has a single chamber which can be easily transported when full. Households collect the excreta themselves, using composted faecal matter and urine as fertiliser on their gardens or few acres of land. Carbonated rice husk, is added to the faecal matter to absorb moisture, improving the composting process and reducing odour to a minimum.

The system protects human health, saves water, prevents water pollution, and reuses nutrients in human excreta (closing the loop). Every barangay is required to construct a Materials Recovery Facility (MRF) for solid waste. Partly composted faeces are stored in MRF, and processed into a useful fertiliser. A urine storage and treatment facility was developed at the San Agustin MRF, under the Philippines' Ecological Solid Waste Management Act. The households take the urine surplus each week to a central collection point, from where a vehicle collects and transports it to the MRF. The urine collection service is arranged by the ecological sanitation committee in cooperation with the city staff.

Construction: Readily available local materials (such as nipa or sawali, dried leaves of trees native to the Philippines) and recyclables for roofs and walls were used to lower the cost of construction for the co-operators.



A Urine Diverting Dry Toilet (UDDT)



A Materials Recovery Facility (MRF)



Construction of UDDTs in various materials

3.FINANCIAL ASPECTS

- The **City Government** budgeted Php 1 million (US\$20,000) for constructing the toilet facilities. The city provided the substructure of the toilet.
- Additional funds came from the **Dutch Government**, through WASTE, an NGO based in Netherlands. In Philippines, the funds are used to provide technical assistance in terms of capacity building, training, research and development, public awareness activities, information and education under the Knowledge Sharing Component. It also provides a facility for loans or credits to promote and enhance viable economic and livelihood related to Ecosan as part of the Waste Venture Component.
- The **Households** joined a financing scheme through which they pay for the urine diversion toilet in installments before the construction of the facility, while they were being trained. The co-operators provided the 'counterpart', i.e. the roof and walls and construction labour. Families received financial incentives from a revolving fund.

factor in pushing through and implementing the project in the City and later in the whole province of La Union.

- **Exploring the uncertainties:** An appropriate UDDT design for differently-abled and the design of toilet sub-structures in flood-prone areas is still to be developed.

Replicability

The model of UDD toilets is replicable particularly in the rural areas where connection to a sanitary sewer system is not possible, or where water supply is very limited. In the context of rural India, where substantial numbers of sanitation facilities at household and school levels are being created in mission mode, promotion of sound sanitation practices founded on the principle of ecological sanitation will be of great benefit to rural communities in general and especially to

communities living in ecologically fragile areas. It is suited for construction in all types of regions including dry, cold, hilly and plain areas.

Success of Ecosan projects in India depends on the social mobilization of the community and their orientation towards a shift in toilet usage. The acceptance of sanitized toilet waste in agriculture is the most important driving force for acceptance of Eco-san toilets. Moreover there is a need to develop ownership among the users to ensure proper use and maintenance of the toilets. Eco-san toilets have been constructed in various parts of India, including many villages in Tamil Nadu, Maharashtra, Andhra, Kerala where toilets have been constructed in flood prone areas. Ecosan activities in India are growing and quite a few NGOs are working at the grass root level to raise awareness and acceptance for ecosan technologies.

THEME 4

PARTNERSHIPS FOR SANITATION

Participatory, community-based approaches to hygiene promotion allow organisations and governments to work with communities to arrive at sustainable solutions to sanitation development problems. This approach brings together representatives of all the local stakeholders, which is often a diverse group of users, health workers, NGO's, etc. Applying a participatory bottom up process in project implementation means that local authorities and service providers as well as the

Community Based Organizations (CBOs) are already involved in the project's start-up phase. The involvement of women is particularly important, given the central role of women in using, and often maintaining and managing, water resources and sanitation needs for personal and domestic use. One example that showcases effective partnership for sanitation is through the Council of Cities in Brazil, which has a system of representation from the very local community right up to national or state level.

COMMUNITY-BASED SANITATION (SANIMAS) IN DENPASAR, BALI PROVINCE, INDONESIA

Location	Kusuma Bangsa, Denpasar, Bali Province, Indonesia
Region	Southeast Asia
Year	2004-05
Agency	Denpasar Municipality, BORDA Indonesia, BALIFOKUS and a Community Based Organization

Project Aim

To improve access of low-income urban households to sanitation services through a community-based development approach.

Context

Kusuma Bangsa in West Denpasar District is one of the most densely populated areas of Denpasar city. The neighbourhood is about 1.5 kilometres from city centre, situated on low-lying land near a drainage stream. Public sanitation utilities providers found it difficult to supply services to the poor settlement due to social and economic barriers. About 80% of houses in the locality had toilets without proper septic tanks and the untreated wastewater was discharged into the nearby stream. Regular flooding in the area caused backflow of polluted stream water resulting in direct physical exposure of residents to wastewater as well as the

COMMUNITY PARTICIPATION

Community-Led Total Sanitation (CLTS) is a participatory approach that 'triggers' communities to take collective action by enabling them to analyze their sanitation practices and identify the subsequent impact on health and dignity. Providing communities with the knowledge and skills to better their own quality of life, harnessing local leadership and encouraging behavioural change at the community level allows for tangible improvements in service delivery in the absence of government intervention. The process, predominantly applied in rural areas, is now also being tested in urban environments and proving to be successful. In India, a demand-driven and people-centered sanitation program was initiated under the name Total Sanitation Campaign (TSC) in 1999 providing thrust on community participation. Many states like Maharashtra, Gujarat, and Tamilnadu have done well in improving the overall status of sanitation under the TSC.

contamination of water supply sources. Lack of basic sanitation infrastructure endangered public health with high incidence of water-borne diseases. Denpasar Municipality therefore, sought

Project Implementation

1. INSTITUTIONAL FRAMEWORK

A Community Based Organization was set up to implement the project with the assistance of an NGO that coordinates and facilitates implementation of SANIMAS projects in Bali and eastern Indonesia. The responsibilities of these were:

- 1) **Community-Based Organization (CBO):** The CBO has legal ownership of the infrastructure, organizes meetings, identifies beneficiaries, compiles action plans, manages funds, and mobilizes people to support and participate in the project. The CBO's members are 5 heads of families connected to the SANIMAS system and chosen by beneficiaries. Together with an appointed operator, who collects user fees from participating households, the CBO ensures the system works properly and takes care of minor repairs.
- 2) **BORDA and BALIFOKUS:** A German NGO (Bremen Overseas Research and Development Association -BORDA) worked through a local NGO (BALIFOKUS) to find a technical solution for the community after needs assessment was done and is responsible for taking effluent samples to monitor the wastewater quality every 6 months.
- 3) **Denpasar Municipality** assumed responsibility for major repairs.

The CBO and BALIFOKUS compiled into one book, **Community Action Plan Book**, all the plans and anticipated activities for construction fund management, sustainable cost coverage for O&M, and system and services maintenance. It was signed by all parties involved. The community used the book as a tool to submit fund disbursement requests to contributors, such as government agencies.

A **Project Joint Account** was opened at a local bank to manage the multi-sourced project funding. Withdrawals required approval from all three account signatories.

CBO managers and treasurers were trained by BALIFOKUS and BORDA to compile simple **Financial Reports** and receipts, which were submitted to all parties in the same financial report.

2. INFRASTRUCTURE PROVISIONS

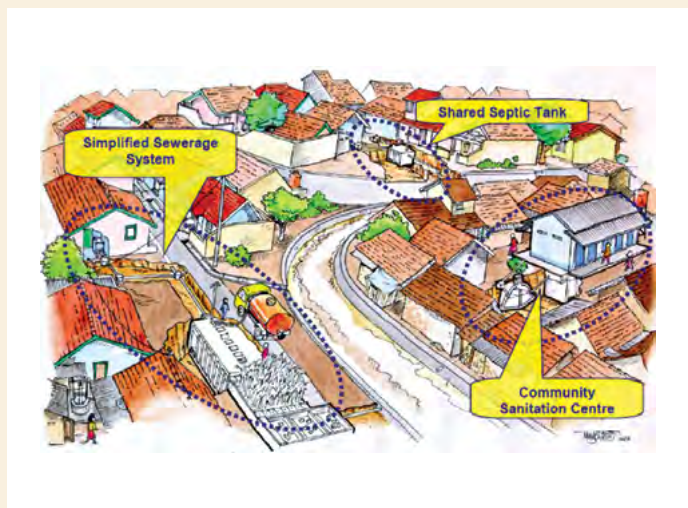
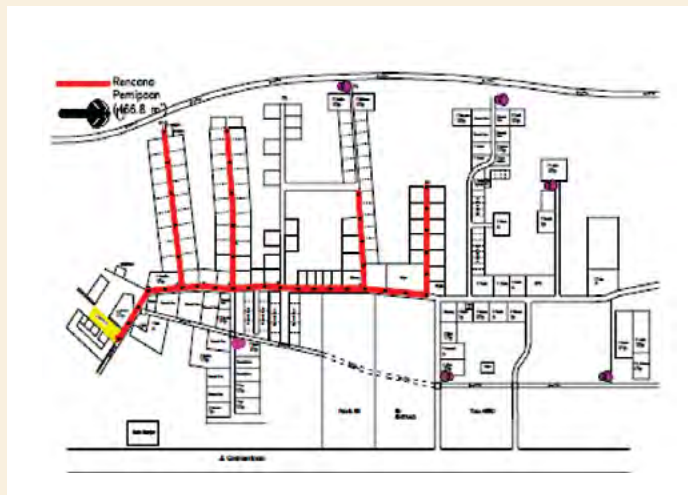
Technology option: The community chose a simple BORDA-designed decentralized wastewater treatment system (DEWATS) to treat about 60 cubic meters of blackwater and greywater per day, using an anaerobic baffled reactor that does not require electricity inputs. The system relies on a micro-organism and biological process to treat the wastewater.



Construction of DEWATS

Infrastructure included the following components:

- Installation of 67 household connection boxes that function as grease-trap unit, at each house. The households must ensure that no unwanted items enter the sewer system.
- 200 control boxes or manholes placed at every intersection and connection and the same to be maintained by the system operator.
- Simple sewage pipes from houses to the wastewater treatment plant, about 1,200 metres.
- A drainage system next to the DEWATS plant.
- An electric pump was installed to provide effluent discharge back-up during floods.



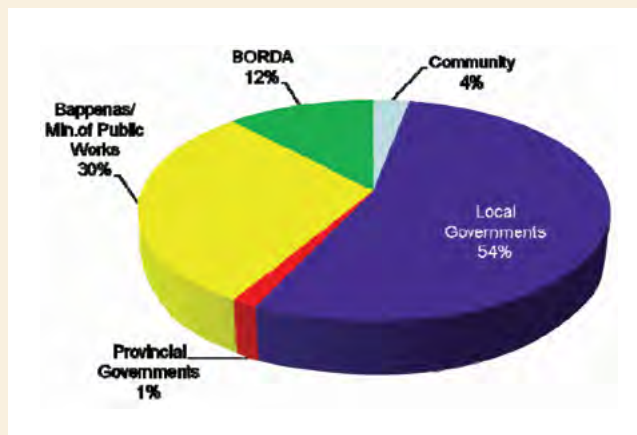
Layout and Construction of Simple Sewer System

3. FINANCIAL ASPECTS

The total cost of implementation, construction, and capacity building was about US\$39,814 (multisource financing). Of this, 76.86% was used for infrastructure and 23.14% for facilitation and capacity building. The project was supported by a multi-financing scheme, with contributions from:

- The Central Government through the **Ministry of Public Works**, Directorate of Environmental Health Development, in the form of in-kind materials
- **Denpasar Municipality's Environmental Agency**, in cash for construction and capacity building
- **BORDA**, in cash for construction and capacity building
- **Beneficiaries and the community** contributed in cash and kind. Their contribution was higher than expected, and excess construction fund was available which was utilized in the construction of concrete paths/ roads and in building dedicated washing spots.

The community agreed on a fee scheme to cover operation and maintenance costs in the long term and decided that all users would equally share the costs.



SANIMAS Multi-sources of Financing

to find an appropriate solution for the poor urban settlement's sanitation problems. The area was planned to be served by communal sanitation facilities and managed by the community or the users - SANIMAS (Sanitation by the community).

Project Description

Indonesia's Sanitation by the Community Program (Sanitasi oleh Masyarakat or SANIMAS) implemented a project to provide off-site sanitation services for 211 households with a population of about 840 people in Kusuma Bangsa neighbourhood. SANIMAS uses a community-based development approach to improve access of low-income urban households to sanitation services. The service infrastructure, as chosen by the community through the Community Action Plan process, was a simple sewage system. The problem was met with the following designed solutions:

- Creation of the SANIMAS Community-Based Organisation (CBO) to lead in the planning, construction and management of selected sanitation services in the community;
- Construction of a decentralized wastewater treatment plant (DEWATS) designed to treat approximately 60 cubic meters of wastewater daily; and
- Multi-source financing scheme to cover costs of construction and capacity building followed by a user fee scheme to finance operation and maintenance in the long term

Sustainability

The example of Kusuma Bangsa shows that the SANIMAS approach is financially, economically, socially and environmentally sustainable. The DEWATS plant, which can treat domestic wastewater to standards set by environmental agencies, requires only simple, low maintenance approaches and procedures.

Greater sustainability could be gained by developing a provincial government infrastructure and implementation fund to support local government funds and inviting more private sector involvement; operation and maintenance costs totally covered by user fees; setting up a team of community-based facilitators to work in communities other than their own; promoting a small-scale operation and maintenance provider where there are several SANIMAS projects in one city; setting a benchmark to measure the quality of services delivered by CBO committees; and making available other infrastructure such as de-sludging trucks and services, as well as a sludge treatment plant.

Key Results and Impacts

- High level of contributions from the community also resulted in solid waste collection service with the new sanitation service, improved pathways, and excess funds in the community account. Residents enjoy better health with reduced health expenses and a clean neighbourhood.
- The community's empowerment through increased awareness on health and hygiene issues gave them the confidence to lobby for initiatives to further improve the area.
- The project also preserves the quality of shallow groundwater.
- User fees are reasonable for the poor and cover all O&M costs.

Lessons Learnt

- Using a demand responsive approach to improve access to sanitation services helped in accelerating the process of project implementation because of broad stakeholder participation and access to multi-sources of financing.
- Selection criteria: The willingness to participate and pay and

land status for community-based sanitation infrastructure should be determined before communities are selected as project beneficiaries.

- To improve efficiency of financial management, the surplus funds should be allocated for additional small-scale infrastructure projects within communities.

Replicability

The case study illustrates how the provision of sustainable sanitation can be made to the unconnected communities, while at the same time empowering them by making them as stakeholders in the project. In India, there is a need to move away from the traditional top-down approach to a community led approach. The ward committees, area sabhas and resident welfare associations (RWAs) in Indian cities can be exploited as effective instruments

for engaging the communities in provision of sanitation services.

Projects in Indian cities such as Kalyani, Nanded and Tiruchirapalli have demonstrated that while community mobilization may be triggered by external stakeholders such as non profits or government, in order to ensure sustainability of sanitation solutions, a sense of ownership and responsibility among users is most crucial. The approach should involve communities in every phase of the project, be it planning and design, resource allocation, construction, administration and maintenance, and quality control of the services. The project can be financed using state and national government funding, donor organizations as well as funds from the community. If projects take into account the varied needs of the communities and involve them through the process, people will be committed to their success and long-term maintenance.

ORANGI PILOT PROJECT IN KARACHI, PAKISTAN

Location	Orangi, Karachi, Pakistan
Region	Asia
Year	1980
Agency	OPP-RTI, Karachi Metropolitan Council
Award	World Habitat Award, 2001

Project Aim

To develop a low-cost sanitation programme which enables low-income households to construct and maintain modern sanitation with their own funds and under their own management.

Context

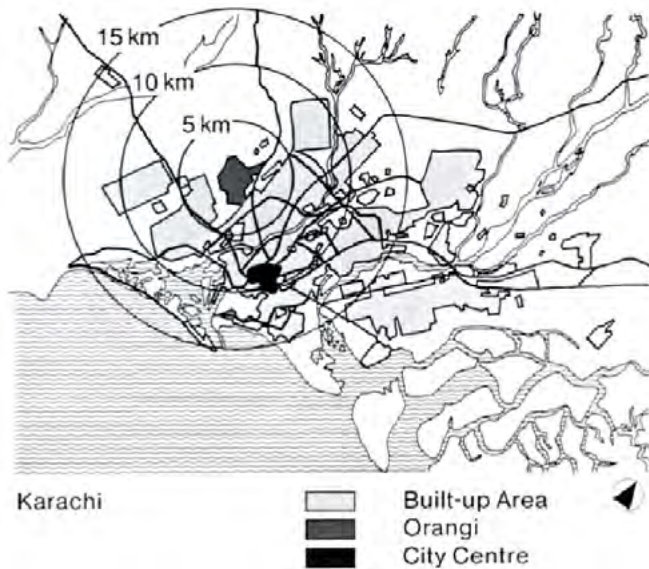
Orangi town, on the periphery of Karachi, is a massive katchi abadi covering an area of approximately 8000 acres with a population of 1.2 million in a cluster of 113 low-income settlements. The infrastructure of the city dated back to 1960s when government agencies or service providers only constructed roads, basic water supply systems, electricity lines, schools and hospitals. Until 1980s, most households had no access to sanitation facilities and used bucket latrines and soak pits for the disposal of human waste and open sewers for the disposal of wastewater, resulting in a high rate of water-borne diseases. Poor sanitation and waste disposal system further reduced property values. Although the residents were aware of the consequences of poor environmental sanitation, they had limited capacity to take any action to improve their quality of life.

The Orangi Pilot Project-Research and Training Institute (OPP-RTI) is a Non-Government Organisation (NGO) that was

NON-GOVERNMENT ORGANIZATION

Non-government organisations (NGOs) have long played a role in delivering sanitation services to communities in Southeast Asia and Pacific countries, particularly in rural areas. Their role in the sanitation sector ranges from community education to research and policy advocacy. They are known for being advocates of equitable, sustainable and cost-effective development and for playing a critical role as intermediaries, between communities and utilities or other service providers. NGOs have assisted in facilitating better access for the poor to sanitation services and typically offer on-the-ground impact in increasing access to services within relatively short timeframes through established community relationships. The Sulabh International Social Service Organisation founded by Dr. Bindeshwar Pathak in the year 1970 is one of the first Indian NGO that came up with the cost-effective concept of maintenance and construction of 'pay and use' public toilets, popularly known as Sulabh Complexes. Sulabh is also producing and using biogas from human excreta from its 118 plants which is again an innovation in the areas of non-conventional energy.

established in 1980 by the renowned social scientist Dr. Akhtar Hameed Khan. OPP-RTI initiated the community self-help programme to strengthen people's initiatives to provide water, sewage disposal, schools and clinics in Orangi town. Its strategy was to help local people achieve their own development needs rather than rely on external sources of aid.



Location of Orangi in Karachi

Project Description

The project is based on the idea of ‘social preparation’ – that before development work and physical infrastructure can be built especially in poor communities, there has to be a prerequisite phase of ‘social infrastructure building.’ This included from imparting basic education, identification and training of local leaders, to complex community consultation approaches, to setting up and maintaining actual social organisations. OPP’s role has been to support community initiatives for development, mobilize local resources and build partnership between people and government.

The sanitation system developed by the OPP used existing informal sewerage that followed the natural slope of the land through various natural drainage channels or *nalas*. With technical and managerial support from the OPP, local people built and financed sewers in 5,479 lanes containing 98,527 houses and supervised external development work. By April 2001 there had been 92,184 families in 6,134 lanes who were benefited by this project, representing almost 90% of the entire settlement. There have also been 409 collector sewers built, and collectively the community has invested Rs. 82.141 million in their sewerage system.

Project Implementation

The OPP’s Low Cost Sanitation Program was established to enable low income families to finance, manage and maintain two levels of a modern sanitation system:

- *Internal development* comprising of sanitary latrines inside the houses, underground sewerage lines in the lanes and secondary or collector sewers that connect to mains. These are financed, managed and maintained by the people.
- *External development* comprising trunk sewer or open drain development, and treatment plant. This remains the responsibility of the government.

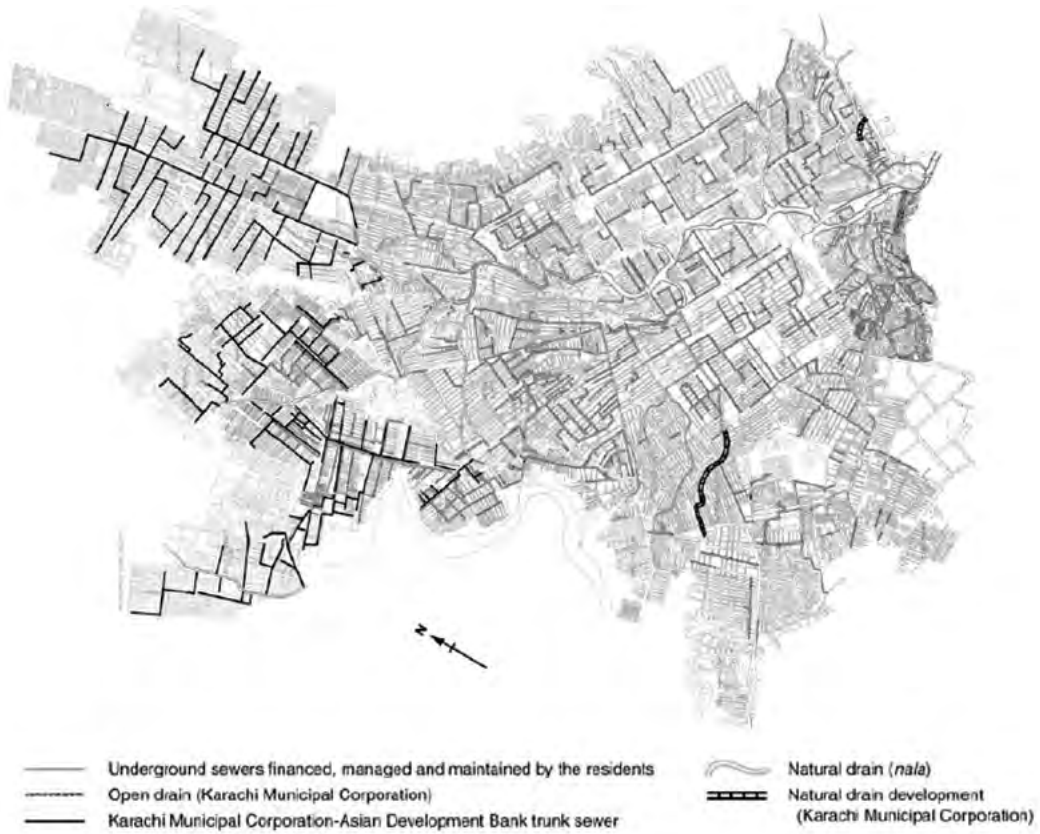


An Overview of Orangi

The Approach: The model that has evolved from the program is the component-sharing concept of development with people and government as partners. The application of the OPP’s Low Cost Sanitation Program had three aspects:

1. *Community organization and participation in the designing and management of the programme:* A lane consisting of 20 to 30 houses was made the unit of community organization. The OPP social organizers developed lane organizations, explaining the program to the people. Each lane then chose its own lane manager, who formally applied to the OPP for assistance. Active community members were also identified in each area, and were encouraged to arrange community meetings where slide shows reiterated the problems and demonstrated solutions.
2. *Appropriating and adapting technology to allow people to carry out the work with reduced costs:* A team of social organizers and technicians was set up to educate and assist the role-players in implementing the program. The technical assistance of the OPP-RTI consisted of providing communities with plans and maps, estimates of labour and materials, tools, training for carrying out the work, and supervision of work. The OPP-RTI’s research developed new construction standards, techniques and tools that are affordable by poor communities and are compatible with the concept of communities’ involvement in construction. Standard engineering designs and practices were scaled down and appropriate low-cost technical approaches like pipe laying, jointing and manhole casting were identified following action research into possible options, and these were shared with community and government partners. Where large main sewers were required, the OPP-RTI (OPP Research and Training Institute) supported government with its expertise in low cost designs, estimates and monitoring.
3. *Maximizing the use of local resources - personal savings and*

THE SEWERS IN ORANGI FINANCED, MANAGED AND MAINTAINED BY THE RESIDENTS



Community organization and participation



Lane surveys and map preparation



The lanes were transformed – situation before and after

initiative, manual and managerial skills, complementing and developing them with the provision of expert assistance: The process of mapping and documenting the existing water and sewage infrastructure played an important role in the project, and has supported the process by providing a powerful tool for advocacy and influencing larger-scale planning. A youth program trained community architects, technicians and surveyors to map the settlements and plan for the future, and this has promoted the component-sharing model whilst developing valuable skills amongst the youth.

Financial aspects: The system was created and paid for by the local community. The residents of Orangi laid 1.3 million feet of sewer line and invested about US\$700,000 in the low-cost sanitation program. If the state had done this, it would have cost over US\$10 million. The project demonstrated that foreign aid was not required due to the availability of local human and financial resources, and this has influenced planning at the city level. The Average cost of sewerage system laid down through community amounted to approximately US\$13 per household. Over 105,670 poor households invested Rs118.7 million (approximately US\$1.2 million) in secondary, lane sewers and sanitary latrines, and government invested Rs807.2 million (approximately US\$8.2 million) on main disposals. The project helps micro enterprises to access credit whilst partnering with government on complementary large-scale investments.

Key Results and Impacts

- The OPP-RTI's Low Cost Sanitation Program extended to service the complete Orangi town, resulting in significant health and environmental improvements in the neighbourhoods it has affected. Infant mortality rate fell from 130 per thousand live births in 1982 to 37 per thousand in 1991.
- Mobility improved within the community both for goods and human traffic, boosting home-based enterprises and small scale trading.
- The availability of cleaner and extended space in front of houses had a significant social and recreational impact as well.
- The model has been replicated by 421 other settlements in Karachi, along with 32 cities/towns and 93 villages covering a population of more than 2 million. The programme proved

so successful that it was adopted by the communities across developing countries.

- OPP-RTI is now the Karachi City Government's team member for developing the city's main sewage disposal and drainage channels. In addition, the National Sanitation Policy of the country now includes OPP-RTI's model of component sharing to be adopted nationwide.

Lessons Learnt

- Communities have the skills, finances and managerial capacity to help themselves, but they need social and technical guidance to put them to proper use.
- A smaller level of organization is better, due to the concentration, time and effort required during the initial stages of a project. This improves understanding and reduces the possibility of conflicts and errors.
- Interaction with communities is needed to understand the extent of problems, how people perceive them and what possible solutions they have tried or would suggest. This interaction in itself starts a process of mutual understanding between the support organisation and the community.

Replicability

The project is an inspiring example of how small scale community-driven interventions, in this case at the level of the lane, can be connected to large government projects to meet the challenges of service extension to the urban poor in a collaborative manner. In India, such NGOs as at Orangi can play a vital role in the provision of sanitation services by mobilizing communities, raising awareness and working with poor and un-served communities to assist them in finding affordable, community-managed solutions to sanitation. NGOs can be instrumental in taking forward research and development of technological options, piloting and implementing sanitation solutions and models for marginalized urban communities. In India, NGOs can partner with the ULBs and participate in the City Sanitation Task Force that implements the City Sanitation Plan and also assist in monitoring and evaluating ULB performance in service delivery. While there is a need and role for NGOs in delivering urban slum sanitation in India, there are few non profits operating in the sector. This is in contrast to rural sanitation, where a much larger number of social organizations have flourished.

WASTEWATER RECYCLING PROJECT, DURBAN, SOUTH AFRICA

Location	Durban, eThekweni Municipality, South Africa
Region	Africa
Year	2001
Agency	eThekweni Metropolitan Municipality and Durban Water recycling company
Award	South African Institution of Civil Engineering Award (2001) and South African Association of Consulting Engineers Award (2001)

Project Aim

To treat domestic and industrial wastewater (approximately 10% of the city's wastewater) to a measure near to potable standards, and sell the same for industrial use.

Context

Durban is part of the eThekweni Municipality, located on the east coast of South Africa. The combination of limited water resources in the city along with sewage capacity constraints, led to the investigation of different wastewater recycling processes since the region produces approximately 450 million litres of wastewater per day. The Council's eThekweni Water Services (EWS) researched the viability of the recycling of treated wastewater. Following laboratory and pilot scale tests on the development of a reclamation process for the production of high quality reclaimed water, it was decided that this was a possible alternative to tackle the water scarcity existing in the area.

Project Description

The project, commissioned in May 2001 was South Africa's first



Durban Wastewater Recycling Plant

PRIVATE SECTOR PARTICIPATION

Private sector participation or Public Private Partnerships (PPPs) are partnerships between the public and the private sector for the purpose of designing, planning, financing, constructing and/or operating sanitation projects, which would be regarded traditionally as falling within the remit of the public sector. Through PPP, the public sector can leverage the private sectors' technical and managerial expertise and financial support. PPPs first emerged in the United States in the late 1970s and early 1980s in response to the poor performance of the public sector, and the view that the State had reached its financial limits as far as the provision of public services were concerned.

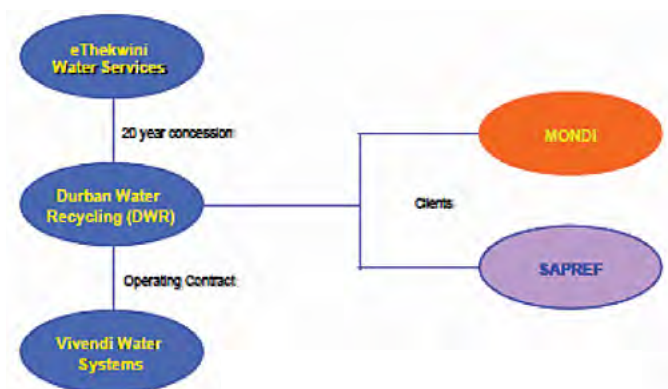
The Government of India (GoI) and the Ministry of Urban Development (MoUD) have instituted several reforms and arrangements to encourage PPPs. GoI have formulated PPP guidelines on Urban Infrastructure, particularly water supply and sanitation which was circulated to states in 2004. Some of the first successful examples of PPP projects in sanitation in India are the, Tirupur water supply and sewerage project (1994) and the Alandur Underground Sewerage Scheme (1996). The Tirupur project other than water supply also included construction of a sewerage system for the Municipality and onsite sanitation facilities for slums within the Municipality while Alandur project represents an effective institutional and financial approach towards the implementation of sustainable sewerage services in India.

private wastewater recycling project to treat about 48 million litres of domestic and industrial wastewater, operating on a 20-year BOT (Build-Operate-Transfer) basis. It provides a good example of Public Private Partnership (PPP), where appropriate wastewater treatment technology was used in order to provide effluent of a particular standard for industries. This enabled potable water to be freed and directed towards previously unserved households and at the same time allowed for key industries to reduce their costs by purchasing reclaimed water rather than previously supplied drinking water.

The project demonstrates innovative approaches to the sustainable development of water resources, minimisation of water consumption and environmental pollution loading and the achievement of technically challenging water and wastewater treatment goals.

Project Implementation

The construction of a *secondary waste water treatment plant* and a



Contractual Arrangement

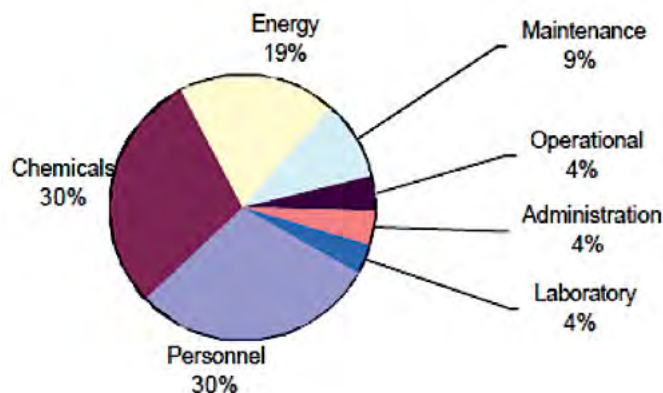
recycling plant was aimed at treating wastewater and supplying the treated effluent to the industries. Mondi Paper located adjacent to the Southern Wastewater Treatment Works (SWTW) was the main customer for reclaimed water, along with Sapref's fuel refinery as a second client. Construction was finished ahead of schedule and the plant began wet commissioning in April 2001. Full water production began in May 2001.

Institutional and Management Arrangements: The project was based on a PPP arrangement, considering the costs, technical complexity and risks associated with the project. Thereafter, following a formal tender process, *Durban Water Recycling (Pty) Ltd.*, was awarded a 20-year concession contract for the production of high quality reclaimed water. Technology and processes are managed by *Vivendi Water Systems (VWS)*, which makes sure that the installations are highly specialised and tailored specifically to meet the water quality requirements of Durban Water Recycling primary clients.

Preliminary and primary wastewater treatment processes were performed by *eThekweni Water Services (EWS)*, while the effluent from the primary settlement tank, which is fed into the activated sludge plant, is operated by VWS. At the end of the contracted 20-year period, the facilities will be handed over to the municipality.

Technology Option: Construction on the tertiary plant started in 2000. In order to provide the service, the existing activated sludge process was upgraded from 50 to 77ml/day, a new tertiary plant was built, the SWTW high level storage tank was refurbished and finally the reclaimed water reticulation system was installed. For the activated sludge process, a conventional design was used removing 95% of the incoming calculated oxygen demand (COD) and 98% of incoming ammonia loads. The tertiary plant on the other hand focused on the removal of iron through lamella settlers. Lastly, dual media filtration was used to remove the iron precipitate as well as ozonation in order to break down the remaining non-biodegradable organic compounds.

Operational Control: Water treatment process control is achieved primarily by on line monitoring with automated control actions. A SCADA system is used to co-ordinate the operation of the plant, with aspects such as chemical dosing and filter back-washing being fully automated. In support of the on-line systems



Breakup of Operating Costs

water samples are taken hourly and analysed for process control and monitoring purposes.

Financing Arrangements: *Capital Investment:* The Development Bank of Southern Africa (DBSA), Rand Merchant Bank, Societe General and Natixis Bank (two French banks) financed the capital investment, which ensured all initial capital expenditure was covered. The cost of further upgrading, including new technology investments and its attendant risks, was covered by VWS under their BOT concession. In addition to this, the company pays the municipality for wastewater as well as renting the land where construction has taken place. With 51% of shareholding, VWS is the main stakeholder in this project. In exchange for the service, the only two clients who make use of this reclaimed pay a standard price/m³ for water.

Cost Recovery: The cost recovery policy was applied through monthly payments by the users. Mondi Paper, through its commitment of using recycled water in its entire paper production, gave the project an assurance of having a secured client for its end product. The project also covers various industries, thus, increasing the profitability of the initiative.

Key Results and Impacts

- **Sustainable Development of Water Resources:** At operational capacity, the reclamation plant meets approx. 7% of city's current potable water demand, and at the same time, reduces the city's treated wastewater output by 10%, thus, minimizing the wastewater discharged into the marine environment. The potable water that was previously drawn by industrial consumers is available for redistribution to previously disadvantaged, peri-urban communities without the need to invest in major bulk water supply and treatment infrastructure. South Africa is a water stressed nation and the project contributes significantly to the preservation of natural water resources.
- **Environmental Pollution Load Minimisation:** EWS treats 470 ML/d of wastewater. Of this volume, approximately 200 ML/d is discharged to sea as screened wastewater. The reclamation project reduces the partially treated load on the marine environment by up to 24%.
- This new perspective is advantageous not only to the

community, who enjoys a more stable supply of drinking water, but also to the reclaimed water clients, who are able to satisfy their production requirements with the treated wastewater for a lower price.

- The project also changes the wastewater industry in South Africa. Sewage can no longer be regarded simply as a waste product, but must now be viewed as a potential resource with significant inherent value. The technology is available to unlock this potential.
- The project is regarded as a model for this type of approach to water resource management in South Africa as well as the continent as a whole. The City of Windhoek in Namibia has taken the same step.

Lessons Learnt

- The Durban Water Recycling Project demonstrates that innovative approaches to water resource management, en-

vironmental management, wastewater treatment technology and institutional arrangements can yield exceptional results. The success of the project is based on innovation and thinking beyond the traditional approaches.

- The project demonstrates a true partnership between the public and private sectors and the success of the partnership lies in the mobilisation of the inherent strengths of both sectors.

Replicability

In order for the model to be replicated in Indian cities, the partnership contract between the public and private entity must clearly define the relationship between the stakeholders and their respective roles and responsibilities. Such projects need to be made financially viable. Investments may be invited from a number of sources including public money, various commercial interests, financial institutions and international funding agencies.

THEME 5

PRO-POOR SANITATION STRATEGY

Sanitation remains a major challenge in many developing countries particularly in the unplanned or informal settlements that are inhabited by more than half of the urban population rendering a substandard quality of life. Such settlements lack access to basic infrastructure facilities and services like water supply and sanitation resulting in degraded environment and living conditions and pose a serious public health concern. The low sanitation coverage is directly related to poverty, and, in many cases, to the inability of governments to finance satisfactory sanitation systems. In this context, the national government is obliged to ensure access to basic sanitation equitably and without discrimination.

Although much has been done by the government for providing sanitation services to the urban poor through various programmes, the overall impact has been insufficient. At the broadest level, the urban poor cannot access adequate sanitation services because existing incentives, institutions, and financing do not promote and support increased pro-poor service delivery. Unless there is a strong support for appropriate, pro-poor system design and administration, slum communities will be ignored in favor of “legal” areas where residents are better able to pay for water and sewer services.

KAMPALA SANITATION PROGRAM, UGANDA

Location	Kampala, Uganda
Region	Africa
Year	2010
Agency	National Water and Sewerage Corporation (NWSC) and Kampala City Council (KCC)
Award	African Development Bank

Project Aim

To improve the health and living standards of the urban poor residents in informal settlements in Kampala through improved management of sludge from domestic sanitation facilities and provision of hygiene education. The project also aims to improve environmental sustainability of the Lake Victoria basin through reduction of pollution entering the lake through the Nakivubo channel.

Context

Increased urbanization and industrialization in Uganda, especially in Kampala, led to an increase in the city's population and development of informal settlements. The population doubled during the day due to the influx of the labour force that worked within the city but resided in the neighbouring districts of Wakiso, Mpigi and Mukono. Between 40 and 70% of the resident population lived in over 20 informal and un-served settlements scattered within the city. The capacity of the municipal authorities to provide basic services to meet the needs of the increasing



COMPREHENSIVE PROGRAM FOR INFORMAL AREAS

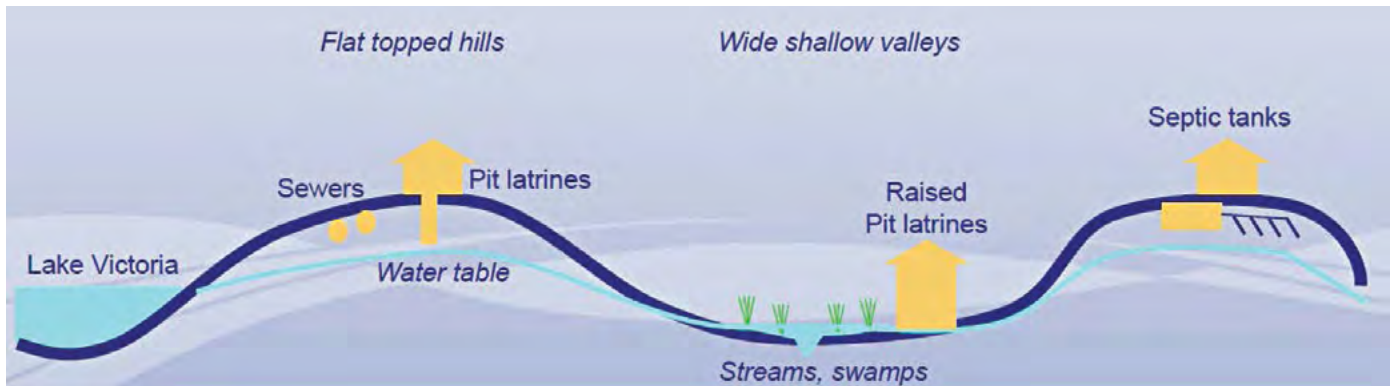
Pro-poor water and sewer systems require that local governments focus on enabling service delivery to slum areas and implement citywide cost recovery strategies. Experience in Ahmedabad, India, and elsewhere shows that the poor can and will pay for better water and sewer service, but they often cannot pay the full cost of operating and maintenance. As a practical matter, pro-poor water and sewer planning often means some level of cross-subsidy from rates charged in middle- and upper-income areas to cover costs that cannot be recovered from slum areas. Through local governments, water and sewer services can be coordinated with more comprehensive strategies for slum upgrading. Experience from the African Development Bank and the World Bank's Water and Sewer Program suggests six key lessons for pro-poor planning: 1) Engage the poor from the very start; 2) Improve on what currently works for the poor; 3) Support community-level investment and community management; 4) Make pro-poor services financially sustainable and affordable; 5) Establish pro-poor incentives for service providers to "scale up" access and 6) Address the technical, administrative, and institutional constraints.

population was limited. In Kampala, efforts to improve water supply yielded some results while sanitation services lagged behind. The sewerage network covered only about 7.3% of the population, mainly in the Central Business District and the affluent areas. 92.7%, mainly the urban poor population relied on various forms of on-site sanitation: pit latrines and septic tanks. The effluent was discharged untreated into the Nakivubo channel and ultimately into the Inner Murchison Bay of Lake Victoria, the source of abstraction for the drinking water supply of Kampala.

The impact of poor sanitation facilities coupled with the lack of hygiene knowledge and practices could be seen in the high incidence of sanitation related diseases, especially in the low income settlements. This indicated the need for urgent improvement to match socio-economic and environmental needs of the people.

Project Description

Extension of clean safe water and good sanitation to un-served areas is a key priority in Uganda's drive to improve the quality of life and alleviate poverty. The national goal for Urban Water Supply and Sanitation (UWSS) is: "To achieve sustainable safe water supply and sanitation facilities, based on management responsibility and ownership by the users, within easy reach of 100% of the urban population with effective use and functionality of the facilities" by 2015. The national coverage target for sanitation is that every household should have access to a sanitation



Topography influenced the sanitation options. The poor often lived in the valley bottoms where high water table restricted sanitation options and was also prone to surface flooding

facility, which at the minimum “contains” /seals the faecal matter to protect humans against health problems and provide privacy. There should be access to and use of hand-washing facilities.

A comprehensive program incorporating sewer network expansion, complemented by improved collection of sludge from pit latrines and septic tanks and sewage treatment was made targeting the informal and unplanned areas of Kampala. The project was intended to address the following issues:

- (i) Establish sanitation services tailored to the needs of the urban poor in the low-income community, with a special focus on excreta management at both household and communal levels. Ecological Sanitation, a concept where the nutrients in human excreta are sanitized and safely reused as biological fertilizer would be promoted.
- (ii) Strengthening the Urban Pro-Poor Unit (UPPU) charged with developing pro-poor infrastructure and operational mechanisms.

Key Results and Impacts

- Reduction in morbidity and mortality caused by sanitation related illnesses among the urban poor population, increased income levels through reduction in medical expenditure contributing to Uganda’s achievement of the related MDGs.

- Improved quality of effluent of Nakivubo channel resulted in improved quality of raw waters at the Inner Murchison Bay; increase in the efficiency of the water treatment processes and reduction in chemicals used reduced the O&M costs of the NWSC, improving financial viability of the utility and availed funds for expansion and improvement works on the network.
- Reduction in distance and time spent to safe water and improved sanitation points.

Lessons Learnt

- Community preferences need to be considered for providing sanitation solutions to ensure environmental sustainability.
- There may be lack of enforcement of existing planning and sanitation regulations due to lack of resources and political interference.

Replicability

Providing adequate water and sanitation services is one of the most critical challenges faced by cities in the developing world. As rapid urbanization continues, local governments face growing challenges to absorb and provide basic services especially to rural immigrants, informal settlements, slum communities etc. The urban poor often cannot access adequate services because

Project Implementation

1. INSTITUTIONAL FRAMEWORK

Service Provider and the Executing Agency: *National Water and Sewerage Corporation (NWSC)* is responsible for providing piped water and transportation of sewage and its treatment in the City. NWSC is also mandated to monitor and control the discharge of industrial and commercial wastes connected to sewer systems. It is also responsible for the treatment of septage originating from septic tanks. A unit within the NWSC, the Urban Pro-Poor Unit (UPPU) is solely responsible for all efforts towards supply of water and sanitation in the informal settlements. The NWSC is the grant recipient and implementing agency of the project.

Kampala City Council (KCC), responsible for storm water drainage, solid waste management through the City Engineer’s department, and public health and on-site sanitation through the health department would be an active beneficiary and would collaborate throughout the project with respect to designs, approvals, private sector participation and enforcement.

2. PLANNING

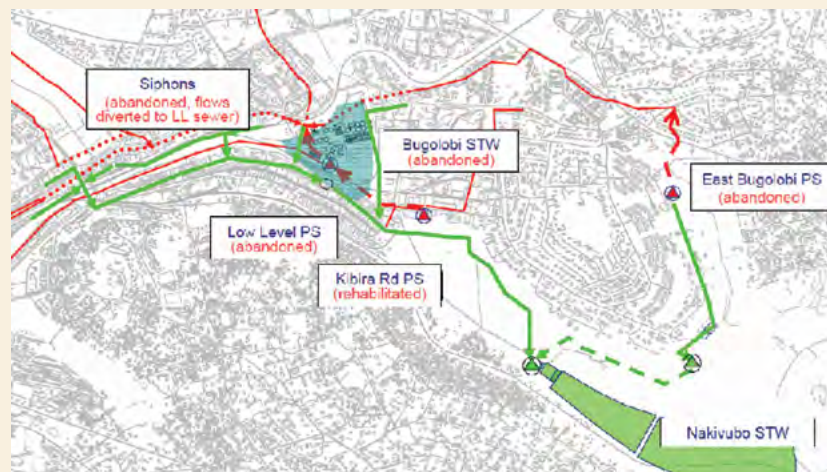
The activities planned under this project will improve the sanitation condition of Kampala through collection of sewage generated in the densely populated parts of the city and subsequent treatment of the sewage to recommended standards for effluent discharge. The activities included:

- *Extension of pipelines, improvement and re-dimensioning of secondary and tertiary sewers* to increase capacities for the next 20 years.
- *Construction of Nakivubo Sewage Treatment Works:* This involved abandoning the existing Bugolobi STP and construction of a new sewage treatment works located in the upper section of the Nakivubo Swamp. The existing East Bugolobi pumping station to be phased out and flows transferred to the proposed Nakivubo STW via a new East Bugolobi PS. New trunk sewers pumping stations to increase collection of sewage in Nakivubo catchment from 30% to 100%. Construction of NSTW and the new pumping station at East Bugolobi to result in a change of operation of the network.
- *Land compensation at Nakivubo STW site:* Land requirements for the proposed NSTW will have to be determined, and the land duly compensated for.
- *Generation of Power Using Biogas from the STW:* In a bid to improve efficiency of plant utilization, and to reduce the energy costs of running the plant and/or any of the NWSC installations, NWSC intends to generate power using a combination of methane gas produced during the sewage treatment process and solar energy.

Phasing of project: The project activities were implemented in 3 phases namely the study (detailed design and tender documentation) phase, the construction phase and the post construction phase.

The study phase included - (i) Community mobilization and sensitization for participation in the project including identification of sanitation facilities to be constructed (and locations) and involvement and commitment of landlords; (ii) Community mobilization for hygiene education; and (iii) Increasing institutional and management capacity through sensitization of staff, and preparation of a Private Sector engagement framework.

The construction phase included - (i) Installation of Communal Ablution Facilities and support for construction of at least 50% ecosan toilets and household on-site sanitation facilities; and (ii) Mobilization and facilitation of the private sector/ civil society to ensure efficient management and operation support for the sanitation facilities.



Construction of Nakivubo Sewage Treatment Works



Wetlands provide tertiary treatment

3. FINANCIAL ASPECTS

Project Funding: NWSC seeks funding from African Water Facility (AWF) for the establishment of sustainable water supply and sanitation services tailored to the needs of the urban poor in the low-income communities of the informal settlements of Kampala City. The Government of Uganda would pay all taxes incurred on the project while NWSC would meet all costs related to its staff during project implementation and guarantee O&M for all components after completion of the project.

Before



Poor quality of toilets



Interaction of on-site sanitation, surface water drainage and springs resulted in pollution of surface and ground water



Manual pit emptying: unsafe and unhygienic

After



Improved construction of toilets



New Ecosan toilet: no emptying service in place



Vacutug: improved technology for mechanical pit emptying

existing incentives, institutions and financing do not promote and support increased pro-poor service delivery. In Indian context, local place-based solutions would work by supporting small sewer and water providers (SSWPs) and integrating them with the formal sewer and water providers (FSWPs) at the local level. For the successful implementation of sanitation program

in such areas it is important that the local government works in partnership with non-governmental organizations (NGOs) or private entities to deliver these critical services. Also, strategies to provide pro-poor water and sanitation services should not be conditioned on the granting or determination of legal land tenure for slum dwellers.

'IKOTOILETS' – SUSTAINABLE SANITATION IN NAIROBI, KENYA

Location	Nairobi, Kenya
Region	Sub-Saharan Africa
Year	2006
Agency	Ecotact and Nairobi City Council (NCC)
Award	UN Habitat Award, the Ashoka Recognition (2007) and the Clinton Global Initiative (2009)

Project Aim

To provide adequate, convenient and sustainable sanitation services to the Bottom-of-the-Pyramid customers and also to revolutionize people's perceptions towards toilets making.

Context

Kenya has experienced a rapid population increase since 1950 from 6 to 40 million in 2011. In Nairobi, 65% of the urban population resides in slums, occupying barely 5% of the city's residential land. This reflects the added pressure on already scarce resources, especially those regarding basic services. The government had not invested in public sanitation facilities in Nairobi for over 30 years, and as a result, whatever facilities existed, were characterized by overcrowding and poor maintenance with inaccessible and unhygienic conditions. In the absence of better alternatives, open defecation was a prominent practice, particularly among the slum residents. Since waste collection services were lacking in the area, land and water contamination posed a hazard to public health. Therefore, there was a need of providing sustainable sanitation services to urban centres particularly to poor communities.

Ecotact, a Nairobi-based social enterprise founded in 2006 by Mr. David Kuria, an architect and city planner, came up with an innovative solution to the growing environmental sanitation problems by conceptualising and designing the 'Ikotoilet', a multi-functional pay-for-use public toilet.

Project Description

The term 'Ikotoilet' is derived from ecological sanitation, with 'iko' meaning 'existing' in Swahili. Ikotoilet was launched in 2008 by Ecotact as a community hub of stores and services built around a public toilet complex such that people can use the facilities, as well as buy products and services available. Ikotoilet has been described as a 'toilet mall' as the initiative extends from offering sanitation services to a range of complimentary business services, such as advertising, kiosks for food stalls, phone and newspaper stands, shoe shining or barber shops, etc. These toilets were built in Nairobi's urban centers as well as in the slums using a cross-subsidy model. Contrary to local tradition, Ikotoilets were placed centrally, in order to also serve as meeting places.

During the first month of operation, there was a turnover of

COMMUNITY TOILETS

Community toilets are the public sanitation facilities that are provided to meet the basic sanitation needs of densely populated low income settlements in the urban and semi-urban areas. Community toilets provide viable solution when provision of toilet at each household level is not possible either due to lack of space for construction or the inability of households to bear the capital costs or both. Municipalities either construct and maintain public toilets or issue open tenders for their construction and maintenance. However, innovation has been in the use of community-designed, implemented and managed toilet blocks that were previously built by contractors. Community management ensured that they could be managed through user charges.

In India, the city government in Pune, worked out a partnership between the municipality, NGO and Community Based Organizations (CBOs), and built more than 400 community toilet blocks between 1999 and 2001, greatly improving sanitation for more than half a million people. It also demonstrated the potential of municipal-community partnerships to improve conditions for low income groups. The Tiruchirapalli model, which won the National Urban Water Award in 2010, attempted to involve self help groups (SHGs) operating and maintaining community toilets. The success of this model has been attributed to its emphasis on multi-stakeholder involvement and its community ownership of the asset. There is a combination of public toilets, provided in commercial areas, and communal toilets used by slum communities. Similar models have been adopted by various cities across India. Community organizations formed by the urban poor have tried community-managed toilet blocks in Kenya, Uganda, Namibia, Zimbabwe, South Africa and Sri Lanka. These represent a pragmatic, locally driven approach that greatly improves provision for large number of poor households, drawing on existing resources.

approximately 200 families registering and using the Ikotoilet. Each of these serves an average of 1,000 persons per day. In 2010, Ecotact launched the Ikotoilet for Schools project, financed by the government, with the vision of building 1000 such toilets in schools by 2020. These were built with bio-digesters designed to convert waste to energy, producing biogas for cooking meals or electricity for lighting.

Key Results and Impacts

- The success of Ikotoilet concept stimulated a demand for

Project Implementation

1. INSTITUTIONAL FRAMEWORK

- Ikotoilets were developed using the build-operate-transfer (BOT) model of public-private partnership (PPP), whereby **Ecotact** entered into agreement with **Nairobi City Council** through which it borne the cost of constructing the facility on municipal land and further is granted the right to run the facilities on a commercial basis for a period of 5 years to ensure recovery of the investment. The facilities would eventually be turned over at no cost to the municipal council to either run on their own account or lease them out.
- **Nairobi City Council** provided land for constructing these facilities.
- In order to operate these facilities, a **Water and Sanitation (WATSAN) Committee** was developed involving several sectors of the population - elders, provincial administration, women and youth groups. The role of this committee was to verify proposed sites for Ikotoilet construction; to oversee community contracting; to identify skilled youth in all areas of contraction and to ensure the safety of building materials. Ecotact's role in the formation of this committee was to assess leadership skills and advice on the structure to ensure that there is equal representation as well as appropriate skills within the committee to carry out the responsibilities.
- WATSAN committee appointed youth workers who with the help of **private companies - Community Cleaning Services Ltd (CCS) and SC Johnson**, were trained on hygiene and safety. These employees were in charge of cleaning the toilet facilities.

In order to keep accounts in place, Ecotact supports management staff training on book keeping, basic entries such as income statements as well as maintenance and operation bank accounts. Sustainability of Ikotoilets is enhanced through youth training programmes that provide sufficient management skills to prepare them to eventually run these facilities as entrepreneurs.

2. PLANNING

Design: Ikotoilet concept was conceived to harmonize with the landscape and be a 'miniature mall' built to a standard design. It is a complete toilet facility consisting of 8 shower/toilet combination stalls, divided evenly among male and female units, with an additional 4 urinals in the male units. Two cleaners are housed outside each facility to maintain hygiene standards.

Technology Options: The Ikotoilet model has integrated several environmental technologies and innovative conservation applications including -

- A complete 'Dry-Toilet System': Water saving innovations includes the use of waterless urinals, low-flush cisterns and water-saving taps,
- Several techniques are used for the recycling of waste material: biogas from waste degradation (Bio-digestion system), urea fertiliser from urine, and compost from sludge,
- Water recycling: Rainwater is collected and stored in tanks to be used as alternative water supply, and
- Water purification systems with UV and filter techniques. A water vending point guarantees clean potable water to residents.



An Ikotoilet in Nairobi's Urban Growth Centers as a multi-use Community Center - a 'toilet mall'



Ikotoilet Urine Collection System, City Park, Nairobi

3. FINANCIAL ASPECTS

Capital Investment: An Ikotoilet costs US\$25,000 to construct using masonry and factory built concrete fibre. The capital cost for this project was funded by Ecotact with the support of several international institutions, including:

- **Acumen Fund:** It is a non-profit global venture fund that uses entrepreneurial approaches to solve the problems of global poverty. Acumen Fund has had significant success investing in small scale businesses that impact positively on the poor.
- **Global Water Challenge (GWC):** It is a coalition of multiple organizations including United Nations Foundation, Ashoka, and UNICEF etc. and aims to accelerate access to safe drinking water and sanitation for the most vulnerable communities. GWC engages in advocacy with the government and donor agencies on behalf of Ecotact.
- **The World Bank:** Funding from the World Bank has enabled replication of the Ikotoilets as well as construction of sanitation blocks within slums and informal settlements.

Most of the external funding is in the form of 'patient funds' that would be repaid as the business grows.

Capital Recovery: The cost recovery policy applied for O&M was a user fee of KES 5 (~US\$0.07) per use of the toilets and KES 20 (~US\$0.29) per use of the showers, complemented with advertising revenues from clients using the Ikotoilets premises for publicity, and from the rent derived from leasing out space to micro-entrepreneurs.

clean public toilets across East Africa with future expansion in Tanzania and Uganda in 2011. By the end of 2010, 29 such units were installed across 12 municipalities in Kenya, inclusive of 2 Ikotoilets in the slums of Mathare and Kawangare, which served more than 5 million users in 2010.

- **Social:** A new standard of hygiene in targeted communities had been achieved, reducing environmental health risks and exposure to waterborne diseases, and restoring dignity by the provision of sanitation services among urban poor.
- **Environmental:** Apart from ensuring a cleaner environment and facilitating green technologies in sanitation, Ikotoilets contributed greatly to positive changes in informal settlements. The project improved the urban landscape for low-income communities.
- **Economical:** Operation and maintenance of Ikotoilets gave employment opportunities to a number of youth groups; this was further enhanced by micro-businesses set up in the same toilet complexes offering other services.

Lessons Learnt

- From hidden to monumental toilets: A crucial lesson to be

learned is the cultural transformation achieved in Kenya through Ikotoilets. People's perception was transformed through awareness and education programmes to the extent that now, sanitation facilities are regarded as a sign of esteem and status.

Replicability

The concept of 'Ikotoilet' can work in India as a long-term creative collaboration between urban communities, city authorities, and business communities in which sanitation needs of the many are turned into returns for private investors and income for the management committees' members. The project would provide usage of toilet at an affordable price while also educate and raise public awareness about sanitation as well as enable and support local entrepreneurship and employment especially among women of poor communities. As the facility is supported by additional sources of revenue (selling of newspapers, advertising etc.), it is financially sustainable. However, social acceptance is the key to any sanitation product's success and the driving force to improve sanitation must come from within the communities.

ANNEXURE

CONTACT DETAILS OF IMPLEMENTING AGENCIES FOR THE CASE STUDIES

Location	Source of Information	Agency's Contact
Theme 1: SANITATION POLICY REFORM		
Port Louis, Mauritius	<ul style="list-style-type: none"> • http://wastewaterinfo.asia/sites/default/files/project-briefs/environmental-sanitation-project-mauritius.pdf (accessed in September 2014) 	Wastewater Management Authority The Celicourt Sir Celicourt Antelme Street Port Louis Tel: (230) 206-3000 Email: wma@intnet.mu Website: http://wma.gov.mu
Theme 2: WASTE WATER TREATMENT, RECLAMATION AND REUSE		
Denmark	<ul style="list-style-type: none"> • "The Pyramid - Ecological Urban Renewal in Kolding/DK" By Jens Holck-Christiansen, Regional Manager, Byfornyelse Danmark • http://en.wikipedia.org/wiki/Sustainable_implant (accessed in September 2014) 	Ministry of Housing and Urban Affairs Email: mbbl@mbbl.dk Website: http://www.mbbl.dk/
Singapore	<ul style="list-style-type: none"> • http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Singapore (accessed in September 2014) • "Sustainable Urban Sanitation - The Singapore Experience" by Wah Yuen Long, Director, Water Reclamation (Plants) Department, Public Utilities Board Singapore 	Public Utilities Board PUB Headquarters 40 Scotts Road #22-01 Environment Building Singapore 228231 Tel: (65) 62358888 Website: http://www.pub.gov.sg/
Udonthani, Thailand	<ul style="list-style-type: none"> • http://www.delgosea.eu/cms/layout/set/print/Best-Practices/Thematic-Area-3-Inclusive-Urban-Public-Services/10-Constructed-Wetland-for-Municipal-Wastewater-Treatment (accessed in September 2014) 	Udonthani Municipality en.wikipedia.org/wiki/Udon_Thani
Theme 3: GENERATING VALUE FROM WASTE		
Naivasha, Kenya	<ul style="list-style-type: none"> • http://www.sswm.info/library/1242 (accessed in September 2014) • http://wastewaterinfo.asia/sites/default/files/project-briefs/toilet-biogas-plant-kenya.pdf (accessed in September 2014) 	Lake Victoria South Water Services Board Lavictors House, Off Ring road Milimani, P.O. BOX 3325-40100, Kisumu, Kenya Tel: (+254) 057-2025128 E-mail: info@lvswaterboard.go.ke Website: http://www.lvswaterboard.go.ke/
San Fernando, Philippines	<ul style="list-style-type: none"> • http://repository.kulib.kyoto-u.ac.jp/dspace/bitstream/2433/108248/1/SANSAI3_37.pdf (accessed in September 2014) 	San Fernando City Corporation City Hall, Harris Promenade San Fernando Email: sfcc@tsstt.net.tt or sfcc.ceo@gmail.com

Location	Source of Information	Agency's Contact
Theme 4: PARTNERSHIPS FOR SANITATION		
Denpasar, Indonesia	<ul style="list-style-type: none"> • http://www.unescap.org/resources/sanitation-community-denpasar-indonesia-sanimas (accessed in September 2014) • http://www.waterforum.jp/eng/iys/agenda/doc/session2/04_Ms.Yyunismawati.pdf (accessed in September 2014) • http://wastewaterinfo.asia/sites/default/files/project-briefs/community-based-sanitation-indonesia.pdf (accessed in September 2014) 	BALIFOKUS Mandalawangi No.5 Jalan Tukad Tegal Wangi, Sesetan Denpasar 80223 - Bali Indonesia Tel: +62-361-233 520 Email: balifokus@balifokus.asia Website: http://www.balifokus.asia
Karachi	<ul style="list-style-type: none"> • http://www.oppinstitutions.org/ (accessed in September 2014) • http://en.wikipedia.org/wiki/Orangi_Pilot_Project (accessed in September 2014) • http://www.communityplanning.net/JohnTurnerArchive/pdfs/BCcases10.pdf (accessed in September 2014) 	Orangi Pilot Project Research and Training Institute (OPP-RTI) Plot no. St-4, Sector 5/A, Qasba Colony, Manghopir Road, Karachi-75800 Tel: (92-21) 38294679 Email: opprti.ngo@gmail.com Website: http://www.oppinstitutions.org/
Durban, South Africa	<ul style="list-style-type: none"> • http://www.ewisa.co.za/literature/files/066%20paper.pdf (accessed in September 2014) 	eThekweni Municipality Email: sizakala@durban.gov.za Website: http://www.durban.gov.za/
Theme 5: PRO-POOR SANITATION STRATEGY		
Kampala, Uganda	<ul style="list-style-type: none"> • http://www.afdb.org/en/projects-and-operations/project-portfolio/project/p-ug-e00-008/ (accessed in September 2014) • http://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/ADF-BD-IF-2008-144-EN-UGANDA-ESIA-KAMPALA-SANITATION-PROGRAMME.PDF (accessed in September 2014) • http://www.ewb-uk.org/system/files/James%20Newton%20-%20Kampala_SMP_Presentation_to_EWB-2010-01-23.pdf (accessed in September 2014) 	National Water & Sewerage Corporation Plot 39 Jinja Road, P.O.Box 7053 Kampala Tel:+256-414315100 Email: info@nWSC.co.ug Website: http://www.nWSC.co.ug/
Nairobi, Kenya	<ul style="list-style-type: none"> • http://www.iwawaterwiki.org/xwiki/bin/view/Articles/Ikotoilets+-+Kenya (accessed in September 2014) • https://www.johnson.cornell.edu/Portals/32/PDFs/2nd%20place.pdf (accessed in September 2014) • http://wastewaterinfo.asia/sites/default/files/project-briefs/ikotoilets-kenya.pdf (accessed in September 2014) 	Nairobi City Council Swaminarayan Rd, Nairobi City, Kenya Website: www.nairobi.go.ke





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