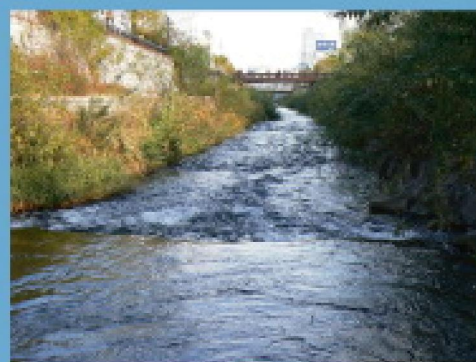
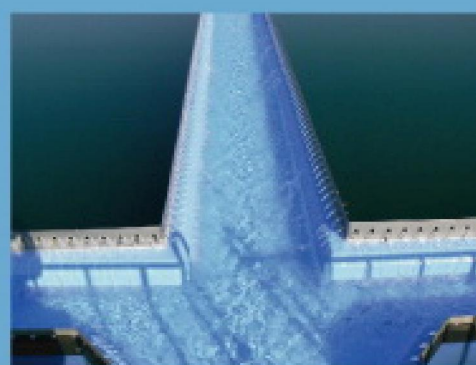


Development of Eco-Efficient Water Infrastructure for
Socio-Economic Development in Asia and the Pacific Region

Good Practices On Eco-efficient Approaches For Water Resource Planning And Management



June 2011

Good Practices On Eco-efficient Approaches for Water Resource Planning and Management in Asia

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Introduction

Developing countries in the Asia-Pacific are presently facing increasing demand of water resources, increasing acute scarcity of water supply and serious socio-economic impact of water related disasters, thereby threatening the sustainability of socio-economic development efforts. Under these circumstances, enhancing the eco-efficiency in water infrastructure development is the critical means to resolve water challenging issues for sustainable development and climate change impacts, which aims at improving ecological efficiency and economic efficiency in an integrated way.

The eco-efficient approach highlight integrated planning based on knowledge of water cycle, decentralized approaches, demand management, design and IT technology for water reuse and recycling, public-private cooperation, application of good practices, and active participation of stakeholders in the planning process, while emphasizing the promotion of innovation and a paradigm shift from market price centered to eco-efficiency centered approaches.

Most of the new approaches including eco-efficient approach for water infrastructure require different perspectives, mindset, and disciplines incorporating social sciences, economics, psychology, sociology and education, as well as awareness, expertise and capacity building to develop strategy, planning design and implementation. In this regard, there are urgent needs for raising awareness, building capacities and setting of clear goals and guidelines for eco efficient water infrastructure through research, country need assessment, consultations, training and workshop activities.

As one of the key activities to achieve the above-said objectives under the project “Development of Eco Efficient Water Infrastructure for Sustainable Development in Asia and the Pacific”, which is financially supported by KOICA, researches from the desk-study on good practices on eco-efficient water resources are compiled.

This compilation aims to introduce good cases on eco-efficient approaches for awareness and knowledge; to facilitate the sharing of these cases in water resource management among countries in the region; and assist policy-makers to use good model, mechanism, and approaches for the planning and implementation of eco-efficient cases in respective countries. This compilation can be used by all development practitioners, authorities at all levels, policy makers and community people and members from organizations working on sustainable management of water resources in general or eco-efficiency water infrastructure in particular.

This is the first collection of good practices from different countries and different organizations which has been viewed through the lens of eco-efficiency and was initiated since early this year. Twenty-five good practices have been compiled at this moment through desk-study as one of the key activities for eco-efficient water infrastructure development in the region. The first section of each case study is an analysis of the good practice and its linkage to the eco-efficiency concept. The second section gives short information about the project to provide readers with an overview of the case. The last

section is the summary of the case study and additional information including description, actions taken, tools used, lessons learned and keys for success is included therein. Contact details for each of the cases are provided at the beginning of each case study overview to enable readers to communicate with the practitioners for further queries. Also the link to the detailed document is given in the information section so that the readers can go to the respective page and read the main document.

Good practices were selected on the following six criteria:

- In line with the selected topics: Projects on water management and planning, rehabilitation of lakes and rivers, rainwater harvesting and stormwater management, and small hydropower project were chosen.
- Innovative: The good practice has developed new and creative solutions to common problems
- Environmental impact: The good practice has a positive and tangible impact to communities and apparently the environment
- Economical: The good practice is economical in long-term perspective as well as has less negative impact on the society.
- Replicable: The good practices can serve as an inspiration framework for generating policies and initiatives elsewhere.
- Non-physical (institutional) aspect: The good practices also have their uniqueness in terms of non-physical infrastructure development such as legislative changes, organization and management of the project through formation of Committees and stake-holder participation at all levels and enthusiastic development of the community.

All good practices were or are being implemented by policymakers and funded from International and national organizations. They are being implemented in different locations, have varying project periods and cover a wide range of approaches, but they all highlight the importance and effectiveness of sustainable approach in terms of physical and non-physical water infrastructure development.

We would like to thank Dr. Le Huu Ti, Chief of the Water Security Section for his guidance, valuable suggestions and continuous support for this piece of work, as well as KOICA for the financial support towards the project “Development of Eco Efficient Water Infrastructure in Asia and the Pacific”.

We hope this collection will bring you some clear pictures for concept, benefits, modality, success factors and approaches to eco-efficient water infrastructure development. We also hope that this collection will help with the implementation plan and lead to better sharing of knowledge and experience among communities, organizations, authorities and stakeholders in the region for the promotion of eco-efficient approaches for sustainable development.

Banashri Sinha and KIM Tae Hyung

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1. IWRM Planning For Khulna-Jessore Drainage Rehabilitation Project in Bangladesh

1. Rationale of a Good Case of Eco-efficiency

- a) This project mobilized beneficiary participation in the design, implementation, and operation and maintenance (O&M) of the project. The inclusive and integrated planning approach develops a sense of belongingness among key stakeholders, and invokes their active participation in operation, post-project operation and maintenance of the project. This kind of integrated approach and involvement of stake-holders are important aspects of eco-efficiency
- b) One of the key components of this project (Component B “Rehabilitation Works”) has improved the overall environment through positive environmental impact by successfully mobilizing beneficiary facilities, and by rehabilitating the drainage infrastructure to reduce drainage congestion, and protect the project area from tidal and seasonal flooding.
- c) Capacity-building is an integral part of eco-efficiency and in this case we find that continuous updating and sharing the progress of the plans made the project stakeholders more capable in making their own water management plans and shouldering their water management responsibility which improved the overall performance.

2. Project Information

- a) *Place:* Khulna-Jessore, Bangladesh
- b) *Objectives:*
 - rehabilitating the drainage infrastructure to reduce drainage congestion, and protect the project area from tidal and seasonal flooding;
 - supporting the expansion of agricultural extension services to the agricultural lands under the project;
 - supporting fisheries management in the polder areas to safeguard the supply of fish caught and consumed primarily by the poor.
 - mobilizing beneficiary participation in the design, implementation, and operation and maintenance (O&M) of the project facilities;
- c) *Document Source:* <http://www.adb.org/Documents/PCRs/BAN/pcr-ban21087.pdf>
- d) *Contact information:* Md. Waji Ullah; wullah@cegisbd.com
- e) *Budget:* The total project cost was estimated at \$44.9 million equivalent.
- f) *Duration:* Started in year 1995 and closed in year 2002. After that under the annual O&M fund of the GoB, short term measures and feasibility study is ongoing for delineation of long term measures to be implemented in the second phase.

3. Summary of the Project

- a) *Description*

- The Bangladesh Water Development Board (BWDB) constructed a series of polders in the 1960s under the Coastal Embankment Project (CEP) that created the scope of growing agricultural crops by preventing the intrusion of saline water. The creation of polders greatly simplified the existing drainage network, which comprised a very large number of tidal creeks and rivers of all sizes, resulting in substantial decrease in the tidal volume accompanied by an increased tidal range.
- After more than a decade of good productivity, drainage congestion began to increasingly affect the northernmost polders from the 1980s when the rivers and creeks were silted up to such an extent that most of them became inoperative. This resulted in vast tracts of land remaining waterlogged round the year.
- The Khulna-Jessore Drainage Rehabilitation Project (KJDRP) was taken up to solve the problem of water logging and drainage congestion in the project area in parts of the Khulna and Jessore districts.

b) Strategies and Actions taken

- The Environment and GIS Support Project for Water Sector Planning (EGIS) conducted the “Environmental and Social Impact Assessment study of KJDRP” with active involvement of stakeholders.
- The study concluded that among the various options, the Tidal Basin Management (TBM) would be the best approach suited on both technical and social grounds for solving the drainage congestion problem in the area on a sustainable basis.
- The study also includes the preparation of an IWRM plan with active participation of the Water Management Associations (WMAs) for establishing sustainable water management during post project and to ensure the proper functioning.
- Besides, other strategies that were used are active involvement of the stakeholders and active participation of the Water Management Associations (WMAs)

c) Lessons Learned

- The project people are highly indigenously educated and, their concept and ideas are very promising.
- Through intensive training and consultation sessions, the capacity of the stakeholders can be build up for this type of complicated and comprehensive water resources planning.
- Monitoring and management information system have played an important role in the preparation and updating of the IWRM plan.
- The Project successfully tested, constructed, operated, and maintained the TRM (Tidal river management) system, which was requested by the beneficiaries in respect of engineering, environment, social, cost, and sustainability.
- The leading role of the BWDB for the project, the government agency responsible for flood control, drainage and irrigation projects, bring big

tangible impacts of the project. Project also contributed to strengthening the institutional capability of BWDB and the Water Management Organizations (WMOs).

- The Project also ensured satisfactory beneficiary participation and ownership of the project facilities as demonstrated by their voluntary contributions of land for embankment and establishment of the TRM, as well as their participation in the operation and maintenance of the structures.
- The organization and management of the executing agencies, especially the many beneficiary organizations, held sufficient knowledge and skill to design and implement similar projects in the future.

d) Results/Impacts

- This project had a positive impact on the environment by solving the menace of drainage congestion, and recovered 48,518 ha of land that used to be under water year round by successfully mobilizing beneficiary participation in the design, implementation, and operation and maintenance (O&M) of the project facilities, and by rehabilitating the drainage infrastructure to reduce drainage congestion, and protect the project area from tidal and seasonal flooding.

2. Integrated Management Of Chilka Lagoon in India

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficient approach of the project lay in the formulation of the management plan for Integrated Resource Management and wise use of the lake's resources by the community depending on it.
- b) Besides, the good environmental practices facilitated the improvement of the ecological health of the lagoon, including a substantial per capita income of the fishing community due to the restoration of the lagoon.
- c) Eco-efficient approaches such as intensive monitoring and assessment system, linkages between the scientific studies and the management interventions are some of the uniqueness of the management practices adopted by CDA for restoration of this unique wetland. This approach can be replicated in many other similar coastal wetlands and has an eco-efficient approach owing to the sustainable nature of the management practices.

2. Project Information

- a) *Place:* Chilika Lake, India
- b) *Objectives:* To prepare a framework for integrated lagoon basin management including interventions in both the coastal processes and the river basin itself for restoration of a severely threatened lagoon with an ecosystem approach.
- c) *Document Source:*
(http://www.gwptoolbox.org/index.php?option=com_case&id=160&Itemid=45)
- d) *Contact information:* Dr. Ajit Pattnaik; ajitpattnaik@hotmail.com
- e) *Duration of the project:*

3. Summary of the Project

- a) *Description*
 - Chilika is a unique assemblage of marine, brackish and fresh water eco-system with estuarine characters and is a hotspot of biodiversity that shelters a number of endangered species listed in the IUCN red list of threatened species. It is an avian grandeur and the wintering ground for more than one million migratory birds.
 - This project is to develop a framework for integrated lagoon basin management including interventions in both the coastal processes and the river basin itself for restoration of a severely threatened lagoon with an ecosystem approach.
 - After the reception of the Ramsar Wetland Conservation Award in 2002, the case has received international recognition, and the experiences demonstrate the promising potentials in reforming the management frameworks of the numerous important coastal wetlands in the Asian region.
 - The intensive monitoring and assessment system, linkages between the scientific studies and the management interventions are some of the

uniqueness of the management practices adopted by CDA for restoration of this unique wetland. This has also facilitated the self-initiated good practices by the community. It can be replicated in many other coastal wetlands facing similar problems.

b) Strategies and Actions Taken

- In 1981, Chilika Lake was designated the first Indian wetland of international importance under the Ramsar Convention due to its rich biodiversity
- In 1992, the Government of Orissa, concerned by the degradation of the lake's ecosystem and cognizant of significant numbers of people who were dependent upon the lake's resources, set up the Chilika Development Authority (CDA). The CDA was set up for restoration and overall development of the lake
- By 1993, the problems in Chilika were so severe that the lake was put under "The Montreux Record" as the lake was considered to have "undergone, to be undergoing, or to be likely to undergo change in its ecological character brought about by human action". The purpose was to stimulate remedial measures for the lake's conservation, supplemented with adequate monitoring. It was expected that such an action would benefit from the advice from Ramsar Advisory Mission and other identified technical assistance programmes.
- Applications of GIS and remote sensing tools have been useful tools for monitoring and assessment of the lagoon.

c) Impacts/ Results

- In 2002, Chilika was taken out of the Montreux Record, in light of the improved conditions of the lake. Chilika lake is the first Ramsar site in Asia to be removed from the Montreux record
- In November 2002, the Ramsar Wetland Conservation Award was presented to the Chilika Development Authority for "outstanding achievements in the field of restoration and wise use of wetlands and effective participation of local communities in these activities"

d) Lessons Learned

- This case demonstrates how a clear understanding of the coastal process and the river basin is essential for restoration of a coastal wetland. The intervention for improvement of the hydrological regime and the participatory management of the watershed resulted in the enhancement of the productivity thereby increase in the per capita income of the community. The outcome has been a significant improvement of the ecological health of the lagoon, including a substantial per capita income of the fishing community due to the restoration of the lagoon.
- The extraordinary implementation success of Chilka Development Authority (CDA) can be related to the non-bureaucratic organizational setup, which actually has no formal legal mandate. Supported by a high-level Governing Body with strong political backing and with full access to government funding,

the CDA combines the stability of a government authority with the implementation flexibility of the private sector, avoiding the constraints of the normal bureaucracy.

- Management steps are widely debated, researched and implemented by the CDA, and this extensive consultative approach has contributed significantly to the success of the management actions undertaken.
- The CDA is also actively involved in socio-economic activities of local communities, including development of a strong outreach programme with active participation of the local communities, NGOs and the community based organisations.
- The hydrological interventions for the restoration of the lagoon have resulted in considerable improvement of its fishery resources, water quality and a positive impact on the biodiversity of the lagoon. Consequently, this has significantly contributed towards the increase in the per capita income of the community who depend on the lagoon for their livelihood.
- The community participation and stewardship, linkage with the various national and international professional institutions, intensive monitoring and assessment system are some of the uniqueness of the management practices adopted by CDA for restoration of this wetland.
- It also started a process to establish a participatory and a self-sustainable mechanism for conservation and wise-use of the resources of the lagoon on a long-term basis.

3. Establishing An Industrial Wastewater Effluent Fee Program, Laguna de Bay in Philippines

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficiency approach was highlighted through well-prepared economic instruments such as providing incentives to change behaviour of the industrial sector, thereby raising revenue to contribute to the financial sustainability of water authorities. This is different from the usual pattern where most governments relied primarily on direct regulation in water resources management.
- b) The use of EUFS in the management of Laguna lake resulted in reduction in pollution loads and expansion of cooperation of major industries, through requests for issuance of discharge permits. The successful complementation of EUFS with the existing CAC approach, however, required the decentralization of decision-making, provision of legal power to levy and retain other than fines and permit fees, and intensified involvement of stakeholders.
- c) The EUFS successfully reduced the pollution loading into the lake by encouraging all liquid waste dischargers to account the cost of environmental degradation and enhancement in the business decisions or actions.
- d) The successful pilot testing of Environmental User Fee System (EUFS) in Laguna Lake and its integration in the LLDA's environmental management program serves as a precedent and catalyst for other local government units, to implement similar or improved system based on the lessons learned.

2. Project Information

- a) *Objectives:* To promote and accelerate the balanced development of the region for environmental management and control through the Laguna Lake Development Authority. It also aims to present the design for a pollution charge program based on the data that can be implemented nationwide.
- b) *Document Source:* <http://www.adb.org/water/Seminars/2004/pdf/blue-bag-16-full-paper-LLDA.pdf>
- c) *Contact information:* Ken Rubin & David Wheeler; ken.rubin@paconsulting.com & dwheeler1@worldbank.org
- d) *Duration:* The EUFS was implemented by virtue of LLDA Board Resolution 22 in 1996. After a 3-year introductory phase (1997-1999); this fee is now regularly implemented.

3. Summary of the Project

- a) *Description*
 - Industrial water pollution had significantly degraded a large watershed near Manila. Following the “polluter pays principle,” an industrial wastewater effluent fee program was developed to create economic leverage for industry to reduce wastewater discharges and raise revenues to finance local government management of the program.

- The effluent fee system was developed for the Laguna de Bay watershed, which includes Laguna de Bay and over 20 feeder rivers. The Laguna Lake Development Authority (LLDA) is a government agency that is responsible for protecting and managing the largest freshwater body in the country. It was covered more than 500 industrial dischargers within 45 industry sectors. The effluent fee system was designed to reflect the quantity of discharges, the costs of environmental externalities created by industrial discharges, and the budget requirements to administer the program. Following hands-on training of personnel, the program was implemented by the LLDA, with portions handled by surrounding municipalities.
- The pilot test of this effluent fee program resulted in reduction of 88 percent of BOD from direct discharges between 1997 and 1999. In addition, during the first two years the government collected over P28,000,000 from Metro Manila firms discharging wastewater into the Laguna de Bay watershed. The regulatory monitoring and enforcement components of the program led to closure of around 50 companies by LLDA between 1998 and 1999 for significant violations.

b) Strategies Used

- The Environment User Fees System (EUFS) is primarily aimed at reducing the pollution loading into the Laguna de Bay. It was designed in a manner that integrates and harmonizes “Command and Control (CAC)” and economic instruments with the objective of generating mechanism to improve environmental enforcement and compliance status of firms located in the Laguna de Bay Region.
- Shifting from Command and Control-based to economic-based instruments
- Economic principles and environmental management were important premises in the design of the pollution charge system.
- Organizational adjustments within industries polluting the Laguna Bay were also made in support of EUFS implementation.

c) Lessons Learned

- Incentives on the water pollution charges were given to the industrial polluters to reduce the impacts of wastewater discharges to a large freshwater watershed and raised revenues for program management. It was important to integrate the pollution charges with the regulatory and enforcement program.
- The use of environmental user fee system proved to be a potent tool in reducing BOD loads in the lake, because the revenues from collected fees were used to refinance important activities e.g. monitoring of industries' discharges and better enforcement of user fees.
- Institutional design was important to ensure that the government had the most appropriate organizational structure, personnel qualifications, trainings, and budget requirements to administer the program.
- The high degree of decentralization in decision-making has made the implementation of EUFS successful along with multi-stakeholder approach and legal power to levy.

4. Active, Beautiful and Clean Waters Programme in Singapore

1. Rationale of a Good Case of Eco-efficiency

- a) The most eco-efficient significant fact is that both land and water, as two critical resources in Singapore, have been more optimally used through the ABC Waters Programme illustrating “value augmentation” through a people-centered urban management to enhance the overall quality of life.
- b) Through this programme of comprehensive approach of integrated water management, the water loop is closed and very little water is lost through the system.
- c) Water which flows through the system, is naturally cleaned through the design concepts such as bioswales, rain gardens and biotopes before being conveyed for storage and further treatment, thereby optimizing the overall system.
- d) Nature areas are also effectively integrated through this programme, to preserve their ecological integrity and enhance their ecological linkages within the island networks. This integration with park planning through the park connector and drainage systems, effectively ensure optimization of limited land resources, all of which is achieved through a carefully and eco-efficiently engineered approach.

2. Policy Description

- a) *Objective:*
 - To tap ideas, expertise and resources from the People-Public-Private sectors in developing and managing the catchments and water bodies as new community spaces, while continuing to safeguard the water quality and safety to the community
 - To develop the water bodies beyond their functional use as resources for water collection, storage and drainage into vibrant, clean and aesthetically pleasing lifestyle attractions where recreational and communal bonding activities take place.
 - To act as an umbrella programme for integrating and holistically managing all initiatives involving catchments and water bodies.
- b) *Document Source:*
<http://www.pub.gov.sg/abcwaters/abcwatermasterplan/Pages/default.aspx>
- c) *Duration:* Started in February 2007 and completed 4 demonstration projects, while 16 other are on-going to be completed by 2012 successfully. More than 100 projects will be implemented in the next 10-15 years of the second phase.
- d) *Contact information:* Dr. Malone-lee Lai Choo & Prof. Heng Chye Kiang;
rstmalon@nus.edu.sg

3. Summary of the Policy

- a) *Description*
 - Singapore’s approach to waterways management in the past has also focused on averting the risk of flooding. An engineering approach was adopted to

design streams and canals as man-made channels, with the primary concern that the stormwater would flow smoothly, with as little interruption as possible.

- This newly introduced concept of ABC waters programme began in part with the planning re-orientation to transform Singapore from a “Garden City” to a “City of Gardens and Water” by the urban planning authorities.
- This programme was formulated as an umbrella programme that embodies the vision of unlocking the hidden potentials and opportunities of Singapore waterways

b) Strategies Used

- The programme takes a comprehensive master planning approach, with detailed guidelines drawn up for all the identified water sheds. The guidelines are responsive to the character of the areas studied, with attention given to functional and design differentiation, the importance of safety and protection of water quality as well as integration with natural systems and biodiversity.
- It also marks a re-orientation of policy and thinking. From the historically grounded engineering approach that regard water resources as an economic good, the approach now embraces many of the principles of eco-efficiency.
- The key strategies for achieving the objectives are: -
 - Catch every drop of stormwater onsite from roofs, carparks, roads, parks, drains, canals, rivers and reservoirs
 - Treat the stormwater onsite and slowly release through green roofs, swales, infiltration techniques, bio-retention systems, wetlands, raingardens, etc.
 - Enhance the aesthetics by using water as the main element like rockpools, dams, canal greening, floating gardens, softwater edges, etc.
 - Create opportunities and spaces for activities related to sports, retreat art & culture, commerce.
- An integrated urban planning approach, which embraces engineering, science, landscape design, the behavioural framework of urban design as well as a commitment to community connection, in a master planning framework is required.
- The Water Conservation Strategy was based on :-
 - Pricing to reflect the strategic importance and scarcity value of water
 - Promote the ownership of water conservation
 - Cut down on excessive flow and wastage of water
- The entire island is divided into 3 watershed catchments, with each one managed by a watershed manager and has a different focus than the other.
- The new strategy adopted is one of stormwater decentralization. The process would then involve treatment or purification of the stormwater by sedimentation, absorption, filtration and/or biological uptake as well as retention of the water to a certain extent.

c) Lessons Learned

- Integrating the river with the park via a holistic sustainable approach that engages the public and foster a sense of communal ownership and appreciation for our water resources is helpful.
- Safety of users must be a foremost concern especially with the intention to ‘get the community closer to the water’. Wherever possible, build upon the natural and traditional and leapfrog to sustainable bioengineering solutions.

5. Promoting Better Environmental Performance of a Tannery Cluster through Shared Wastewater Treatment Facilities in Thailand

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficiency approach in this case was that the wastewater treatment plants used an aerobic digestion process effectively to treat the wastewater discharged from the tanning process, which meets the effluent standards set by the government. The treatment process has been continuously improved, so as to be suitable for the increasing wastewater load in order to comply with the legislative framework. According to a study by the Department of Industrial Works, the properties of wastewater discharges have significantly improved.
- b) The main drivers that made companies to adopt a cleaner production process (eco efficient process) were to eliminate costs associated with inefficiencies within the existing process. In this case, top management identified these costs through energy audits and benchmarking. Accordingly, it can be seen that these are effective tools for an organisation to use in order to assess actual performance, which may finally lead to performance improvement as a result of identifying inefficiencies and room for improvement in business activities. This can be categorized as an eco-efficient approach with long-term impact.
- c) In this case, the regulatory instruments were strengthened and strong interrelationships between the industrial players were encouraged for a long-term sustainable impact which is the need for achieving eco-efficiency.

2. Project Information

- a) *Objectives:* To relocate tanneries and develop shared water treatment facilities, with the aim of improving the environmental performance of the tanneries in terms of wastewater management and pollution control.
- b) *Project cost:* The total investment for the whole project was about US\$ 20 million, while monthly electricity bills amount to more than \$50,000.
- c) *Document Source:* <http://www.iges.or.jp/APEIS/RISPO/inventory/db/pdf/0072.pdf>
- d) *Contact information:* Ms.Vilai Kosontrakool; tittaya@tei.or.th

3. Summary of the Project

- a) *Description*
 - The tanning industry in Thailand was first established over 60 years ago and is one of the country's oldest industries. In a nutshell, the tanning industry is the only industry in Thailand to be located in a single industrial estate.
 - According to the Department of Industrial Works (DIW), there are 146 tanneries in Thailand, over 90 percent of which are SMEs, and it employs over 150,000 workers.
 - The tanning process is generally comprised of three main stages: beamhouse, tanning, and finishing. The tanning process is chemical and water intensive;

thus, it produces a large quantity of wastewater. Due to high water and chemical consumption, wastewater is the major environmental problem.

b) Action Taken

- Due to wastewater discharge containing high levels of organic and inorganic substances, two central wastewater treatment plants, occupying 8.5 hectares of land, were built for the mutual benefit of the tannery factories in the area.
- These plants serve 130 tanneries in the area, with a total daily discharge of 20,000 cubic metres (m³). Both of the treatment plants are operated by the Thai Tanning Industry Association (TTIA), in which the TTIA members share the initial investment and annual operating costs.

c) Strategies Used

- Awareness and Capacity Building: The tanneries have developed capacity building in terms of pollution management.
- Shared operating costs
- Establishing the Thai Tanning Industrial Association
- Regulatory Instrument: The government's policy to relocate industrial factories was the main reason that brought about the tannery cluster development.
- Technical: Installation of central treatment plants

d) Lessons Learned

- Applying shared waste treatment facilities at the cluster level requires large investment and resources.
- Moreover, successful operation also requires strong commitment from all users; therefore, the management of the facilities must provide equity to all members, in order to share benefits and costs equally so as to create mutual interest and trust among the members. Without this factor, this practice would be difficult to achieve.
- The operation of the TTIA is a good illustration of effective management of shared waste treatment facilities, which can be applied to other industrial clusters.
- Cluster development is not a once-off implementation; on the other hand, it needs a fundamental establishment of industrial players. This can be led by strengthening regulatory instruments and encouraging strong interrelationships between the industrial players.
- Shared facilities can help in increasing overall economic efficiency through sharing of costs, personnel, and other associated resources, but require a systematic management in order to provide equity and accessibility to all users.
- Successful operation also requires strong commitment from all users; therefore, the management of the facilities must provide equity to all members, in order to share benefits and costs equally so as to create mutual interest and trust among the members.

6. Water Management in Singapore

1. Rationale of a Good Case of Eco-efficiency:

- a) This is a good case of eco-efficiency because a balanced approach through developing and implementing extremely efficient demand and supply water management practices can completely reduce its dependence on external sources for this city-state.
- b) The eco-efficiency approach leads to the success of this management practice through the development of various alternate water resources such as a combination of rainfall storage, desalination and very sophisticated technology for recycling used water as well as right balances between these sources.
- c) Eco-efficient approach was demonstrated through a balanced and integrated approach in the public sector and private sector participation; strategic national interest and economic efficiency; and strengthening internal capacities and reliance on external sources

2. Project Information:

- a) *Objectives:* The objective of this management plan was to provide clean water to the population of the water-scarce country of Singapore which has to import water from neighboring countries.
- b) *Document Source:*
<http://www.adb.org/Documents/Books/AWDO/2007/br01.pdf>
- c) *Contact for more information:* ctortajada@thirdworldcentre.org; Cecilia Tortajada

3. Summary of the Project:

- a) *Description:*
 - Singapore is a city-state with an area of about 700 km², a population of approximately 4.4 million people and an annual growth of 1.9%. The average GDP growth of 7.7% per year during the last decade has resulted in economic prosperity.
 - Singapore is considered to be a water-scarce country not because of lack of rainfall (2400 mm/year), but because of the limited amount of land area where rainfall can be stored. Singapore imports its entitlement of water from the neighbouring Johor state of Malaysia, under long-term agreements.
 - Institutionally, Public Utilities Board (PUB) currently manages the entire water cycle of Singapore which allows PUB to develop and implement a holistic policy, which included protection and expansion of water sources, stormwater management, desalination, demand management, community-driven programmes, catchment management, outsourcing to private sector specific activities which are not core to its mission, and public education and awareness programmes.
- b) *Strategies Used*

- The success can be attributed to the proper management of water and wastewater through
 - concurrent emphasis on supply and demand management,
 - wastewater and stormwater management,
 - institutional effectiveness
 - creating an enabling environment - a strong political will, effective legal and regulatory frameworks and an experienced and motivated workforce.
- Protected catchment areas are well demarcated and gazetted, and no pollution-causing activities are allowed in such protected areas. In land-scarce Singapore, protected catchment classification covers less than 5% of the area. The Trade Effluent Regulations of 1976 promulgated the idea of partly protected catchments, where wastewater discharges to streams require prior treatment.
- Strict implementation of these regulations and there are no illegal connections to its water supply system. At present with a 100% sewer connection, all wastewater is collected and treated. NEWater is used for industrial and commercial purposes and water thus saved is being used for domestic purposes. By 2011, NEWater is expected to meet 15% of Singapore's water needs.
- PUB has managed to lower unaccounted for water (UFW) consistently to around 5% in recent years. This is a level that no other country can match at present.

c) *Lessons Learned*

- Some major steps taken towards water supply management: - concept of partly protected catchment, desalination concept, water reclamation plants set-up, proper monitoring of the UFW losses, has been a success story.
- A comprehensive demand management policy by PUB included new tariff patterns that had a notable impact on the behaviour of the consumers, and have turned out to be an effective instrument for demand management.
- Examples of a good management which has led to the achievement of an eco-efficient water infrastructure are: - 100% of population have access to drinking water and sanitation, entire water supply system from water works to consumers is 100% metered, monthly bill collection efficiency was 995 in 2004, monthly bill collection in terms of days of sales outstanding was 35 days in 2004.
- The success was achievable by ensuring efficient use of its limited water resources through economic instruments, adopting the latest technological development to produce 'new' sources of water, enhancing storage capacities by proper catchment management, practicing water conservation measures, and ensuring concurrent consideration of social, economic and environmental factors.

7. Policy Direction for Clean Water Supply and Development of Water Industry for Green Growth in Korea

1. Rationale of a Good Case of Eco-efficiency

- a) This policy approach is eco-efficient because it fosters the concept of green growth which aims to maintain sound growth with minimum use of energy and resources.
- b) It aims to improve eco-efficiency of establishment/operation of public sewerage systems by introduction of basin sewerage systems
- c) Sustenance of the eco-efficient approach lies in the advancement of water-pipe management by introducing an optimal management system to reduce the gap between the rural and the urban areas
- d) The establishment of energy-independent sewerage facilities will account for around 45% savings in energy by 2030 if the trend continues, which is an eco-efficient step in itself.
- e) Implementation of the conversion of sewage sludge to energy is an eco-efficient approach
- f) Eco-efficient approach in this policy direction also lie in the establishment of water recycling and reuse for buildings of different dimensions (such as accommodation facilities, sports complexes, government buildings, etc)

2. Policy Information

- a) *Objective:* To provide the policy direction for achieving clean water supply and development while promoting green growth
- b) *Contact information:* Dr. Jong chun Kim,
- c) *Document Source:*
<http://www.unescap.org/esd/water/projects/ewi/workshop/2nd/presentation.asp>

3. Summary of the Policy

- a) *Description*
 - This age of resource/environmental crisis with imminent depletion of natural resources, water shortages, continuous emission of greenhouse gases and desertification/ food crisis has led to the advent of green growth approach.
 - Green growth is the new engine at the advent of the age of resource and environmental crisis, which aims to maintain sound growth with minimum use of energy and resources. The three major goals include: - new national development, enhancement in the public's quality of life and contribute to the international community's efforts to tackle climate change.
- b) *Strategies Used*
 - The four major strategies included in the policy direction are: - Clean water supply, advancement of sewerage policy, water recycling and reuse and promotion of water industry.

- Diversification of water sources through expansion of indirect water collection. Bank filtration and riverbed filtration and artificial recharge of groundwater were some of the options suggested and in operation.
- Advanced water purification by increased use of granular activated carbon, biological activated carbon and membrane filtration
- Advanced water businesses – Steps such as optimal water-pipe management system combining real-time monitoring and telecontrol, increase in fiscal investment to reduce gap between urban and rural areas, establish water pipe diagnosis system are being taken.
- Replacement/improvement of old water pipes to resolve the problems of rusty water outflow and lowered water pressure and support improvement of house water pipes for low-income families.
- Readjustment of current water supply system into 9 large zones will improve the water supply system.
- Establishment of energy-independent sewerage facilities and to lay the foundation for advancement of sewerage policy to improve efficiency and satisfy the public as well as tackle climate change related problems.
- Establishment/ management of rainwater use facilities, wastewater reclamation and reuse system, treated sewage/wastewater reuse facilities could be the major steps towards water recycling and reuse.
- Fostering water industry to resolve water imbalance, enhance operational efficiency and secure competitiveness of water-related industries.
- Plan to foster water industry in 4 stages- establish foundation for technology development, develop element technologies and integrated system, optimize and commercialize the system, promote the use of the system.

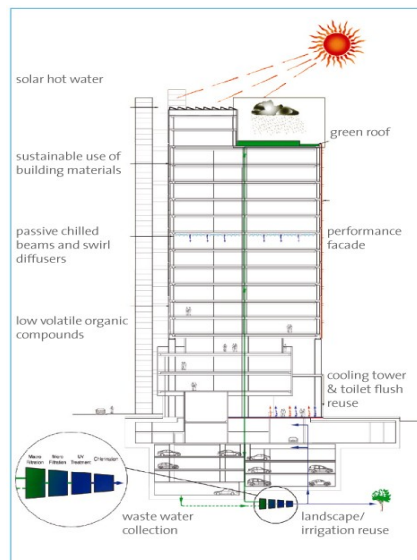
c) *Keys to Success*

- Increase in the participation of private businesses from 1 to 11 within 2003 to 2008.
- A long-term comprehensive technology development plan for water industry.
- Entitle professional research institutes to carry out pilot projects applying new technology, in order to promote technology development related to water reuse.
- Reduction in the tap water usage fees for those who install water reuse facilities or are supplied with reused water.

8. Sustainability- The Key To Redeveloping Kogarah's Town Centre in Australia

1. Rationale of a Good Case of Eco-efficiency

- a) The redevelopment plan successfully incorporates state-of-the-art urban planning and architectural design such as green roof, passive chilled beams and swirl diffusers to improve the eco efficiency.
- b) One of the important steps to eco-efficiency lies in its economic efficiency. This project plan included the possibility for expected social and community benefits from the investment, such as increased employment opportunities and new public facilities and services as an eco-efficient approach.
- c) The adoption of water sensitive urban design initiatives is an important eco-efficiency component of infrastructure development. This saved the water by use of collected and treated rainwater for gardens, toilet flushing, cooling purposes and washing cars.
- d) Eco-efficient approaches through the promotion of solar energy industry and new technology is projected to save approximately 375 tonnes of greenhouse gases annually.



2. Project Information

- a) *Place:* Kogarah Council, New South Wales, Australia
- b) *Objectives:* To redevelop Kogarah as the first environmentally sustainable town centre in Australia.
- c) *Document Source:*
<http://www.kogarah.nsw.gov.au/www/html/2074-kogarah-town-square-re-development-.asp>
- d) *Contact information:* Rance Salan, rance.salan@kogarah.nsw.gov.au

3. Summary of the Project

a) *Description*

- “The Kogarah Town Square redevelopment project” is part of a 10-year strategy for a “Wider Urban Renewal Program for the Kogarah Town Centre”
- As a key step, the Kogarah Town Square Development Control Plan (DCP) was developed after extensive community consultation.
- The redevelopment project successfully incorporates state-of-the-art urban planning and architectural designs. The Kogarah Town Square design includes reuse of stormwater, natural cross-flow ventilation, using natural lighting, water efficient fixtures and fittings, and passive solar design principles.. The above-mentioned criteria for the Kogarah were also established by the DCP.

b) *Strategies Taken*

- Australia’s largest solar powered medium-density residential development
- Developed tertiary treated stormwater systems
- Applied energy-efficient good designs such as wide spread use of natural lighting and building techniques to minimize heat gain and refract light deeper into the commercial spaces have been used.
- Involvement of councilors, community members, local business people, developers, architects, urban planners and specialists all contributed to its development.
- To help implement the 10-year revitalisation strategy, a number of internal working groups were established and they formed a significant partnership to drive the process
- Formation of an advisory committee to assist with delivery

c) *Lessons Learned*

- The project demonstrated that sustainable development is feasible through negotiated solutions and public/private partnerships. Council assets, such as Kogarah's carpark, can be used as leverage to gain environmental and community benefits from the redevelopment of urban areas.
- The main key to success was the Council’s commitment to regenerating Kogarah, demonstrating leadership and providing a sustainable future/vision for its residents. Community members were involved at consultation process since the beginning of the project planning. Council recognized the potentials of using a council owned car park as a catalyst for wider urban renewal and seized the opportunity to conceptualize a unique development.
- It formulated some internal working groups and advisory panel of community members and representatives from the area’s major employer organisations to lead the project
- It has generated \$200 million of capital investment and, based on growth projections for the town centre, it is expected to generate in excess of \$250 million of capital investment over the next decade. Social and community benefits are expected from the investment with increased employment opportunities and new public facilities and services.

9. Rehabilitation of Lakes in Kelana Jaya Municipal Park in Malaysia

1. Rationale of a Good Case of Eco-efficiency

- a) The educational aspect to achieve eco-efficiency was the establishment of “Friends of Kelana Jaya Park (FoKJP)” in 2005 to develop plans and strategies for rehabilitation of the lakes. This group works alongside other organizations to increase community’s awareness on the importance of rehabilitating biodiversity of the lake and the linkage of their household activities and pollution of the lakes.
- b) This project improved the water quality of one of the lakes by collaborating between a low-cost technology (Ecofan) and human activities. Ecofan has been designed based on water movement theory developed by Japanese researchers and is considered to be an eco-efficient approach.
- c) The community was informed of the importance of re establishing a more natural ecosystem which can provide better habitats for wildlife and subsequently they were mobilized to minimize and eventually stop the pollution source from entering the lake system, ultimately having a positive impact on the environment.

2. Project Information

- a) *Objectives:* The major aims of this project were to reduce the level of pollution flowing into the lakes and to increase community awareness. The second phase aims at:
 - To demonstrate an innovative and affordable solution to improve water quality in the polluted lake.
 - To strengthen the role of the local residents especially Friends of Kelana Jaya Municipal Park (FoKJP) and other partners in the stewardship of the lakes and the park
- b) *Duration:* Initially 20 months and then extended for the next phase successfully.
- c) *Document Source:* <http://www.kelanjayapark.com/index.cfm>
- d) *Contact information:* Suzana Mohkeri; suzana@genet.po.my

3. Summary of the Project

- a) *Description*
 - Malaysia has very few natural lakes but past tin-mining activities and construction of water reservoirs have created many man-made lakes and ponds. Although water from lakes and ponds could provide ample supply of non-potable water, it was heavily polluted. Ex-mining ponds and lakes mainly serve as flood retention areas, developed for recreational uses or reclaimed for other developments.
 - Barely after the Kelana Jaya Park was developed around a former mining pond in early 1990s, a gradual decline in the water quality of the lakes was observed. The main cause was rapid development resulting in wastewater, rubbish and sewage overflows draining into the lakes from a storm water drainage system.

- A local university expert has confirmed that the lakes have very high algal content and characterised as eutrophic. Fish sampling has shown that 90% of the fish population in the lakes is non-native species. In addition, untreated sewage effluents from an old oxidation pond located next to the Park flowed directly into the lake system.
- The lake ecosystem completely changed due to loss of wetland plants in and surrounding the lakes, poor water quality and loss of animal life.

b) Strategies and Actions taken

- In 2002, the project to promote the concept of community participation was initiated aiming to establish local groups who will take the lead to guide the local community in pollution reduction and rehabilitation programs.
- A Project Committee lead by the local council members becomes the platform for partnership between government agencies, NGOs, private sector and resident groups. The committee was important as a medium both for stakeholder discussion and to catalyze the initiation and drive the activities.
- The project focused on three strategic areas: pollution reduction, rehabilitation and community involvement. There are now more than 400 residents registered as Friends of Kelana Jaya Park (FoKJP) with a 15 member committee established.
- A Waste Management and Water Education Programme introduced to three schools in the catchment has been successful in promoting waste recycling and water monitoring among students, their parents and teachers.

c) Lessons Learned

- This case provides an example of how an integrated approach can be used to solve water pollution problems in an urban lake ecosystem. The case integrates environmental and urban planning with support from the community and local authority. Involve active community leaders (e.g. state assemblymen, resident leaders) in the project implementation and organization
- Develop community's interest and desire to conserve local environment which will lead to actions. Illustrate short term success and results to community and go get them engaged and make a connection between community and project benefits i.e. quality parks, better health;
- This rehabilitation programme was initiated in 2002 and didn't stop there. It has managed to establish Friends of Kelana Jaya Park in 2005 and in August 2007, the second phase known as Rehabilitation of Kelana Jaya Lake through Community Participation was approved/ funded.
- Within the first 18 months of the project, solid waste and wastewater from the storm water drain was reduced almost 60% and discharge from the oxidation pond improved due to refurbishment work

10. Lake Ngaroto Restoration in Canada

1. Rationale of a Good Case of Eco-efficiency

- a) The restoration project received a wetlands conservation award from the Minister of Conservation in February 2000, and was nominated for a Ministry for the Environment Green Ribbon Award in 2002.
- b) The key eco-efficiency features was a combination of best landuse practice by landowners, local conservation efforts and aligned management by Waipa Accord agencies with the vision that these nationally significant heritage assets can be preserved and improved for future generations.
- c) Setting up of the sediment and nutrient traps are considered as eco-efficient approach to help lake's recovery.
- d) Newly planted native species will encourage more wildlife (including native birds) back to the area. The lake is also used for recreation, and the boardwalk built by a local Club greatly enhances access to and around the lake, bringing people closer to nature, which can be considered as an eco-efficiency approach.

2. Project Information

- a) *Place:* Hamilton, Canada
- b) *Objectives:* The purpose of this project was to restore the lake to its previous conditions by using techniques to reduce external as well as internal nutrient load on the lake
- c) *Document Source:* <http://www.mfe.govt.nz/publications/water/lake-ngaroto-case-study-jun01.pdf>
- d) *Contact information:* John Greenwood; jgreenwood@wave.co.nz

3. Summary of the Project

- a) *Description*
 - Lake Ngaroto is the largest peat lake of the lakes in the Waipa District and is a valuable landscape and recreational amenity.
 - Peat lakes and the wetlands that surround them are a unique and important resource. They are valued for their unique ecological values, their scientific and educational interest, the recreational opportunities they offer as well as their cultural, spiritual and historic significance. The name 'peat lake' simply means that the lake is associated with peat soil.
 - This lake and the remaining riparian margins bear little relation to the original lake environment. Hence, Waipa District Council started a restoration project in 1995, creating marginal strips of land around the lake that could be fenced and planted.
- b) *Actions Taken*

- The boundary of the lake to be recognised as the outside boundary of a legal road that encircles the Lake Ngarato Recreation Reserve and the entire boundary of the reserve to be fenced on the proposed new legal boundary.
- Water discharges to the lake to have some form of silt and nutrient filtration before final discharge into the lake in an attempt to limit the infilling and nitrification of the waters
- Grey willow to be removed totally from the lake reserve over a period of time and restoration plantings to be primarily native, with some exotics, in groupings for aesthetic reasons and for wildlife feed.
- The size of the silt traps was calculated so as to allow a reduction in water velocity during normal water flow and the nutrient traps were designed to handle normal flows and allow flood flows to bypass the traps.
- A track to be constructed around the perimeter as part of the restoration proposals to allow and encourage the public to view the work being done and to enlist public support for the restoration work.
- Catchments of the individual drains were measured off a topographical map. The areas were then calculated and used alongside rainfall figures for various months to cross check the size of silt or nutrient traps needed at each stream/drain inlet.

c) Lessons Learned

- The formation of the Waipa Peat Lakes and Wetlands Accord was a milestone in working towards achieving focused multi-agency conservation and management.
- A 10-year maintenance programme involving plantings and weed control was adopted by the Waipa District Council.
- Some major actions taken include: all inlets (mainly farm drains) were examined and studied; water flows at low flow times were measured; eel and minnow traps were set in several of the drains and streams to gauge the diversity of fish life present in the water courses.
- The whole lake boundary is now fenced and well over half of the lake edge is planted. Considerable effort has been made to plant native species grown from locally sourced seed which is an eco-efficient approach in the context of getting closer to the nature.
- Environment Waikato' monitoring for the lake's water quality in order to establish a benchmark can tell how the plantings, and sediment and nutrient controls improve water quality

d) Keys to Success

- Long-term support from the controlling authority
- A strong labour base to maintain the impetus of a project for long-term was available.
- The most challenging issue was to address the public perception and understanding of what restoration actually means, which was done successfully by commissioning an interpretive programme to communicate the goals and ideals to the public.

11. A promising Case of Rehabilitation of West Lake in China

1. Rationale of a Good Case of Eco-efficiency

- a) An integrated and eco-efficient approach was clearly presented in this plan by taking into account all correlated issues including land use, social aspects of residential relocation, ecotourism, water engineering, safeguards, sewage and drainage system, transport, adjustment of inflow from Qiantang river, and outlet from West Lake, etc.
- b) The success of the eco-efficient approach was realized through the establishment of a new public green space of more than 110 ha and the lake increased with the increase in average depth from 1.65m to 2.5 m and the transparency from 50 cm to 73 centimeters.
- c) Some of the key eco-efficient features to improve the water quality of the West Lake were through water diversion, surface greening, cleaning, sewage interception, upstream watershed renovation and ecological conservation. Since the project was implemented in 2002, the lake area experienced significant improvement and is no longer in eutrophication status.
- d) Therefore, the eco-efficiency or ecological value of the lake has significantly improved and the number of visiting migratory birds has risen from 1,000 to more than 10,000. In 2007, many rare species were seen in the lake.

2. Project Information

- a) *Place:* Zhejiang Province, China
- b) *Objectives:* The purpose of this study was to improve the situation in the lake with the overall underlying principle “protecting first, and prioritizing ecosystem conservation and sustainable development”.
- c) *Document Source:*
<http://www.adb.org/Documents/Books/PRC-Reviving-Lakes/>
- d) *Contact information:* ADB; adbpub@adb.org

3. Summary of the Project

- a) *Description*
 - West Lake is one of the most famous scenic lakes in the People’s Republic of China. The lake is highly valued as a recreational resource for the people of the city as well as visitors, but as the city grew rapidly during the 1980s and 1990s, the lake became badly polluted.
 - In 2002, the water quality in the lake was worse than Class V because of pollution from point and non-point sources. Efforts to improve the situation began and many steps were taken which are described below.
- b) *Actions Taken*
 - In 1950s, dredging operations were carried out to remove the sludge which deepened the lake from 0.5m to 1.8m. In 1986, a water diversion project was

constructed to solve the water shortage problem. In 2003, two major water treatment plants were constructed to deal with the inflow water quality problem.

- Controlling land-use in the catchment of the lake; removing significant point sources of pollution; strengthening compliance with pollution control regulations; reconstructing streams and wetlands, and controlling pollution from tourism developments in the catchment were other actions taken in order to rehabilitate the lake.
- Recognition from the decision-makers and creation of an effective management structure was carried out. Financial support was backed by a wide range of legislative developments to strengthen management arrangements and institutionalize the development plan.
- Management was strengthened by creating the Hangzhou West Lake Scenic Area Management Committee in 2000, which was accountable to the municipal government and responsible for comprehensive protection, management, planning and construction of the West Lake scenic area.
- In 2005, based on the approved master plan, the committee developed 11th FYP for the West Lake Scenic Area Rehabilitation, which was identified as a priority program in the Hangzhou municipality's 11th FYP for economic and social development. Clear targets were set for 2010: 80% of lake planned areas become a natural park; overall sewage treatment rate reaches 95%; extraction of groundwater decreases to 50% compared to 2005 and integrated effort put in to reach these outputs.
- There was a high level of awareness among senior political leaders on the significance of the problems being encountered. A strong management structure was created that clarified responsibility for planning and implementation, provided management control over all participating units, and provided a clear accountability framework

c) *Lessons Learned*

- A notable obstacle to all progress in reversing water pollution is the lack of effective control over land use in the catchment. Hence, in this case integrated planning and analysis of the growth within the catchment helped a lot to achieve the goal.
- The industrial pollution control and prevention projects were initiated with the support of the Government and addressed in its totality and comprehensively in the case West Lake. In the 5 years of implementing the project since 2002, many illegally built buildings were torn down.
- It is considered to be one of the five most beautiful lakes of PRC and the priority sight-seeing choice for tourists.
- Before the project waterweeds would die of oxygen when planted at the bottom of the lake. Now they are able to grow smoothly which is rare in megacities. Although the lake still relies on the people's help to survive, once the two ecological chains can live harmoniously, the lake adopted a recycling and metabolic system for purification.

12. Chilka Lake: Ecological Restoration in India

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficiency approach improved the chemical, physical and biological parameters of the lake.
- b) Some eco-efficient features include- control of silt load by plantation in catchment area, restoration of eco-system of Nalabana island, weed management with community participation and its use in biogas generation, improvement of the communication network, fishery resource development, upliftment of economic condition and other allied activities of the stake-holders of the peripheral villages, creation of mass awareness, development of an interpretation center at Barkul, and a research centre on wetland management at Balugaon had a positive impact in the environment.

2. Project Information

- a) *Objectives:*
 - to restore the ecological balance of the lake
 - to provide the livelihood to the villages surrounding the lake/lagoon
- b) *Time frame:* 2000-2004 and extended till date
- c) *Document Source:* <http://www.worldlakes.org/lakedetails.asp?lakeid=8607>
- d) *Contact information:* info@worldlakes.org

3. Summary of the Project

- a) *Description*
 - The Chilka Lake, located in the east coast of state of Orissa, India is the largest lagoon and salt water lake in Asia. The salinity level in the lake is directed by river discharges during different seasons, wind action and extent of tidal influx carrying marine water from Bay of Bengal. The Chilka lagoon remains a vital life line for more than 200,000 people in 141 villages who live in around the lagoon. The communities in the river drainage basin subsist on agricultural practices but the villagers around the lagoon area are dependent on aquaculture and capture fisheries for their livelihoods.
 - The Chilka lake was spread over 908 sq. km., in the summer and 1165 sq. km., during monsoon in the early part of 20th Century and by late 1990's it had reduced to 760 sq. km., according to landsat TM data.
 - The demand of intensification of agriculture is to be supported by irrigation, chemical fertilizer and pesticides. The upstream erosion and sedimentation process in the lagoon directly contributed to the loss of depth of lake bed as also to the choking of mouth; this in turn led to decline in salinity which resulted in rapid growth of invasive weed species and macrophytes disturbing the delicate ecosystem of the lake.
- b) *Actions Taken and Strategies Used*

- Improvement of water exchange and maintenance of salinity gradient. (Dredging; Bathymetry & Hydrologic monitoring)
- Hydrobiological monitoring
- Mass awareness programme and stakeholders participation
- Fishery Resource Development programme (net mesh-size regulation, prohibiting catching brood fish and prawn juveniles, identification)
- Upliftment of Socio Economic Condition of Rural Community around the lake
- Setting up Wetland Management Research Centre at Balugaon. Improvement of road network around Chilka.
- Financing Mechanism
- Linkages with other Water Resource Management Programme
- Importance of Scientific Information and Research

c) *Results/Impacts*

- Salinity Change: Salinity level in the northern sector changed from 0.5 – 2.5 ppt recorded in the last decade to 0.1-36.00 ppt.
- Fishery productivity : The fish land, which had declined to 1600 mt before intervention changed to 11,877 mt in 2001-2002 and crab landing increased from 3MT in 1994-95 to 150 MTs in 2002-03. There is also a marked change in ranking order.
- Auto recruitment of fish, prawn and crab: The fish and crab landing data further indicate the significant level of increase in auto recruitment from the sea into the lake after intervention. The shrimp species *Paenaeus indicus* alone showed a record yield of 438 mt, which is higher than any other figure in last one-decade.
- Decline in weed infestation: The trend of invasive fresh water species reaching an area of 523.01 sq. km., in 2000 (October) leaving an weed free area of 333.82 sq. km., was greatly changed following a reduction of 172 sq. km., of weed spread area.
- Depth of Channel: The opening of mouth and consequent changes in tidal flux led to significant flushing of sediment from the channel thereby increasing the depth to 30-45 cm level.
- Changes in local community income: lake restoration resulted in enhanced fish and crab yield thereby increasing the per capita average annual income by Rs. 50,000/-
- Improved stakeholder awareness: the stakeholders have self adopted good practices like regulation of mesh size, discouraging juvenile catches.
- A better linkage has been established between CDA and fisher community following implementation of action plan.

13. School Helps Clean The 'Dago rongchhu' Stream, Paro Lango in Bhutan

1. Rationale of a Good Case of Eco-efficiency

- a) This is an eco-efficient approach because it highlights that generating the awareness through education and hands on demonstration on the upkeep of the stream and garbage disposal in proper designated areas could improve the overall health of both the residents and the environment
- b) The visible effect of the eco-efficiency approach is the marked difference and dramatic improvement in the village scene and along the banks of the stream with no litter around and a cleaner environment. The schools and communities in other parts of the country are also trying to replicate to accrue similar benefits and results. Hence it can be considered a good practice for a small frame.
- c) The immediate impacts, such as the improvement in the appearance of the village and some subtle and long term impacts on our ecosystems should not be under-emphasised as this lays the path towards an eco-efficient approach of the rehabilitation of a part of the stream and thereby having a positive impact on the environment

2. Project Information

- a) *Objectives:* The objectives of such activities are to inculcate a civic sense in people and motivate them that their help and actions to upkeep of the environment will bear results that will be cherished by both the present and future generations.
- b) *Document Source:* (http://www.gwptoolbox.org/index.php?option=com_case&id=173&Itemid=45)
- c) *Contact information:* G. Karma Chhopel ; gkchhopel@nec.gov.bt

3. Summary of the Project

- a) *Description*
 - This project describes a process where the students of Paro Lango Lower Secondary School assist the local community in taking care of the surrounding environment particularly the stream that runs through the village.
 - At the headwater this stream was used for drinking purposes but as it passes through the village, the contamination renders it unfit for human consumption.
 - With the proactive participation of the students, some of the age-old practices which are not healthy to both people and environment are eradicated for good.
 - With the funding and encouragement from the National Environment Commission Secretariat and the Royal Society for Protection of Nature (NGO), most schools around the kingdom have started the “follow that stream” project as part of their school’s nature club activity.

- Lango Lower Secondary School in Paro district also adopted the “Dago rongchhu”, a stream in the locality. Prior to the adoption and cleaning of the stream, there were several cases of water borne diseases in the locality. Prior to cleaning the students described the stream as “flowing garbage”.

b) Action Taken

- Involvement of the local community and the future generation
- Change of the mind-set to understand what long-term effects are associated with environment friendly steps approach.
- Removing the pig sties away from the immediate vicinity of the stream
- Formation of four action groups, who were made responsible for the upkeep and regular cleaning of their share.
- Removal of the toilets and discouraging people to use the banks of the stream in lieu of the toilet and open air defecation has brought significant improvement to the stream.

c) Strategies Used

- Participatory management and empowerment in civil society
- Knowledge sharing
- Risk assessment and management
- Water campaigns and awareness raising
- The importance of education and awareness that will go a long way in taking care of our natural resource and improving the living conditions through better health and sanitation while helping the upkeep of our natural environment.
- An action group comprising of four groups of ten people were formed. The entire stretch of the stream from the headwater till it confluences with the main river was divided among the four groups.

d) Lessons Learned

- As popularly known by an adage “where there is a will, there is a way”, even problems that seem quite daunting could be resolved through cooperation, participation and team work.
- In spite of the age old practice of using the nearby bushes and river banks in lieu of toilet the efforts of the Lango community paid off. Now the village wore a new look without the scattered shacks used as toilet; the stench from the faeces and toilets has also become a thing of the past; community has become proactive in areas of environment protection. They have developed a trash collecting center to dispose their litter. Open littering gives an ugly picture to the village and during times of monsoon trashes are swept into the river destroying our aquatic ecosystem.

14. Four major rivers restoration project in Korea

1. Rationale of a Good Case of Eco-efficiency

- a) This case will contribute to the sound restoration of the ecosystem through water quality enhancement and rehabilitation of rivers. The eco-efficiency measures taken will include improvement of the environment by the development of waterside belts and securing green-area belts through the development of ecological wetlands and riverside forests.
- b) Readjustments of farmlands in riversides which will reduce non-point pollution sources and improve the ecological environment are also an important eco-efficiency step.
- c) As a part of the Green New Deal, which is an eco-efficiency instrument, the rivers restoration project will be utilized as a new growth engine.
- d) The development of remote sensors will enable real-time monitoring of water pollution, water level, vulnerable areas upon disasters, and facilities such as bridges and dams. This is an eco-efficient approach as it will allow us to assess the impact on environment and act accordingly.

2. Policy Information

- a) *Objective:*
 - To establish fundamental countermeasures against repetitive damage from floods and droughts
 - As a part of the Green New Deal, this project will provide Korea an opportunity to position itself as a powerhouse in water resources
 - To provide various spaces and programs to meet the rising public demand for water sports and cultural activities
- b) *Document Source:*
http://www.macauley.ac.uk/hydroworkshop/background_summary.pdf
- c) *Contact information:*

3. Summary of the Policy

- a) *Description*
 - Fundamental measures are necessary due to frequent damages from flood and drought led by global warming. While the magnitude of damages from flood is increasing, there are insufficient investments for prevention activities, thus excessive amount of money is spent for post-restoration.
 - In order to restore the stagnant real economy, investment on river improvement is necessary in order to create new jobs and boost domestic demand. Furthermore, foundation for revitalizing the regional economy should be made by developing various riverside areas and programs for water leisure and cultural activities.
 - The rivers restoration is a packaged project that will resolve water-related problems and renew our territory centering on water. It is also a

comprehensive pan-government project that consists of various plans set up by diverse ministries with massive investment over a short-term period

b) Strategies Used

- Project to reinforce outworn riverbanks, amend washed-out areas, and restore ecosystem of rivers
- Proactive response against climate change- by converting from investment-centered on disaster recovery into investment focused on prevention.
- Diversification of ways to secure water resources by dredging sediments, instalment of reservoirs, expansion and connection of existing water resources and continuous development of new water resources
- Paradigm shift in waterway management policies
- Utilization of river areas as multipurpose spaces for the coexistence of the people and environment.

c) Five Core Challenges

- Need to secure adequate water supply (1.3 billion m³) to respond to future water scarcity drought due to climate change.
- Preemptive measures are necessary against repetitive floods due to climate change, as well as 200year floods.
- By 2012, the water quality of the mainstream will be improved to an average of level two by expanding sewage treatment facilities and establishing green algae reduction facilities.
- Rivers will turn into multipurpose areas for lifestyle, leisure, tourism, cultural activities, and green growth. To this end, bicycle lanes will be developed, hands-on tour programs will be promoted, and walkways and sport facilities will be expanded.
- The project will also contribute to regional development through various plans that utilize the infrastructure planned in the project and the scenery.

d) Expected Outcomes

- Reduce damages (2.7 trillion/year) and restoration cost (4.2 trillion/year) incurred every year due to flood by reinforcing riverbanks, constructing small- and medium-sized dams, and creating flood control area
- Supply water adequately in times of emergency by enlarging the size of water body through amendment of washed down areas, establishment of dammed pools, and redevelopment of reservoirs. This can also improve water quality.
- Create recreational spaces in the river front and bicycle lanes to give people more opportunities to enjoy leisure activities
- Produce new renewable energy with photovoltaic and hydro power generation and reduce CO₂ through eco-wetland and river forest development
- Leverage revitalization of regional economy through Korean version of the Green New Deal policy including the creation of new jobs for 190,000 people and generation of 23 trillion won of production.

15. Cleaning Up of Singapore River And Kallang Basin in Singapore

1. Rationale of a Good Case of Eco-efficiency

- a) This project can be used as a model for the rapidly developing and urbanized cities. It contains many aspects of the eco-efficiency approach ranging from social, economic and environmental issues that a city can adopt or modify to suit its needs.
- b) This was achievable by putting in place legislative instrument and enforcement measures as well as monitoring programmes which are worthy for replication.
- c) Several eco-efficient techniques, such as vertical gratings were installed at selected outlet drains leading to main canals and rivers to prevent litter and debris inside the drains from entering the canals and rivers. In addition, float booms were installed at strategic locations in rivers and canals to prevent litter and debris in the rivers and canals from entering the Kallang Basin and Singapore River. The debris trapped by the gratings and booms are removed for disposal daily. Thus we can see that the overall eco-efficiency in the scientific techniques used could help for the clean-up of the river basin.
- d) Proper monitoring is a part of any sustainable approach and hence regular inspections are conducted to ensure that all wastewater is discharged into the sewerage system and trade effluent treatment facilities installed by industries are properly and efficiently operated and maintained.

2. Project Information

- a) *Objectives:* To clean up the rivers such that clean water can flow in our rivers and support aquatic life.
- b) *Budget:* Amount: S\$200 million; *Source(s) of funds:* Government of Singapore
- c) *Document Source:*
http://www.unescap.org/drpad/vc/conference/ex_sg_14_csr.htm
- d) *Contact information:* Ministry of the Environment

3. Summary of the Project

- a) *Background*
 - Singapore River and Kallang Basin catchments cover about one-fifth of Singapore's total land area. Since the founding of Singapore in 1819, Singapore River had been the life line of trading and business activities. With rapid population growth and urbanization over the years, the waterways leading to the Singapore River and Kallang Basin degenerated into an open sewer and rubbish dump as all forms of waste were indiscriminately discharged into them.
 - The main sources of water pollution in the rivers were squatter colonies, backyard industries, street hawkers and vegetable wholesalers, and pig and duck farms.

- There were sewerage facility for these premises and wastewater was discharged directly into the river. There were also people living on board lighters in the river. Wastes from these lighters were dumped into the river.
- By 1977, the water in the Singapore River was black, foul smelling and devoid of aquatic life. The river was dead.

b) Description

- The Ministry of the Environment drew up an Action Plan in 1977. The plan included resettlement of more than 16,000 families living in squatter colonies into public housing estates served by public sewerage system and waste storage and removal facilities, and the relocation of 2,800 polluting backyard trade industries to new industrial workshops in new industrial estates. About 5,000 street hawkers were relocated into food centers premises provided with public sewer and waste disposal facilities. Some 610 pig farms and 500 duck farms were either phased out or relocated to other areas. Polluting industries and trades were also resited to other areas with proper pollution control facilities. In addition, extension and provision of sewer facilities were extended to the entire Singapore River and Kallang Basin catchment.
- After the sources of pollution were removed, work was started to improve the physical appearance of the rivers. The river was dredged to remove tonnes of bentonite deposit at the riverbed. Quay steps and rubble along the river waterfront that had deteriorated were repaired.
- The riverside walkway along the Singapore River were tiled, turfed and filled with bushes to add colour and greenery to the riverside scene. Physical improvements to the 3km stretch of the beach along the Basin were also carried out. Facilities such as river walls, piers, shelters and benches were provided to turn the surrounding area into a riverside park.
- The project was spearheaded by the Ministry of the Environment. Action Programmes were formulated and submitted to Cabinet for approval. A high-level Working Committee comprising various government ministries and statutory boards was set up to look into the implementation and monitoring of the action programmes. Besides government agencies, the 10-year project of Cleaning up Singapore River and Kallang Basin involved grassroots and civic organization, business community and NGOs.

c) Strategies Used

- Introduction of an environmental management strategy - i.e. prevention, enforcement, monitoring and education
- Implementation of land use planning - i.e. ensure that developments are properly sited and are compatible with surrounding land uses to achieve a quality environment
- Putting in place comprehensive environmental infrastructure, such as the sewerage system and refuse collection system
- Putting in place legislative instrument and enforcement measures as well as monitoring programmes

- Cultivating an environmentally conscious population through environmental education
- Cooperation amongst the various government agencies implementing the various programmes e.g. provision of public housing and industrial workshops, relocation of farms, etc.
- Ownership of Singapore River and Kallang Basin by the 3P (People, Private and Public) sectors.
- Above all, the critical factor for the success of cleaning up of Singapore River and Kallang Basin is the political will of the government.

d) Lessons Learned

- After 10 years of cleanup, the project was finally completed in 1987. A cleaner environment, cleaner water and the return of aquatic life are what we have achieved after the cleanup.
- The clean rivers have now been harnessed for recreational uses, and the land along the rivers has been developed for commercial and residential uses. Several areas along the rivers have become interesting recreational areas for both tourists and locals.
- With careful land use planning, land for various uses is safeguarded to achieve social and economic development and to maintain a quality environment. Environmental controls have been factored into the land use planning to help ensure that developments are properly sited and are compatible with surrounding land uses.
- To ensure sustainability of clean water in the rivers, Singapore continues to plan, coordinate and implement programmes to prevent pollution from entering into the rivers. In addition, Singapore launched the Singapore Green Plan 2012 (SGP 2012) in 2002 to set down clear targets to enable Singapore to strive for environmental sustainability.

e) Results/Impacts

- Singapore and Kallang Basin were cleaned up by 1987. The foul odour from Singapore River is history. Aquatic life has returned to the rivers. The next task was to manage and control pollution. Because of the high degree of urbanisation, problems such as littering and sullage water discharge still remain. To keep the rivers clean, engineering measures were adapted to minimise pollution of the rivers. Programmes were also carried out to educate the public against littering and the discharge of wastes in to the rivers. Another key factor in water pollution control is the effective enforcement of legislation.
- The river which was black, foul smelling and devoid of aquatic life and dead in 1977 was cleaned up by 1987. A cleaner environment, cleaner water and the return of aquatic life are what were achieved after the cleanup.
- The project was a complex and massive one that planned 10 years. It had many components and there is the option of choosing one of the components for a short-term action plan with an impact.

16 Experience of Taehwa River Development in Republic of Korea

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficiency concept was highlighted through the waterway management policies which also simultaneously alleviated flooding risk and damages.
- b) Any other point of importance was the riverside ecosystem recovery and the utilization of the river areas as multipurpose spaces for the co-existence of the people and environment which is eco-efficient approach towards the overall ecosystem.
- c) This project had a positive impact on the environment and a great variety of fish, including a rare goby minnow, is known to be found in the river nowadays which had turned to be a dead river in late 1990s.
- d) Details action plans to stop the discharge of pollutions, new installment of drainage pipes into wastewater treatment plants, educational programmes for awareness, and strict enforcements together accounted for the positive impact.

2. Project Information

- a) *Objective:* The master plan for the improvement of water quality and the preservation and restoration of the water ecosystem of Taehwa River included the following four themes:
 - Safe and clean Taehwa River
 - Ecologically healthy Taehwa River
 - Familiar and intimate Taehwa
 - Taehwa River in history and in the future
- b) *Contact information:* Dr. Kwon Changki, kwon@udi.re.kr; udi7337@hanmail.net

3. Summary of the Project

- a) *Description*
 - Korea needs fundamental measures against damages from floods and droughts that are increasing due to climate change as well as an adequate amount of water resources to prepare for water security.
 - The changing landscape of Taehwa River since 1960s as a consequence of post-war industrialization, heavy & chemical industrialization and automobile industry which led to the death of the Taehwa River has urged the need to restore it.
 - As a part of the Green New Deal, the project will provide Korea an opportunity to position itself as a powerhouse in water resources and securing abundant water resources against water security. To become an environment-friendly ecological city, the “organization of world-renowned Taehwa River” plan was adopted.
- b) *Strategies Taken*
 - Enhanced discharging water of the Eonyang Water Quality Improvement Office, improved river self-purification, and the main current source contaminants

control will be promoted.

- In addition, non-point source pollutants management (formation of a riverside buffer zone in Baekcheon), chlorophyta prevention, sustained water security (utilization of under flow water, river-bed filtration method), and natural environment improvement will be done.
- Riverside ecosystem recovery (formation of fishways and vegetation zones, etc.), natural river formation (formation of rapids, ponds, ecological revetment, etc.), ecological infrastructure implementation (formation of ecological pathways and biotops for birds), connection with Ohsansipri bamboo forest (Shinsamho Bridge to Ohsan Bridge), and construction of ecology park (Eonyang, Samsan Water Drainage System, reclamation sites, etc.) will be promoted.
- Construction of ecology parking lot (Eonyang National River area), construction of riverside stage, improvement of pedestrian pathways, construction of bicycle roads, scenery improvement and remodeling of bridges, construction of a Water Environment Pavilion, and construction of water leisure sporting areas were selected to be promoted.
- of guidelines and standards for decentralized rainwater management in housing complex.
- Excavation of the historical and cultural exploration path of Taehwa River, historical restoration survey and designing of Taehwaroo, establishment of the Taehwa River Culture Festival, and issuance of the ordinance to improve the scenery of Taehwa River of integrated model (RainStock) for decision support of rainwater management systems in housing complex will be done.

c) Activities Undertaken

- The main activities included the process of expanding the basic infrastructure of the upper stream of Taehwa River, restoration of water ecosystem in Taehwa River and improvement of water quality in major streams of Taehwa River.
- The bottom was dredged, which allowed abundant water to flow, and the polluted river was reengineered in an eco-friendly manner.
- By securing enough water, improving its quality and restoring the ecosystem as well as preserving cultural legacies in the vicinity of rivers, it is possible to increase the value added from the rivers.

d) Keys to Success

- The success of the project to revive the River can be attributed to the establishment of local governance which mobilized the ability and capability of Ulsan citizens, the leadership of the mayor, and the effort and tenacity of public servants.
- A precautionary approach was taken with efforts and roles of citizens, local companies, etc, provided a steadfast support to make local governance work in cooperation with administrative organizations, citizen groups and local experts to revive the ecosystem of Taehwa River and preserve its history.

17. Tsurumi River Basin Water Master Plan in Japan

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficient approach in this plan tried to minimize disaster damage even if it is beyond the design level. It is important to predict and take preservation measures against impact on the hydrologic environment due to change in watershed land use.
- b) Several eco-efficient features such as, greenery preservation areas, disaster mitigation regulating reservoirs and levee construction had a positive impact on the environment.
- c) The multipurpose retarding basin was an eco-efficient step which was built as a flood control measure, features a wide open space. This space serves as a sports venue, a recreation area, and a lush national park for local residents in addition to protecting people from flood and improved the overall environment.
- d) Capacity-building and participation of stakeholders in planning is likely to result in reduction in cost and time for decision making, which is an important part of eco-efficient approach. It is important to take preventive measures in advance. There was a group to provide guidance on evacuation plans.
- e) Tsurumi River Basin Action Plan gives the first priority to feasibility, and thus it should serve as a useful reference on steady implementations of action plans.
- f) Thus, we see that many aspects of the environment were taken into consideration in this plan. The eco-efficient features such as formulation of proper working groups, and integrating green environment with the mitigation measures had an overall positive impact.

2. Project Information

- a) *Objectives:* The Tsurumi River Basin Water Master Plan was pursued with an aim to:
 - Protect Tsurumi River Basin from flood disasters;
 - Create rich and clean water environment;
 - Regenerate a city where people and nature can interact in harmony while preserving and utilizing the basin landscape and biodiversity;
 - Protection of Tsurumi River Basin from earthquake and fire disasters;
 - Achievement of pleasant life with basin awareness through promoting people's engagement with the river
- b) *Time span:* The plan was completed in six years time after thirty meetings with various participants.
- c) *Document Source:*
<http://www.csdwand.net/data/sheet.asp?cn=Japan&fn=LA1470>
- d) *Contact information:* Masaru Kunitomo; kunitomo-m82ac@mlit.go.jp

3. Summary of the Project

- a) *Description*

- The Tsurumi River Basin, located in the suburbs of Tokyo, extends over an area of 235 square kilometers and a river length of 42.5 kilometres. The Tsurumi River Basin is regarded as one of the most important and representative river basins in Japan.
- The process of the rapid urbanization in the basin generated a great concern to keep advancement of flood control for the region. In other words, the traditional concept of river development became inadequate for securing the safety-level against flood.
- To formulate adequate solutions, the basin management authority called for the establishment of a committee consisting of experts from the academia, basin municipalities and river administrations. The committee undertook the efforts of simultaneously advancing river development and flood control measures with the aim to solve water problems basin-wide.
- In this effort, measures such as those against urban rain runoff increase were addressed in the basin from the stages of the city planning and development by the basin municipalities. This initiative set a precedent for integrated flood control measures in Japan.

b) Action Taken and Strategies Used

- The water master plan agreement was reached through cooperation and discussion among various administrative sectors
- Particularly, the Tsurumi River Basin Commission invites for public participation and up to present 100 people are registered.
- Formation of the Tsurumi River Basin Water Preparatory Committee and the Tsurumi River Basin Water Committee
- Nine times Tsurumi River Basin Water Master Plan Administrative Conference was held.
- Opinions from citizens and administrative agencies are exchanged consistently within Tsurumi River Basin Water Commission.
- Tsurumi River Basin Water Council evolved from the reorganization of Tsurumi River Integrated Flood Control Measures Committee.
- Some of the strategies used were: -Building partnerships, participatory capacity and empowerment in civil society, training to build capacity in water professionals, developing water management indicators, information and transparency for raising awareness, shared vision planning and consensus building.
- Four scientific facilities aimed at improving the water quality were used:
 - Environmental preservation hybrid water quality purification system using vegetation waterways
 - Water cycle, water repurification system based on biological treatment
 - Natural cycle water purification system using microorganisms
 - Rapid water purification system during times of rainfall to rapidly separate clean and contaminated water flows.

c) Lessons Learned

- The agreement on the water master plan was reached through cooperation and discussion among various administrative sectors (river, sewage, water-supply, roads, parks, cities, environment, agriculture, construction, disaster prevention and education), citizens, enterprises and NGOs.
- To implement the Tsurumi River Basin Water Master Plan, which involved the large number of concerned parties as participants, many years (6 years) and many meetings (30 times) were needed. However, in order to gather a wide range of opinions from all concerned parties and to reflect them in the Master Plan, patience and steady effort was essential for its success even if it took a long time.
- To implement action plans steadily, it was important to set short-term targets and to conduct continued reviews of its progress.
- Monitoring by measurable indicators and the reporting of its results were essential tools for concerned parties to share the effects of the implemented measures.
- By involving various stakeholders in planning and implementation process, diverse methods of finance became available. Tsurumi River Basin Water Master Plan was intended to be carried out through cooperation and collaboration among residents, civic groups, enterprises and administrations within the basin, opinions of various concerned parties were incorporated during its formulation process.

18. Pasig River Rehabilitation Project in Philippines

1. Rationale of a Good Case of Eco-efficiency

- a) PRRC facilitated the relocation of informal settlers along the banks of the Pasig River to secure and affordable socialized housing project.
- b) As an eco-efficient approach, the PRRC with the assistance of some government agencies and private sector is using the toxic absorbing capability and aesthetically pleasing characteristics of the Millionaires Vine Plant for the treatment of the contaminated waters of Pasig River and the greening of its riverbanks. This method, called phytoremediation, utilizes plants to absorb and break down organic and non-organic pollutants in the river.
- c) The factories along the river will not be allowed to dump toxic water into the river and there has been a call for the use of environmentally friendly chemicals and totally biodegradable products as well as use of technologies that can bioremediate at the source to improve the eco-efficiency.

2. Project Information

- a) *Objectives:* The vision of the mandate was “a Pasig river, clean and alive reflecting the country’s noble history and socio-economic progress” while the mission was “to restore the Pasig river to its historically pristine condition by applying bio-eco-engineering and attain a sustainable socio-economic development.” The goal is to restore river water quality to Class “C” level.
- b) *Document Source:* <http://www.hic-net.org/document.asp?PID=197>
- c) *Contact information:* David Von Rueden;

3. Summary of the Project

- a) *Description*
 - The Pasig River which runs through the heart of the metropolis was the city’s center and lifeline. Deterioration of the Pasig River became noticeable as far back as the 1930s. By the early 1990s, the Pasig River was generally considered biologically inactive. Rehabilitation of the river began in 1991 with help from the DANIDA, where relocation of families was emphasized. There was much opposition from the people initially.
 - The Pasig River Rehabilitation Commission (PRRC) was created on January 1999 through Executive Order 54 to ensure that the Pasig River is rehabilitated to its historically pristine condition conducive to transport, recreation and tourism. It was amended by Executive Order 65 to involve the private sector in the rehabilitation of Pasig River. Consolidating the various government offices in charge of aspects of Pasig River rehabilitation into a single body, the Commission has the mandate to plan, coordinate, evaluate, approve, implement, supervise, and monitor plans, programs, projects and activities; and enforce rules and regulations towards the rehabilitation of the river.

b) Action Taken and Strategies Used

- Legal actions taken in the form of Executive order numbers 54, 65 and 510 and also implementing rules and regulations.
- Construction of artificial wetlands, ferry stations, housing units to relocate people, linear parks in different cities along the river.
- Formation of Environmental Protection Areas and a master plan to integrate and coordinate development programs
- Abate industrial wastewater and sewerage dumping and enforce environmental laws.
- Relocation of formal and informal settlers.
- Undertake civil works such as dredging, clearing of structures, cleaning of the river and its tributaries/esteros.
- Formulate implementing rules and regulations and send the status report to the President
- Coordinate with national and local government agencies/units.

c) Lessons Learned

- It was found that the polluting industries had adequate waste treatment facilities but still could not comply with the standards due to the inefficiency of their operations. This program should conduct training for waste treatment plant operators for these companies.
- The presence of laws and regulations and their enforcement against littering and dumping have helped the programme in its drive to reduce floating wastes on the river.
- As exemplified by the municipal government of Marikina, the development of the riverbanks depends mainly on the local government's political will and actions.
- The long-term success of the programme also hinges on the capability of its managers to obtain the resources required to meet its objectives.
- Increased co-ordination between the agencies and organizations involved in the programme through closer review of the plans or implementation, common efforts at capacity building, and critical support to key projects.
- Constant review and upgrading of the plan of operation. The programme should be flexible in order to respond to rapid changes in the economic and political environment.
- An aggressive campaign to raise resources to ensure the implementation of the key projects in the plan of operation.
- Strengthening public participation in the programme. Private organisations are usually more capable than a government of sustaining initiatives because they are less affected by political considerations.
- A total of 24.64 linear meters of parks have been completed extending from the City of Manila to Taguig City.

19.The Eight Principles of Successful Rainwater Harvesting, Melbourne

Rationale of a Good Case of Eco-efficiency

- a) All these principles integrate the eco-efficiency approach and can apply equally to the conceptualization, design, and implementation of all water-harvesting landscapes and need to be integrated to realize a site's full potential. These can greatly enhance success, reduce mistakes and enable to adapt and integrate a range of strategies.
- b) These are the basic principles adopted in Australia for the success of rainwater harvesting technique and can be used anywhere with slight modifications according to the country needs.

Document Source:

<http://www.harvestingrainwater.com/rainwater-harvesting-inforesources/>

The eight principles for successful rainwater harvesting are as given below:

1. *Begin with long and thoughtful observation*
Use all your senses to see where the water flows and how. What is working, what is not? Build on what works.
2. *Start at the top (highpoint) of your watershed and work your way down*
Water travels downhill, so collect water at your high points for more immediate infiltration and easy gravity-fed distribution. Start at the top where there is less volume and velocity of water.
3. *Start small and simple*
Work at the human scale so you can build and repair everything. Many small strategies are far more effective than one big one when you are trying to infiltrate water into the soil.
4. *Slow, spread and infiltrate the flow of water*
Rather than having water run erosively off the land's surface, encourage it to stick around, "walk" around, and infiltrate into the soil. Slow it, spread it, sink it.
5. *Always plan an overflow route, and manage that overflow as a resource*
Always have an overflow route for the water in times of extra heavy rains, and where possible, use the overflow as a resource.
6. *Maximize living and organic groundcover*
Create a living sponge so the harvested water is used to create more resources, while the soil's ability to infiltrate and hold water steadily improves.
7. *Maximize beneficial relationships and efficiency by "stacking functions"*
Get your water harvesting strategies to do more than hold water. Berms can double as high-and-dry raised paths. Plantings can be placed to cool buildings in summer. Vegetation can be selected to provide food.
8. *Continually reassure your system: the "feedback loop"*
Observe how your work affects the site, beginning again with the first principle. Make any needed changes, using the principles to guide you.

20. Integrated Storm Water (Rainwater) Management in RoK

1. Rationale of a Good Case of Eco-efficiency

- a) The integrated stormwater management in itself is an eco-efficient method because of the double benefits to the society through the integration of stormwater management and rainwater harvesting.
- b) The integrated planning contains all possible use of eco-efficient infrastructures and devices to increase the storage, infiltration, use and reuse of stormwater as a new source of water.
- c) Analysis and design of rainwater management facilities are based on water balance relationship which is considered to be an eco-efficient approach. This approach includes – design of storm or catchment area, estimation of rainwater storage and infiltration, simulation by dimension cases and finally the economic efficiency.
- d) The eco-efficiency concept was highlighted through the development of green filters where no external power source is required for operation. The filter media is made from recycled wood (manufactured in USDA Forest products Lab), which removed pollutants and particles from rainwater in an environment friendly way for usage by common.
- e) The rain-city approach has positive impact on the society and the plan, design and management of rainwater facility adds to the limited water resources available and side-by-side reduces pollution of the main rivers across Korea.

2. Project Information

- a) *Objective:*
 - Technology diffusion and commercialization of rainwater management technologies for housing complex through a pilot project
 - Direct and indirect security of 0.8 m³ of water
 - Improvement of technology level up to 80 % of developed countries.
 - Development of decision support system for rainwater storage and utilization, which is optimized for Korean weather conditions and environment
- b) *Document Source:* <http://www.water21.re.kr/en/6-2.asp>
- c) *Contact information:* Dr. Reeho Kim, rhkim@kict.re.kr

3. Summary of the Project

- a) *Description*
 - Average annual rainfall has slightly increased over the last century, but variations in annual rainfall have significantly increased over the years leading to distortions in the water and heat cycles. This has given rise to a need for alternative water resources.
 - Rainwater Management includes many major functions like:- prevention of river flow drying, supply of additional water, control of non-point source pollutants, prevention of urban flooding, alleviation in heat island, restoration of hydrological cycle.

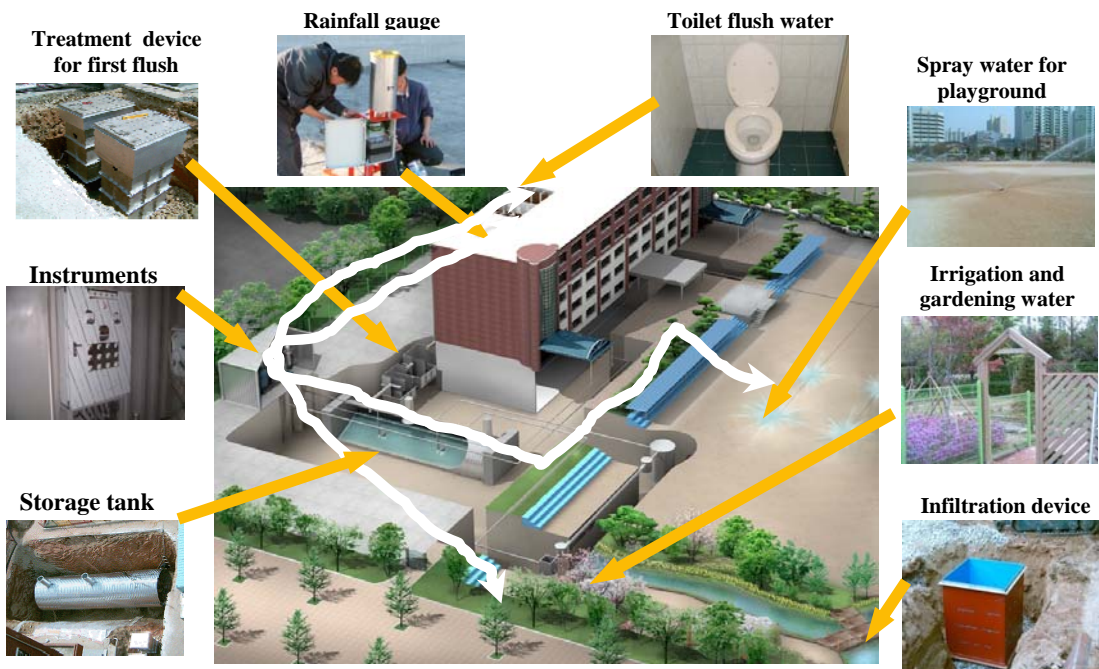
- Low carbon green growth is the national vision of Korea over the next 60 years. Hence, the need to build the policies related to rainwater management on the concept “The Green New Deal” where there is a need to convert to systems with low carbon emissions and high efficiency.

b) Strategies Taken

- Development of technologies for application, planning, and designing of multi-functional catchment system using planted area
- Technology diffusion and commercialization of rainwater management technologies for housing complex through a pilot project
- Development of monitoring and management technologies for rainwater management systems in housing complex
- Preparation of guidelines and standards for decentralized rainwater management in housing complex
- Commercialization of integrated model (RainStock) for decision support of rainwater management systems in housing complex
- Several ordinances by the local governments and rules and laws by the central government with support from different ministries have been passed for rainwater use, rainwater management and integrated water management.
- Ubiquitous management system through integrated operation and maintenance system based on remote monitoring and control with minimum man-power.

c) Activities Undertaken

- The “Green School” Project undertaken by the Ministry of Education and Science, Technology is for the application of environmentally friendly techniques such as green space and rainwater harvesting in schools
- Project for Rainwater Storage and Infiltration by the National Emergency Management Agency invests to establish facilities for rainwater storage and infiltration. They also invested 20 billion won in Busan to support rainwater storage system upto 45,000 m³ in public families and parks.
- Law to promote and support water reuse was established by the Ministry of Environment so as to encourage widespread application of rainwater harvesting facilities, thereby also improving the water quality of four big rivers through control of non-point source pollutions.
- New towns with decentralized rainwater management for saving water resource and improving amenity have been introduced by the Ministry of Land, Transport and Maritime Affairs.
- Construction of a nature-adapted city in Asan city through rainwater management. This is done by underground connections of rainwater collection tanks and infiltration tanks and trenches.
- Demonstration town for disaster prevention in Samcheok, Geumsan, Janghung via a packed approach for various projects of disaster prevention, rainwater storage and infiltration for stormwater control and introduction of rainwater management facility for sound water cycle and improved efficiency of water use.



d) *Keys to Success*

- Field experiments and demonstrative projects of construction of nature-adapted cities through rainwater management have helped the understanding by the common and intrigued an overall interest.
- Support from the decision-makers and policy-makers and passing of ordinances, laws and rules to promote integrated stormwater management.

21. Utilization of Rainwater Catchment in Flood Control in Taiwan

1. Rationale of a Good Case of Eco-efficiency

- a) This project implemented the integrated planning of stormwater and land management to improve the eco-efficiency by collecting storm runoff water in infiltration enhancement facilities or storing it in retention ponds.
- b) The use of AGNPS model to assess watershed conditions and objectively evaluate storm-related generation and transport combined with the data analysis and other technologies (pollutants flow through cells in a step-wise manner) helped to improve the eco-efficiency through integrated planning.
- c) Collected rainwater (runoff water storage) could increase the availability of alternate water resources and rainwater thus collected could be used for irrigation, livestock husbandry, aquaculture, recreation, and reclamation of wasteland and/or introduction of high yielding cash crops. This is considered to be an eco-efficient approach, adding more value to the environment on one hand and diminishing the negative impact on the other hand.
- d) This planning provided other indirect benefits that include depressing flood peaks, diminishing soil erosion, providing large sediment storage space, and improving the operation of reservoirs and channels, thereby having a positive impact on the environment.

2. Project Information

- a) *Place:* Hsichih area, Taiwan
- b) *Objectives:* The purpose of this project is to demonstrate the effectiveness of stormwater collection using small infiltration enhancement structures and retention ponds in Hsichih area, Taipei.
- c) *Document Source:* <http://www.philwatershed.org/rwu/flood-control>
- d) *Contact information:* K.F. Andrew Lo; ufab0043@ms5.hinet.net

3. Summary of the Project

- a) *Description*
 - Taiwan is a country with frequent flood and drought problems. Suitable reservoir sites are limited. Wet and dry seasons are very pronounced and the available water resources are limited. Torrential typhoon rains often lead to massive soil movement and concentrated runoff and large peak flow, causing significant damages downstream in the Hsichih area, Taipei.
 - Up till now, the most popular flood control strategy always focuses at the end treatment method using engineering structures. So far, no major breakthrough has been achieved. It is therefore, the purpose of this study to control floodwater using low-impact runoff retardation technology.
 - The Agricultural Non-point Source (AGNPS) model is a computer simulation model capable of evaluating nonpoint source pollution at any point within a watershed. It is also capable of identifying areas within the watershed with

high runoff and erosion. This provides a guide useful for selecting the best sites to install infiltration enhancement facilities and retention ponds.

b) Strategies and Actions Taken

- Different types of runoff retardation facilities were used: (1) Dry pond (2) Wet pond (3) Wetland (4) Bio-retention storage (5) Gravel-pore storage (6) Rooftop rainwater catchment (7) Underground storage, and (8) Infiltration enhancement
- Watershed data being gathered in Hsichih that includes soil, topography, hydrology, and land use.
- These information along with the AGNPS model are used to assess watershed conditions and objectively evaluate storm-related generation and transport.
- Potential pollutants are routed through cells in a stepwise manner, proceeding from the headwaters of the watershed to the outlet. This allows flow as well as water quality parameters to be examined at any point.
- To form the input data file needed to operate the model, the Hsichih watershed was first divided into 526 uniform cells. Each cell occupied approximately 10.7 ha in area. The drainage direction of each cell, defined as the direction of flow leaving the cell, was estimated based on its shape and topographic setting.
- The erosion and runoff potential of the Hsichih watershed was first determined with a rainfall amount of about 3,050 mm and a rainfall erosivity index of 12,254.
- Use of computer modeling to select the best sites to install devices.
- A total of 36 sites were selected and most are situated at the upper northern and southern parts of the watershed.
- Storm water is controlled in the upstream of the watershed.

c) Lessons Learned

- Although the effectiveness of this technology is only limited to a certain size of storm events, it can easily control ordinary flood with satisfactory results.
- Usually small-scale runoff retardation facilities may not be able to prevent large storm runoff events. However, they may mitigate the problem to a certain extent.
- To allow automatic site-selection, necessary design parameters such as the range of slope gradient, runoff volume or depth, and acceptable sediment load, need to be specified.
- The ideal sitting of infiltration enhancement facilities and ponds should satisfy the following design criteria: (1) upper reaches of the watershed; (2) maximum runoff interception; (3) minimum sediment load, (4) the drainage pattern of the watershed
- The effectiveness of storm water collection was proved to be eco-efficient because it diminished the effects of growing population and economies such as severe soil erosion and runoff, ruined water retention capacity, accelerated water pollution rate, and water pollution problems in reservoirs, through utilization of rainwater catchment in small-scale run-off retardation facilities.

22. Rainwater Harvesting in The North-Eastern Region in Thailand

1. Rationale of a Good Case of Eco-efficiency

- a) Rainwater harvesting can coexist with and provide a good supplement to other water sources and utility systems, thus relieving pressure on other water resources and hence can be considered as an eco-efficient approach.
- b) The eco-efficient aspect is that traditional rainwater harvesting can be adapted to provide a sustainable option for rural drought-prone areas where groundwater and surface water are scarce and contaminated.
- c) Initially implemented by the Population and Community Development Association (PDA) in Thailand, the demonstrated success of the rainwater jar project has encouraged the Thai government to embark on an extensive national program for rainwater harvesting as an eco-efficient approach.

2. Project Information

- a) *Objectives:* Water savings through rainwater harvesting and a demonstration case
- b) *Document Source:*
- c) http://www.gwptoolbox.org/index.php?option=com_case&id=28&Itemid=46
- d) *Contact information:* Wilas Techo; pda@pda.or.th

3. Summary of the Project

- a) *Description*
 - Rainwater harvesting has been practised since time immemorial but water stored in traditional earthen jars was not enough to last 6 months of dry seasons and often contaminated. Government of Thailand had a policy of providing all villages with a water supply system but faced a large backlog of villages to be assisted.
 - Population Development Association (PDA) coordinated with government in the assistance to villages in the Northeast.
 - The new rainwater harvesting equipment comprised standardized models of water tank and a giant jar (capacity of 2 to 11.3 cubic meters) which were constructed locally. Each village enters into a contract with PDA. PDA trains a village technician on rainwater harvesting systems; PDA identifies villagers interested in getting a system and offers technical options; cost recovery scheme is adapted to each household (usually 6 to 12 months); trained technician installs the system and waste water disposal; a water committee is established in case of village piped water system; operation and maintenance is fully paid and assumed by households and/or villages; villages plan and implement reforestation schemes.
 - A revolving fund was set up to support the programme, appropriate to the capacity to pay of rural people However, cost recovery is cumbersome for technicians; villages have been reluctant to participate at the outset because

government promised to provide free assistance in water resource development.

b) Action Taken

- The first approach involves technical assistance and training villagers on water jar fabrication. This approach is suitable for many villages, and encourages the villagers to work cooperatively. Added benefits are that this environmentally appropriate technology is easy to learn, and villagers can fabricate water jars for sale at local markets.
- The second approach is applicable to those villages that do not have sufficient labour for making water jars. It involves access to a revolving loan fund to assist these villages in purchasing the jars.
- Villagers are also trained on how to ensure a safe supply of water and how to extend the life of the jars.

c) Strategies Used

- Ownership and self-maintenance of the water jars are important. Training of the villagers and their commitment and understanding of the concept.
- Use of rainwater harvesting at large scale for drought prone, water scarce areas, is feasible; but community participation to ensure financial sustainability is the key with proper access to a revolving loan fund.
- Co-ordination of the PDA with the government for assistance to villages
- The decision to assist villages was based on willingness and ability to pay the full cost, and poor households were supported by affordable options.

d) Lessons Learned

- Villagers are willing to help themselves with development of water facilities provided they are given the opportunity and skills. Villagers seem to value their water tanks more since they spent money on it.
- Trained village technicians can perform most of the tasks necessary for construction, operation and maintenance of rainwater harvesting structures; however, it is important to pay the technicians to keep them working for the project and ensure sustainability of the revolving fund of the project.
- Villagers understand better the need to protect water resources by planting trees and protecting vegetation cover. Users of rainwater are usually the owners who operate and manage the catchment system, hence, they are more likely to exercise water conservation because they know how much water is in storage and they will try to prevent the storage tank from drying up.
- Rainwater harvesting provides a water supply buffer for use in times of emergency or breakdown of the public water supply systems, particularly during natural disasters and can reduce storm drainage load and flooding in city streets.

23. Rainwater Harvesting And Utilization In Urban Areas in Japan

1. Rationale of a Good Case of Eco-efficiency

- a) The eco-efficiency approach has been initiated through rainwater harvesting and utilisation programme in order to change the way the city interacts with the natural water cycle, leading to a more stable water supply system.
- b) One of the key features to achieve eco-efficiency is knowledge transfer and community awareness. The threats such as, degradation of water quality due to lack of inadequate sewers and lack of awareness of proper waste disposal and recycling could have worked as survival risks. But, diffusion of rainwater harvesting with social networks resulted in an effective and positive impact on the residents and businesses.

2. Project Information

- a) *Place:* Sumida Ward, Japan
- b) *Objectives:* To propagate rainwater harvesting movement among local community in order to reduce water related risks and fill up water supply for the community.
- c) *Document Source:*
<http://www.dpri.kyotou.ac.jp/dat/nenpo/no50/ronbunB/a50b0p21.pdf>
- d) *Contact information:* Dr. Makoto Murase, kankyuu@city.sumida.tokyo.jp

3. Summary of the Project

- a) *Description*
 - Sumida Ward is one of the 23 wards in Metropolitan Tokyo, with high rainfall and geography (the ward is surrounded by the Sumida and Arakawa Rivers). Sumida residents have often suffered from floods but paradoxically had concerns on inadequate water supply.
 - The biggest problem is concentrated torrential rains in small areas. Even if the torrential rain doesn't take place in Sumida Ward, it is vulnerable because water flows to Sumida Ward via the Sumida River. The result is overflowing sewage drain pipes.
- b) *Action Taken*
 - Introduction of rainwater utilisation facilities to public facilities, private housings, businesses and communities in the ward. Stored rainwater in the facilities is used to flush toilets, sparkle gardens and cool water in air conditionings. The subsidy programme arranged by the ward, along with guidance and information services, provides incentives for local businesses to efficiently use water resources by installing 'miniature dams (small-scale rainwater utilisation facilities)'. Invention of 'Rojison (community rainwater tanks with hand-operated pumps)' by the community residents also provided opportunities for raising environmental awareness.

- The ward invited local governments nationwide to organise the Rainwater Utilization Liaison Council for Local Governments to exchange policy ideas and experiences related to rainwater utilisation.
- Large efforts include the National Sumo Stadium, which has one of the largest rainwater collection facilities (over 100). The rainwater collected here is stored underground and is used to flush the toilets in the stadium.

c) *Keys for Success*

- The project leader (Dr. Murase) is the first to develop practical ways to use rain on such a scale in urban environments. His life-passion - to solve urban water shortages, provide water for many household uses to millions of people and change the way city planners view rainfall- has changed the mindsets of the city fathers and the Japan Sumo Wrestling Federation.
- One of the initial efforts of the ward was to install rainwater utilisation facilities in public buildings. Public facilities are visually attractive and relatively easy for residents to understand the mechanisms and advantages of rainwater utilisation.

d) *Results/Impacts*

- Installation of rainwater utilisation facilities in Japan's primary sumo wrestling stadium:- 26 public buildings, more than 160 private facilities and 9 'rojisons'.
- Organising the Tokyo International Conference on Rainwater Utilization (1994)
- Publication of the rainwater utilisation guidelines (1995)
- Formation of the Association of Businesses for Rainwater Utilization (2001)
- Establishment of the Rainwater Museum
- Publication of 'Rainwater Harvesting and Utilization: An Environmentally Sound Approach for Sustainable Urban Water Management (2002)'
- Sumida's rainwater utilisation projects are selected as a 'best practice' by the G8 Environmental Futures Forum 2000 and also received an excellent local initiative award from International Council for Local Environmental Initiatives (ICLEI) in 2000. Dr. Makoto Murase, Project leader and official of the Sumida Ward, has also received the Rolex Awards for Enterprise in 2002.

e) *Lessons Learned*

- Community revitalisation and creation of community identity.
- Ongoing practices
- Contribution to future policy planning
- Use of low and transferable technology
- Sustainable resource use
- Collaboration among municipal governments, citizens and local enterprises
- Rainwater utilization involved various stakeholders and the facilities turned to be a symbol of the communities.

24. Innovative Rainwater Harvesting and Management in RoK

1. Rationale of a Good Case of Eco-efficiency

- a) A new regulation to enforce the installation of a rainwater harvesting system in all buildings in December 2004 was enforced.
- b) Construction code was revised to provide incentives and to strengthen the regulations for rainwater harvesting
- c) In order to meet the requirements of the MDGs, mitigate flooding and drought, and maintain sustainability during changing climate and energy crises, a new paradigm for rainwater management is suggested in this case.

2. Project Information

- a) *Objectives:* To build a multipurpose rainwater management system for climate change adaptation
- b) *Document Source:*
http://www.iwapublishing.com/template.cfm?name=w21_december_2008
- c) *Contact information:* Professor Mooyoung Han; myhan@snu.ac.kr

3. Summary of the Project

- a) *Description*
 - Most of the world's water problems occur because of uneven distribution of rainfall in terms of time and space. Each year Korea experiences severe flooding after severe droughts including Seoul, Korea.
 - Existing infrastructure, such as storm water sewerage and river bank flood controls, may not be capable of containing the increased rainwater runoff, resulting in flooding.
 - The area for Star City Building (Apartment) in Seoul, Korea is also one of the recurrent flooding areas in Seoul.
- b) *Strategies and Actions Taken*
 - The city of Seoul announced a new regulation to enforce the installation of a rainwater harvesting system in all buildings in December 2004 while providing the incentives to owner of the building by changing the construction code.
 - i. All public buildings: compulsory for new buildings and recommended to the extent possible for existing buildings.
 - ii. New public facilities such as parks, parking lots, and schools should apply to the extent possible
 - iii. Private buildings: recommended for new buildings subject to building permission (floor area larger than 3000 m²).
 - iv. Large development plans such as new town projects: installation of a rainwater management system as a first priority.
 - Involvement of different stakeholders

- Research and development of technologies
- Developing a logical background and supporting materials for decision makers
- Education and public awareness
- Constructing worldwide networks

c) *Lessons Learned*

- Water problems are site specific, so the solutions should be site specific, too. Therefore, the solution to the water problems in a region can best be found from the old wisdom and traditions accumulated in that region, incorporated with modern technology.
- The vision of rainwater harvesting is to create a harmonized environment by properly and wisely utilizing rainwater, appreciating that it is a gift from heaven.

d) *Keys to Success*

- Rainwater is the source of all water
- Management by area (instead of by line)
- Decentralized management (instead of centralized)
- Source control (instead of end-of-pipe control)
- Involvement of local action (instead of top-down policies)
- Multi-purpose rainwater management (instead of single purpose)

e) *Future Activities*

- **Research and Technology Development:** We need to learn lessons from the past by investigating the old wisdom and philosophies from ancestors. In addition, parallel research on this field is also needed.
- **Information Exchange:** Despite the most severe weather conditions in the world, the wisdom and culture on how to survive has been proven throughout the millenniums. It is worthwhile to use the time-proven information that has been developed in order to find possible solutions to many of the world's water problems.
- **Education and Public Awareness:** The most important and efficient way to solve the world's water problem is to teach the next generation when they are in school by including it in their courses.
- **International Networking:** Networks for both experts and citizens in the world are suggested.
- The implementation of rainwater utilisation requires the support of government officials along with cross-departmental cooperation and coordination as well as training and educational opportunities

25. Wastewater Reclamation and Reuse Practices for Agriculture in Korea

1. Rationale of a Good Case of Eco-efficiency

- a) Wastewater reuse is to reduce water diversions from the environment (streams, rivers, and lakes), and to reduce point source pollution loadings. That helps the ecosystem which remains less affected by human activities.
- b) This is a promising alternative water resource that can be safely used for irrigation. It also reduces the application of fertilizer rates as much as by half.
- c) The eco-efficiency concept was highlighted through the use of economic feasibility studies for the reuse projects.
- d) The technical component of this project will help in the development of eco-efficient water infrastructure. The practical approaches for reclaimed wastewater and systems, as well as its high possibility for application to other countries are an eco-efficient approach.

2. Project Information

- a) *Objectives:*
 - To develop low cost and high efficient prototype wastewater treatment systems to reclaim effluent from wastewater treatment plants (WTP) and to reuse for agricultural uses.
 - To develop the reclamation (treatment) criteria and water quality criteria (standards/guidelines)
 - To evaluate crop yields and environment effects from wastewater reuse in agricultural lands
 - To assess health hazard risk for wastewater reuse for agriculture
 - To provide technical assistance for safe and sustainable wastewater reuse practices.
- b) *Project cost:* 580 Million Won (US\$480,000) in 2009
- c) *Document Source:* <http://www.water21.re.kr/en/6-4.asp>
- d) *Contact information:* Prof. Seung W. Park, swpark@snu.ac.kr
- e) *Duration:* The project has been implemented in 3 phases of research programs since October 2001
 - The First Phase (October 2001~ June 2004): Development of least cost and high efficient reclamation technologies for agricultural uses.
 - The Second Phase (July 2004 ~ March 2007): Applications of reclaimed wastewater for agriculture.
 - The Third Phase (April 2007 ~ March 2011): Applying integrated technologies for wastewater reclamation and reuse for agriculture

3. Summary of the Project

- a) *Description*
 - A higher priority has been given to the wastewater reuse projects for industrial,

agricultural, and in-stream uses in Korea. Total wastewater generated is 6.8 billion m³/year, and only 10% of them re-used as of 2007.

- While approximately 78% of paddy fields are irrigated, significant crop damage occurs through severe drought once in every four years. Alternative water resources are needed to mitigate drought damages in agricultural sectors.
- The research project is to develop technologies for sustainable wastewater reuse for crop irrigation. The benefits of using reclaimed water are:
 - To mitigate water shortage problems
 - To beneficially utilize nutrients in wastewater for crop production
 - To reduce potential pollution loadings from point sources
 - To utilize wastewater as alternative water resources and reduce new water resources development
 - To stimulate water industries by expanding wastewater reclamation projects
- The drawbacks of using reclaimed water are:
 - Health hazard risk and 'food safety concerns'
 - High initial and operational costs

b) Strategies Taken

- To develop sustainable, low-cost reclamation systems for crop irrigation so that the projects are affordable
- To demonstrate that reclaimed water irrigation is safe and sound through field experiments and exhibitive projects
- To provide technical assistants to local governments and farmers who are planning for new reclamation projects
- To provide continuous scientific monitoring for reclamation projects
- Technologies for wastewater reclamation and reuse have been applied to rice irrigation districts for the total of 2,050 hectares of paddy and dry cropland. Reclaimed wastewater that has been used for agricultural uses through the technical transfer from this research project will amount to 30 million m³ by 2010.

c) Lessons Learned

- Farmers tend to hesitate accepting reclaimed water as irrigation water resources in the beginning. Scientific evidences from field experiments and demonstrative projects were presented at town meetings until their concerns were answered and resolved.
- Reclamation systems should be low-cost and high efficient, and good maintenance is important to preventing any failure of the systems

d) Results

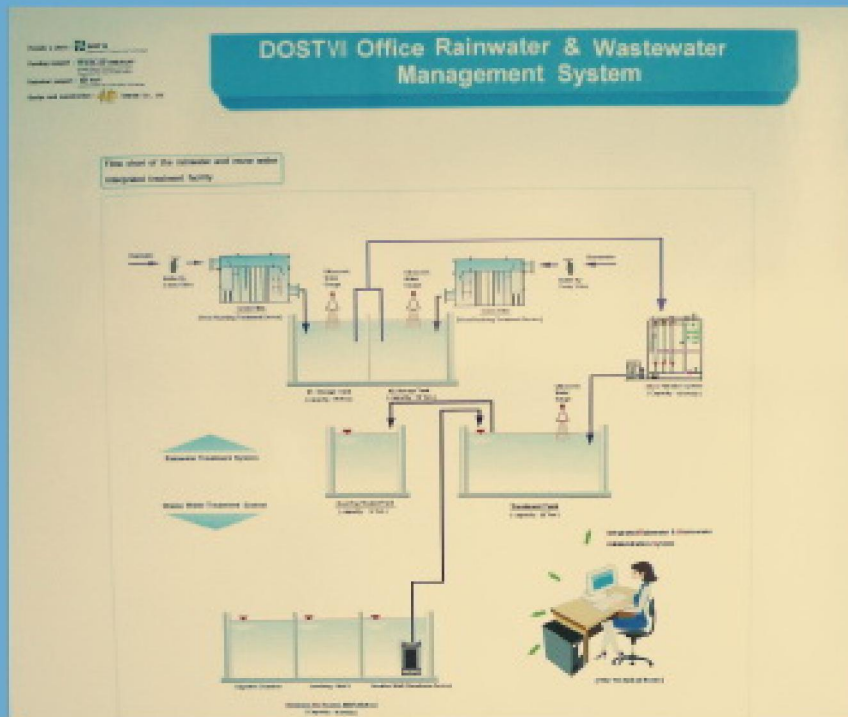
- Rice yields from reclaimed wastewater irrigation increase by 20 percent as compared with conventional irrigation water while no significant side effects due to nutrient rich irrigation water have been observed.
- No accumulation of metal and toxic constituents at rice and barley grains and vegetable was observed from long-term reclaimed wastewater irrigation.
- Health effect studies justified that disinfection is a prerequisite for safe applica

tions of wastewater to agricultural systems. Untreated effluent from wastewater treatment plants may not be safe to be used for crop irrigation since the long-term applications cause farmers and children subject to virus and pathogen infection hazards significantly.

- Paddy irrigation with reclaimed wastewater reduces dissolved nitrogen load to streamflow by approximately 60 percent. No significant accumulation of nutrients and metal constitutes in paddy soils was observed during eight years of reclaimed wastewater irrigation practices.
- No significant difference in biodiversity was observed between paddy blocks with wastewater and conventional water irrigation.¹

e) Keys to Success

- Field experiments and demonstrative projects using reclaimed wastewater were implemented. The sites have been open to the public including news media.
- Farmers' consent is important; they should be given all the scientific facts and results from the reuse.



Discussion Paper



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