



United Nations
Educational, Scientific and
Cultural Organization

HUMID TROPICS CENTRE KUALA LUMPUR

*The Regional Humid Tropics Hydrology and Water Resources Centre for
Southeast Asia and The Pacific*



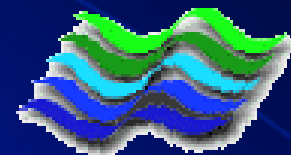
Water for Cities of Tomorrow – From Black to Blue



WATER FOR
OUR FUTURE

Dr. Mohamed Roseli bin Zainal Abidin
Director Humid Tropics Centre
Kuala Lumpur

Department of Irrigation and Drainage Malaysia



Email: drroseli@water.gov.my
website: <http://htckl.org.my>



*Water for Our Future: Post 7th World Water Forum
Seminar, Putrajaya, Malaysia, 6th October 2015*

7th WWF: Water and Cities

Daegu & Gyeongbuk, Rep. of Korea; April 12 – 17, 2015



**Type: Thematic Process; Theme 2: Water for Development and Prosperity;
Theme 2.3: Water and Cities**

No.	Sessions	Organizer
1.	T.2.3.5. Recycling and reuse for resource positive Cities	Veolia Environment (Veolia)/Japan Sanitation Consortium (JSC)
2.	SE-00191 OECD Side event on water security and cities	OECD
3.	S.1.3 Creative City with Sustainable Water-Cycle: Understanding and Implementing GI with LID Technology over the World	Pusan National University
4.	INR.2.3. Opening: Living with water in cities of tomorrow Challenges and ways forward towards implementation of solutions based on cases from Europe, Asia-Pacific, Americas and Arab countries	Danish Water Forum (DWF)
5.	INR.2.3.EU Living with water in cities of tomorrow Challenges and ways forward towards implementation of solutions based on cases from Europe, Asia-Pacific, Americas and Arab countries / European regional session	Danish Water Forum (DWF) / European Water Association (EWA)

7th WWF: Water and Cities

Daegu & Gyeongbuk, Rep. of Korea; April 12 – 17, 2015



**Type: Thematic Process; Theme 2: Water for Development and Prosperity;
Theme 2.3: Water and Cities**

No.	Sessions	Organizer
6.	INR.2.3.AR Living with water in cities of tomorrow Challenges and ways forward towards implementation of solutions based on cases from Europe, Asia-Pacific, Americas and Arab countries / Arab Countries regional session	Arab Countries Water Utilities Association (ACWUA) / Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD)
7.	INR.2.3.AP Living with water in cities of tomorrow Challenges and ways forward towards implementation of solutions based on cases from Europe, Asia-Pacific, Americas and Arab countries / Asia-Pacific regional session	UN Educational, Scientific and Cultural Organization (UNESCO)
8.	INR.2.3. Closing: Living with water in cities of tomorrow Challenges and ways forward towards implementation of solutions based on cases from Europe, Asia-Pacific, Americas and Arab countries	Danish Water Forum (DWF)
9.	T.2.3.1 Water security for Cities through integrated urban planning and services	International Water Association (IWA)/UN-Habitat
10.	T.2.3.2 Adaptation to climate change: Increasing cities resilience	United Cities and Local Governments (UCLG)/SUEZ ENVIRONNEMENT

7th WWF: Water and Cities

Daegu & Gyeongbuk, Rep. of Korea; April 12 – 17, 2015



**Type: Thematic Process; Theme 2: Water for Development and Prosperity;
Theme 2.3: Water and Cities**

No.	Sessions	Organizer
11.	T.2.3.3 Water and Sanitation Operators: Capacity for an Urban Era	Global Water Operators Partnerships Alliance (GWOPA) /UN-Habitat, Nairobi City Water and Sewerage Company, Global Water Partnership (GWP)
12.	Joint. T.2.3.6/S.4.6 Information and Communication Technologies effectively used to achieve water security –“The Smart City”	International Water Association (IWA)/SUEZ ENVIRONNEMENT
13.	SE-00505 Water-energy nexus in cities	Seoul Metropolitan Government (Global Urban Partnership Division
14.	SE-00193 Transferring Innovative Cases and Commitments on Resilience: WaterTech in Resilient Cities Workshop	U.S. Water Partnership
15.	SE-00177 Enhancing urban water environment in developing countries	United Nations University - Institute for the Advance Study of Sustainability
16.	T.2.3.Con: Concluding Session 2.3: Water and Cities	UN-Habitat/International Water Association (IWA)



United Nations
Educational, Scientific and
Cultural Organization

7th WWF: Water and Cities

The Suggested Roadmap



The Goal

- to **provide water security** for cities by embracing a city planning agenda in link with the proposed **SDGs**.
- Apply the **5R principles**: “reduce”, “reuse”, “recover”, “recycle” and “replenish”.
 - 1) **Reduce water loss** and increase water efficiency.
 - 2) **Re-use water**, especially for those urban areas that are located in water stressed areas.
 - 3) **Recover energy**, nutrients and other materials from waste water.
 - 4) **Recycle** those materials in fertilizers, plastic appliances, supplying materials to industries and farmers alike.
 - 5) **Replenishing** the environment within and around cities. Replenish watersheds, lakes and groundwater reserves.



United Nations
Educational, Scientific and
Cultural Organization

7th WWF: Water and Cities

The Suggested Roadmap



5 Key Focus Areas :

- **Focus area 1: Vision and Leadership**

Develop a top down and bottom-up vision and leadership that survives political cycles. Inspiring case studies are needed to develop the vision and foster leadership.

- **Focus area 2: Governance and Integrated Services**

Good governance is key, including equity, transparency, accountability, sound financing, citizens' engagement.

Synergies within sectors are key to applying the 5R principles, and require integrated regulations and institutions, as well as City planning services organized with trans-disciplinary teams working at the 4 scales.

- **Focus Area 3: Capacity Building**

Technical, organizational, and institutional capacity building is needed:

- *Technical: what measures can be implemented along the 5R principle to best plan for a healthy, liveable and risk-resilient city? Targeting students and professionals continuing education*
- *Organizational: how to work in synergies with other sectors? Targeting city planning departments, and utilities (Energy, Waste and Water management)*
- *Institutional: how to enable and incentivize synergies? Targeting regulatory and financing institutions*
- *Local authorities: which solutions to consider and how to enable?*



United Nations
Educational, Scientific and
Cultural Organization

7th WWF: Water and Cities

The Suggested Roadmap



5 Key Focus Areas :

- **Focus Area 4: Tools for planning and decision making**

Tools for cities to plan and make science based decisions that best embrace the 5R principles for a healthy, liveable and risk-resilient city, using cross sector synergies, are needed:

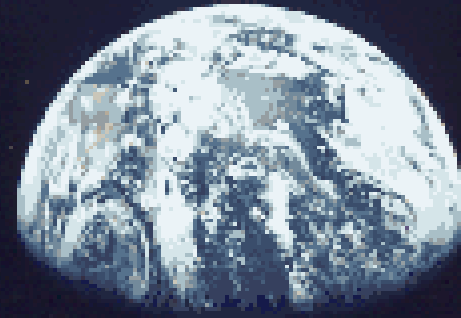
- *Data collection, management and analysis tools, including an urban metabolism approach.*
- *Citizens participatory process tools*
- *Assessment tools of financial and non-market values*

- **Focus Area 5: Adapted implementation tools**

An Urban Water Framework tool is needed to assess and monitor how Cities are implementing the 5R principles for a healthy, liveable and risk-resilient city and how and where they could improve. The Framework covers Governance, Economic and Technical aspects.

Financing mechanisms, including new green business models, are needed.

Water is life.....



Water as a resource, are critical to sustainable development. Prerequisite for human health and well-being as well as for the preservation of the environment.





United Nations
Educational, Scientific and
Cultural Organization

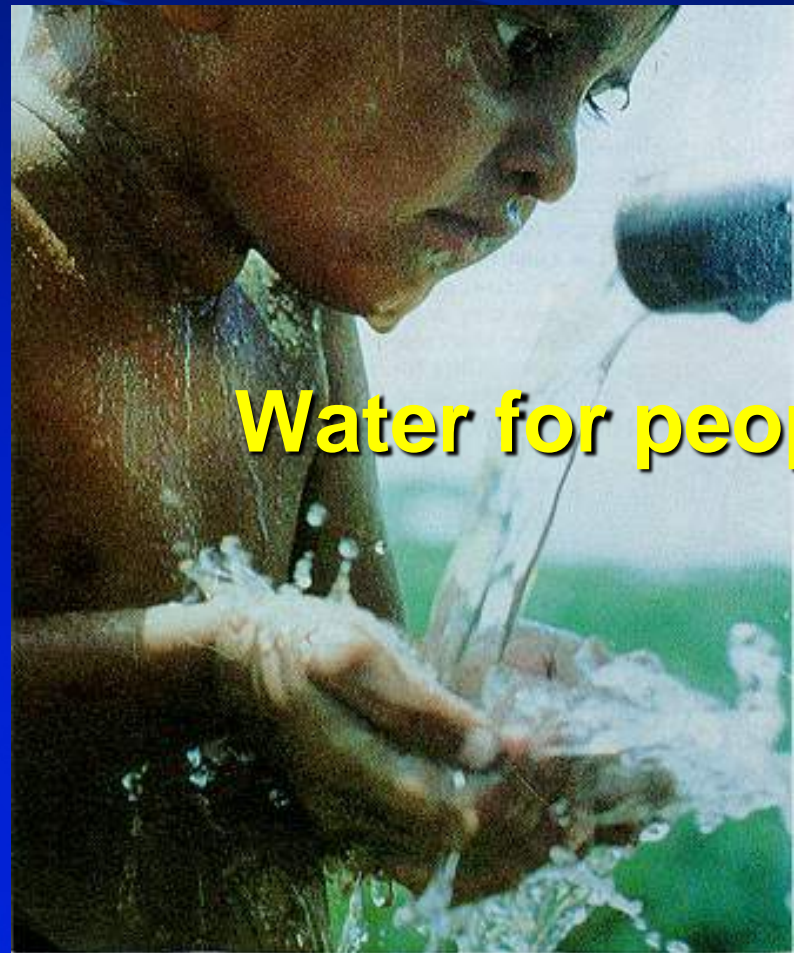
Roles of water



Water for food



Water for people





United Nations
Educational, Scientific and
Cultural Organization

Water for Industry

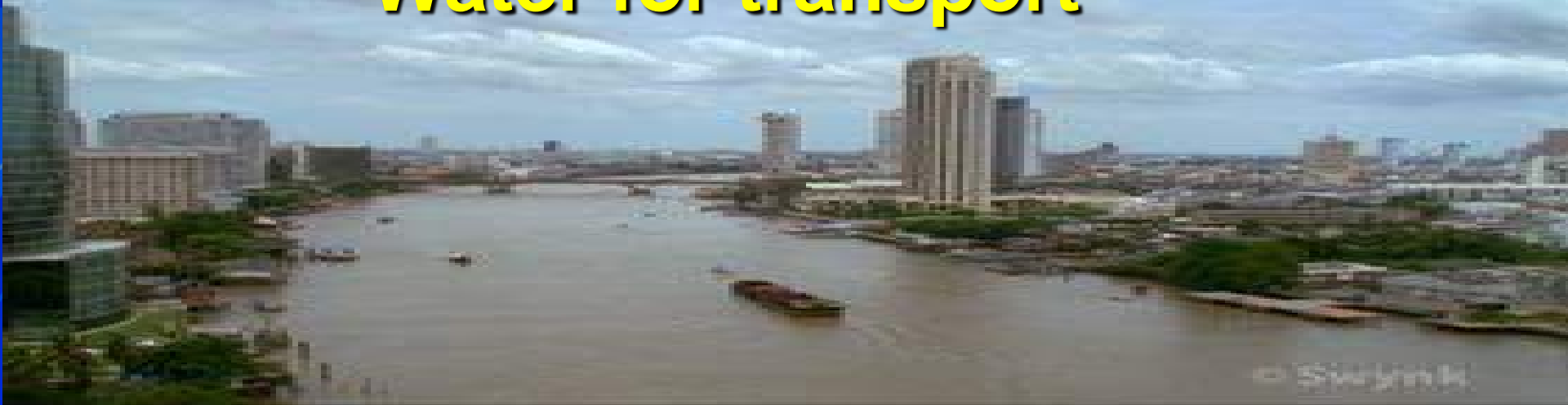


Water for Energy



United Nations
Educational, Scientific and
Cultural Organization

Water for transport



Water for recreation and tourism



Water for Nature





United Nations
Educational, Scientific and
Cultural Organization

CHALLENGES

Water and people:

- 0.8 billion people without improved water
- 2.5 billion without improved sanitation
- 5 billion live near polluted water
- Millions (often children) die from water borne disease every year
- 1 billion people hungry!





United Nations
Educational, Scientific and
Cultural Organization

CHALLENGES

Water quantity and quality:

- Sharp increase in worldwide water use
- Depletion of Groundwater sources
- Food security
- Climate change – extreme events (eg. flood, draught)
- Rapid urbanisation – water footprints (the amount of water used by an individual, community, business, or nation)
- Massive pollution of water resources: sewage, nitrogen, pesticides, endocrine disruptors
- Loss of associated ecosystems and biodiversity
- Public health risks





United Nations
Educational, Scientific and
Cultural Organization

10 Key Global Challenges

- Poverty eradication
- Pollution
- Population growth and urbanization
- Food security and sustainable production
- Old and New diseases
- Energy
- Disasters
- Water and environmental resources
- Climate change
- Peace and security

Water a defining issue !





United Nations
Educational, Scientific and
Cultural Organization

Examples of Water Resources Management Issues



Ranking	Water-Related Issues
1	River Water Quality
2	Catchment/Landuse Management
3	Flooding
4	Potable Water Supply
5	Institutional Arrangement
6	Segmented Management
7	River Corridor Management
8	Wetlands Management
9	Water Borne Diseases
10	Biodiversity
11	Drought
12	Environmental Flow

Keep our river
clean

A Defining Moment in Time



MDGs



2015

Post-2015 Agenda

The future
we want for all

2000

2015

2030

2050

Post-2015 Water Related Actions UN Development Agenda

United Nations
Educational, Scientific and



The Suggested Goal and The Key Interlinked Targets - countries to reach the goal by 2030

- **Water** - the core of sustainable development and critical for socio-economic development, and healthy ecosystems .
- Efforts towards achieving development goals related to freshwater and sanitation.
- To support the protection of water resources from over exploitation and pollution while meeting drinking water and sanitation needs, energy, agriculture and other uses.
- To protect communities from water-related disasters.

Sustainable Development Goals (SDG's) and Post-2015

Educational
Cultural

“We recognize that people are at the centre of sustainable development and, in this regard, we strive for a world that is just, equitable and inclusive, and we commit to work together to promote sustained and inclusive economic growth, social development and environmental protection and thereby to benefit all.”

Rio+20 Outcome Document, The Future We Want



Science is critical to help meet the challenges for **sustainable development**, as it lays the foundations for new approaches and technologies to identify, clarify and tackle global challenges for the future. Science can thus significantly contribute to sustainable development, but requires to that end a broad understanding of science as such.

It requires a massive global cooperative effort and one major task of sustainability science is to assist integrated cross-disciplinary coordination.

Six essential elements for delivering the SDGs (dignity, people, prosperity, planet, justice, and partnership)

The Post-2015 Global Development Framework is centered on 17 no. SDG's

The Three Pillars of Sustainability

Economic Sustainability



Consumption and production patterns, growth, development and productivity while promoting the use of resources in ways that are efficient, responsible and likely to provide long term benefits

Social Sustainability



The availability of resources for the **well being of individuals and communities** such as food, shelter, education, work, income, safe living and working conditions, creativity, cultural heritage, inclusion

Environmental Sustainability



The **protection and maintenance** of **natural functions** and **ecosystem components** so that humans and other species are sustained



United Nations
Educational, Scientific and
Cultural Organization

Inter-connected complex challenges

Water, food and energy are at the heart of Sustainable Development



Water for Cities

**Sewer
Network**



**Effluent
discharge**

Centralised WWTP



**Food
Security**

Distribution network

**Water
Treatment**



Urban Water Management

3 Main Objectives:

- Provide a good service to people and industry
- Improve Public Health
- Environmental sustainability





United Nations
Educational, Scientific and
Cultural Organization



We need to SWITCH !

Development of sustainable and effective water management in 'The City of the Future'

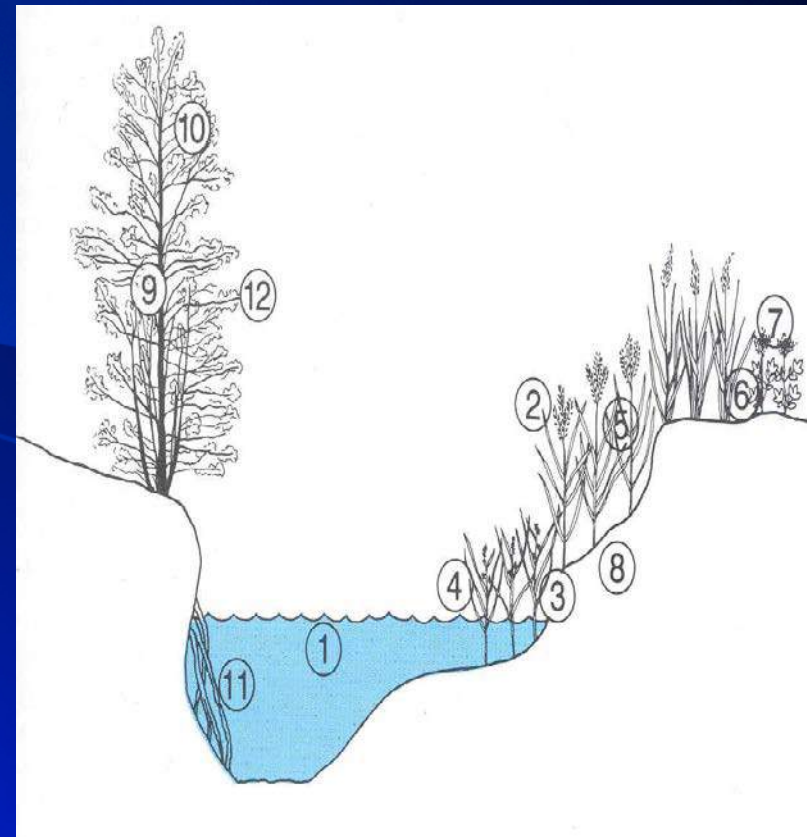
Three Simple Steps:

- Reduce water use (all uses)
- Reuse water (water chain)
- Help water eco-systems cope



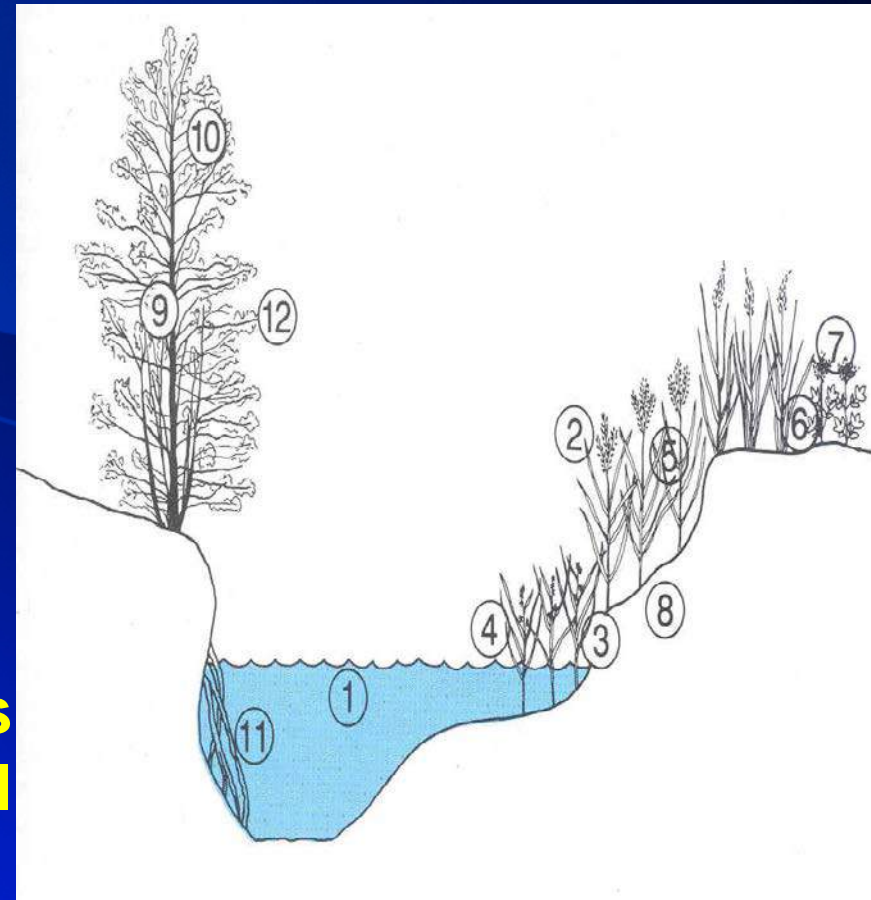
Bank Vegetation is necessary for habitat.

- 7 A good habitat for butterflies and beetles**
- 8 The roots reinforce the banks**
- 9 Birds find food in the trees**
- 10 Many insects inhabit trees**
- 11 The roots of the tree are a good hiding place for fish.**
- 12 Dead leaves are a good food source for the aquatic invertebrates**



**And river ecology
is necessary for
watercourse
quality.**

- 3 The larvae of aquatic insects crawl up and metamorphose into adults.**
- 4 Aquatic insects lay their eggs here, and the small larvae fall into the water.**
- 5 The stream's adult insects seek shelter here.**
- 6 Birds from the fields nest here.**

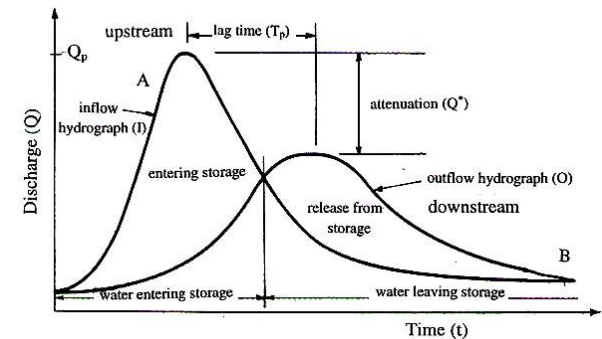
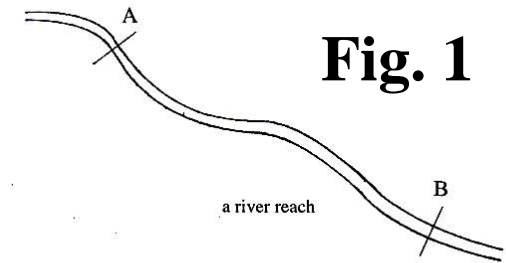


1. The shade keeps the water cool and oxygenated
2. Insects and other small animals from among the plants are caught by fish when they fall into the water.



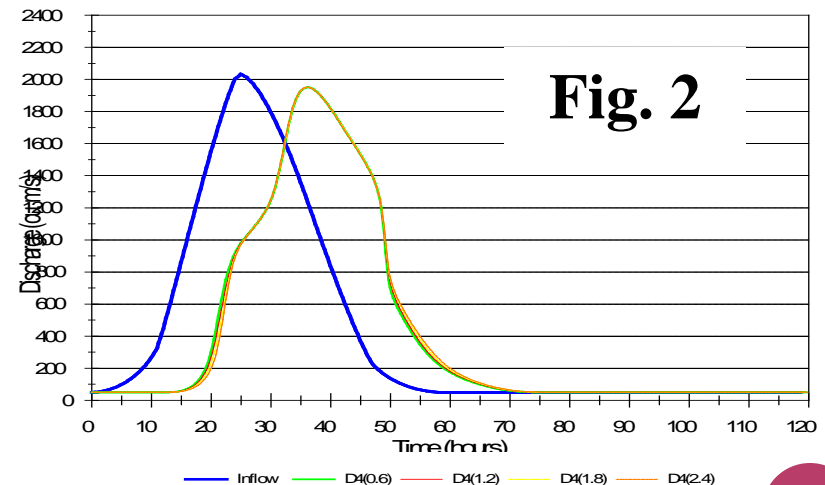
Understanding Natural River Behavior

- **Compound Channel:** main channel + floodplains
- **Outflow hydrograph attenuated and delayed** due to channel resistance and storage capacity (Fig. 1)



- Continuum of hydraulic processes above bankfull. **Floodplains functions as conveyance and storage.** Deform the hydrograph further. Time of peak of the peak outflow delayed further, hence more attenuation (Fig. 2).
- **Through river modeling, a typical river cross-section, that is close to nature can be determined.**

SENSITIVITY TESTS ON COMPOUND CHANNELS
Comparison of outflow hydrographs



Understanding Natural River Behavior

- Floodplains an integral part of the whole river system.
- Cross-section shape change significantly from its inbank shape.
- Streamwise pathways for flow may alter considerably. Interaction process between main channel and floodplain flows (Fig. 3).
- In overbank flow, resistance to flow varies with depth because of momentum transfer between main channel and floodplain.

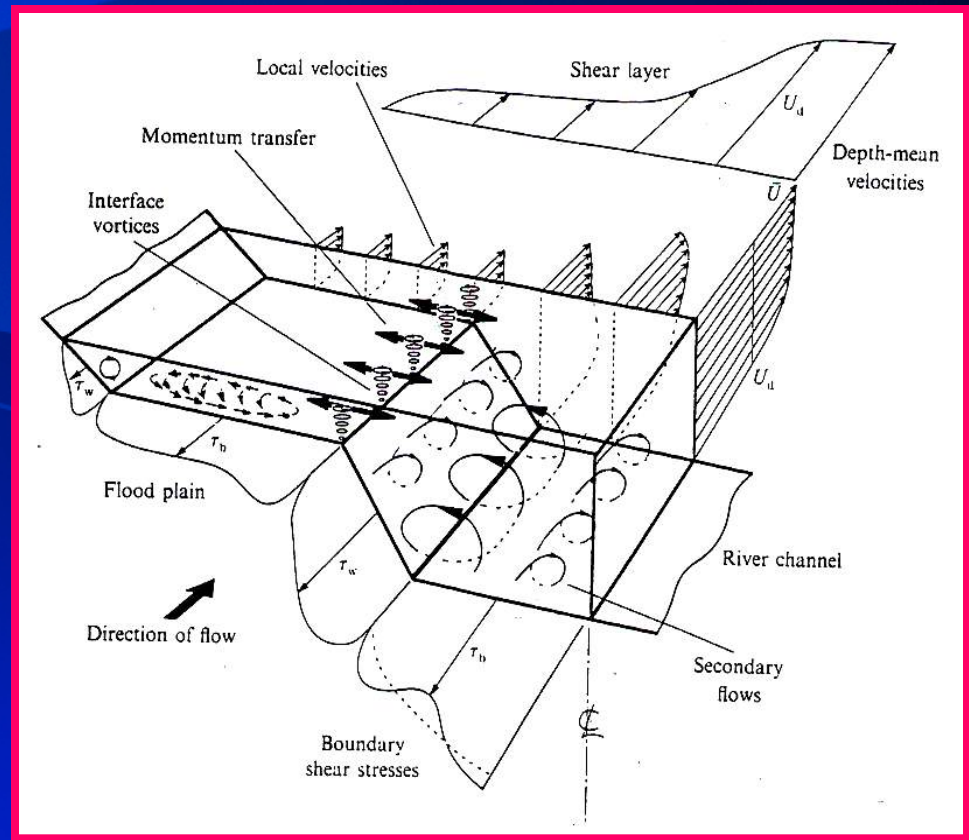


Fig. 3: Hydraulic parameters associated with overbank flow

- At slightly above bankfull flows, flow resistance started to increase to a certain depth and decreases again.
- This shows in flood mitigation works there is an optimum water level to be designed for maximum flood attenuation.
- In flood mitigation works, it is advisable to include the storage in the design, hence a two stage channel (compound channel).

This typical river section is closer to the shape of natural river and recommended to be use in the design of river section

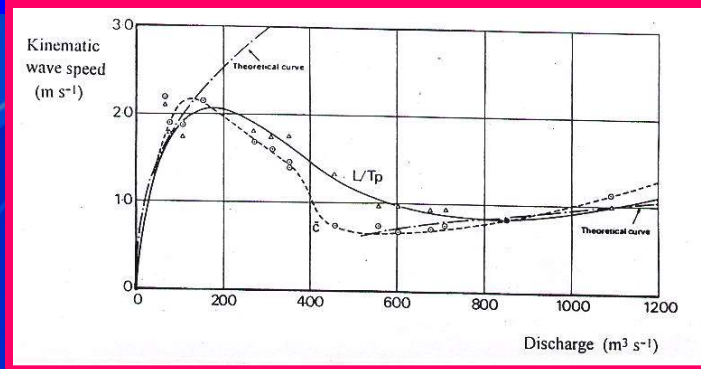


Fig. 4: Example of wave speed discharge – curve for River Wye, Erwood to Belmont Reach, UK

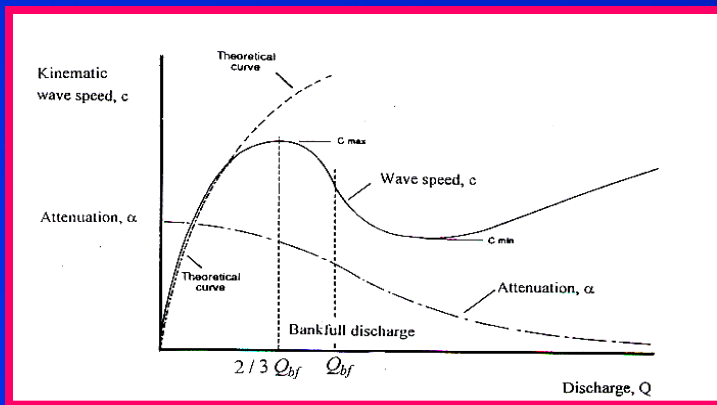


Fig. 5: Typical kinematic wave speed – discharge and attenuation parameter – discharge curve

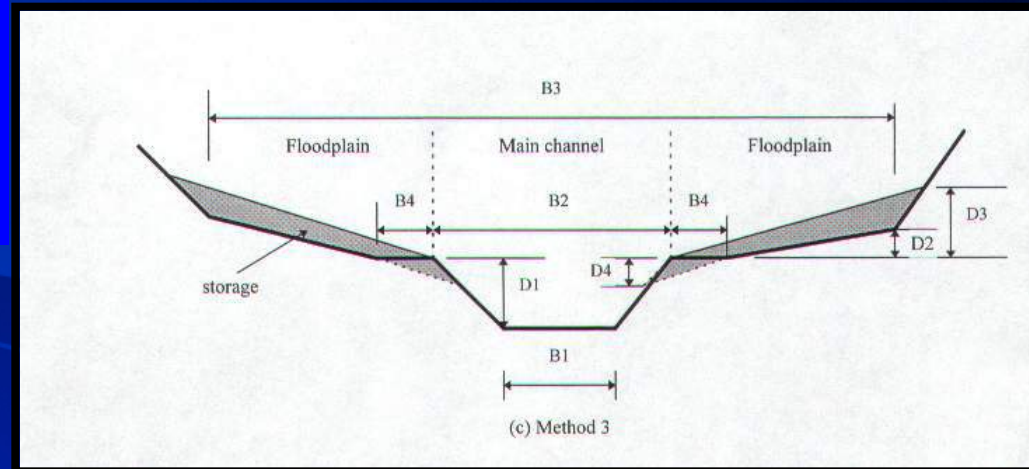


Fig. 6: A typical compound channel with the concept of natural waterway features

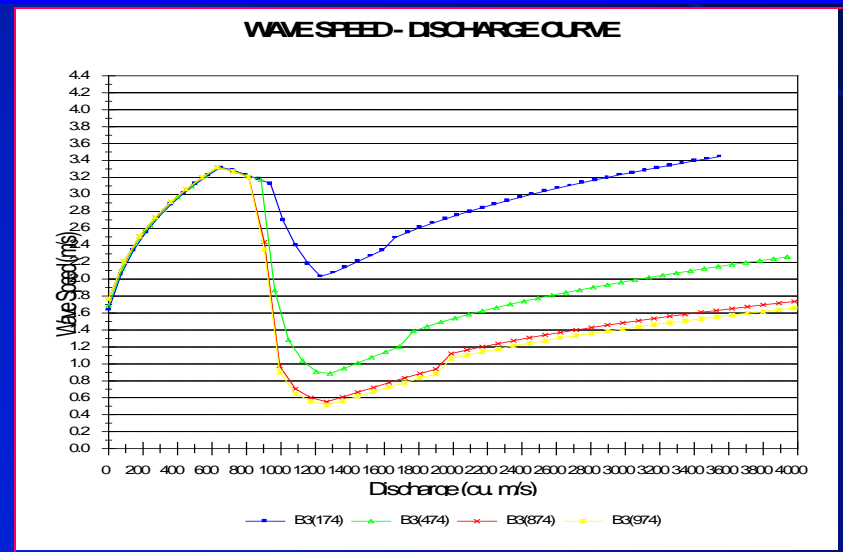


Fig. 7: Example of wave speed-discharge curve for different floodplain width



United Nations
Educational, Scientific and
Cultural Organization

Example of Rivers Action Plan in the City

Dr. Rosaji

THE LONDON RIVERS ACTION PLAN

A tool to help restore rivers
for people and nature

January 2009

www.therrc.co.uk/lrap.php

INTRODUCTION

This Action Plan has been developed to provide a delivery mechanism to take forward London's river restoration strategies - "A strategy for restoring rivers in North London" (2006) and "River restoration - a stepping stone to urban regeneration highlighting the opportunities in South London" (2002). These strategies have been very successful in stimulating river restoration across the London area. This plan will build upon their success and look for river restoration opportunities that will benefit people, businesses and wildlife by putting river corridors at the heart of regeneration and renewal through the enhancement of riverside parks, green spaces and the built environment.

The main aim of this London Rivers Action Plan (LRAP) is to provide a forum for identifying stretches of river that can be brought back to life. This can be done by improving river channel or riparian habitats, by removing or modifying flood defence structures where safe to do so, or by reclaiming 'lost' rivers currently buried under the Capital's surface. Nearly 100 projects have been identified with numerous large scale projects on the Lee, Wandale, Ravensbourne, Crane and Roding catchments.

This document focuses primarily on restoration opportunities along the non-tidal freshwater tributaries in the context of the planning process and the Mayor of London's aspirations for all Londoners to have access to high quality natural green spaces. However, it also recognises the contribution of other organisations that have specific restoration related roles along the River Thames and its estuary. *See page 20.*

The plan

- Supports the delivery of the Thames River Basin Management Plan under the Water Framework Directive;
- Contributes to sustainable regeneration through the implementation of the Blue Ribbon policies (Chapter 4C of the London Plan);
- Contributes to the implementation of the Mayor's access to nature aspirations;
- Supports one of the London Plan's biodiversity targets to restore 15km of river by 2015;
- Supports the delivery of the Environment Agency's Thames Catchment Flood Management Plan.

Note:

All of the weblinks relating to the above strategies and others discussed within this document can be found on *pages 10-14.*

Five key aspirations

- 1) Improve flood management using more natural processes;
- 2) Reduce the likely negative impacts of climate change;
- 3) Reconnect people to the natural environment through urban regeneration;
- 4) Gain better access for recreation and improved well-being;
- 5) Enhance habitats for wildlife.

This document provides an overview of the plan. Detailed information on restoration sites and opportunities is held on the associated LRAP website (www.therrc.co.uk/lrap.php) where opportunities and activities will be geographically referenced periodically updated.

Reconnecting people
to the natural
environment!

NEW APPROACHES TO FLOOD RISK MANAGEMENT

In London and other urban centres where buildings encroach to the edge of the rivers, flood risk has often been managed by encasing rivers in concrete with many culverts. These constraints result in river maintenance difficulties and reduce the ability of channels to cope with increasingly intense summer storms. Many concrete-lined channels were designed to accommodate major flooding (i.e. every 20 – 30 years). This may no longer be adequate due to predicted climate change impacts.

Space for floodwater

Flood risk managers are now committed to creating space for floodwater where possible through river restoration activities, in line with government policy outlined in the DEFRA document "Making Space for Water". To achieve this will require the creation of long-term master plans to ensure that functional floodplain creation is linked to regeneration activities through the planning control process. This needs partnerships. DEFRA's Planning Policy Statement 25 (PPS25) provides a policy framework to enable the Environment Agency, the London boroughs, developers and local communities to work together to ensure that flood risk is taken into account all stages of the planning process and help to direct development away from areas of highest risk.



Making space for water during flood conditions at Chinbrook Meadows, River Quaggy¹

Flood risk managers are now committed to creating space for floodwater where possible through river restoration activities, in line with government policy 'Making Space for Water'

River restoration is promoted in the Catchment Flood Management Plan and is recognised as an essential measure in reducing flood risk

Thames catchment flood management

- Up to 80% of the floodplain in the Thames area is developed and flood risk will increase unless we take radical steps to improve flood management;
- There are approximately 45,000 properties at risk from a flood that, on average, would be expected to occur every 100 years;
- Most of these flood-prone properties are located in socially-deprived areas;
- When flooding occurs it results in surface water, sewer and fluvial flooding often within minutes of heavy rainfall;
- Because of these rapid occurrences at any time of the year, flood warning time is short;
- The UK Climate Impacts Programme (UKCIP) predicts that flood risk in the Thames basin will increase due to climate change.

River restoration is promoted within the Environment Agency's Thames Catchment Flood Management Plan and is recognised as an essential measure in reducing flood risk across London.

Sutcliffe Park: New approaches to flood risk management¹

Some projects have incorporated innovative ways of designing-in better, more natural flood management. Sutcliffe Park on the River Quaggy was an area where floodwaters could be stored and is an example of where wetland and river habitat have been added as part of river restoration with benefits for local residents. See page 18.



LINKING PEOPLE TO NATURE THROUGH URBAN REGENERATION

Providing high quality green space in urban environments is at the heart of sustainable regeneration and renewal. Just as it is critical to maintain and enhance the built environment and its supporting infrastructure, it is vital to maintain and enhance a city's green infrastructure.

Planning-in opportunities

Major river restoration is, in part, dependent upon urban regeneration, for it is often when an urban area is being transformed that significant opportunities arise. Indeed, river restoration is sometimes a prerequisite to urban regeneration as improved, more sustainable flood management, or a better local environmental quality, are seen as integral to transforming social and economic conditions.



Cornmill Gardens: A river encased in concrete and disconnected from its surrounding environment!



Great crested grebe: Connecting people to nature in London!

Creating an identity

Restored rivers can be instrumental in creating an identity for a newly-regenerated urban area. A sense of place can be established that enables people to connect with each other and connect with their neighbourhood.

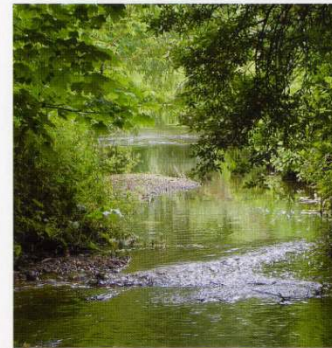
The Blue Ribbon Policies in Chapter 4C of the London Plan state that, among other things, regeneration activities should be designing new waterside developments in ways that increase habitat value and take opportunities to open culverts and re-naturalise river channels.

The opportunity to naturalise rivers and encourage local communities to establish a place of which they are proud, has been demonstrated in a number of places within London. At Cornmill Gardens, Lewisham, an open space adjoining a new housing development, has provided residents with better access to the River Ravensbourne, a river now released from its concrete walls. [See page 15.](#)

Cornmill Gardens: A river released with benefits for local people and nature!

CONSERVING AND ENHANCING RIVER WILDLIFE

Restoring the life to our rivers and wetlands aids the implementation of national and local initiatives aimed at improving our natural environment. Such initiatives include the delivery of Biodiversity Action Plans, driven by the London Biodiversity Partnership, A 50-Year Vision for (England's) Wetlands, the EU Water Framework Directive, the Million Ponds Project and Living Landscapes.



River Wandle with pools and shallow riffles providing a range of habitat for wildlife!

London river types

The rivers and streams of Greater London total over 600km in length (excluding the main stem of the River Thames). London's rivers are broadly classified as chalk or clay depending upon the underlying geology. The clean water and gravel beds of chalk rivers can support a rich variety of wildlife, including water-crowfoot, mayflies and brown trout. Chalk-type rivers are fragile systems and sensitive to low flows during periods of drought.

Clay rivers typically have deep pools and shallow riffles supporting wildlife such as kingfishers, dragonflies and damselflies, heron and fish species such as chub, roach and dace. Water levels in clay rivers can fluctuate considerably in response to rainfall. However, the effects of urbanisation have masked many of the characteristics of both chalk and clay rivers.

Damaged habitats

Previous human activities over hundreds of years (including navigation, hydro-power and flood defence) have altered London's rivers. These activities have resulted in significant changes to the river ecology. Important habitats within and alongside them have been removed, damaging the river ecology and fragmenting their vital role as a wildlife corridor. Many species rely on rivers without artificial barriers or low flows to complete their life cycles, such as fish migrating from estuaries to headwaters to breed.

Re-creating lost habitats

River restoration addresses damaged ecological environments by re-creating conditions that allow wildlife to re-colonise the river, use it to migrate to complete their life cycle, or move to more suitable areas to escape the impacts of climate change. This may include: the establishment of backwaters and wetlands where wildlife can shelter during storm events; the creation of channel features such as pools and riffles; the introduction of river gravels to increase the range of habitats partially destroyed through previous human intervention; or the removal (or adaptation) of obstructions to species' movement (such as weirs, culverts and concrete channels).

The Watermeads project at Morden Hall Park, Mitcham, on the River Wandle, demonstrates how a simple technique of skilfully excavating ditches can improve habitat for wildlife, in this instance for water voles. [See page 16.](#)

A natural river margin reed habitat is essential for the life cycle of wildlife such as this grey heron!



CONNECTING WITH THE NATURAL ENVIRONMENT

More than 80% of the UK's population now live in cities. Limited open spaces in many residential areas and busy lifestyles have resulted in a greater need for public green areas in which to relax and reflect.

Such areas can offer a much needed change of scenery but work best when they are visually diverse and welcoming. People rightly expect their local open spaces to offer a wide range of services such as sports and play facilities, as well as opportunities to experience wildlife. If designed and managed sympathetically, they can also offer an opportunity to interact with the surrounding natural world.

Opportunities to improve well-being

Restoring rivers enhances the quality of parks and urban green spaces by providing wildlife rich areas, often replacing unappealing hard-engineered drains. Restored rivers can create positive and dramatic changes by making the waterway a central feature. The sight and sound of running water and the feeling of being closer to nature can all help to improve mental well-being by relieving anxiety and helping people to relax and unwind.



Fishing platform provides an ideal opportunity for people to connect with the natural environment!

River corridors for people and wildlife

If green spaces are adopted by local communities and well cared for, they can provide safe and attractive spaces in which to exercise. Restored river corridors not only contribute towards such activities by creating recreational routes that improve connections between parks and other open spaces for walkers and cyclists. They also provide much needed routes for wildlife.

Experiencing the changes in river patterns and water levels helps people to reconnect with natural processes as annual seasonal rhythms and weather patterns are mirrored in the ebb and flow of the river.

The Chinbrook Meadows river restoration project that was completed in 2002, has demonstrated the benefits of bringing people closer to their natural environment by providing routeways designed to mirror the river's new meandering course and an opportunity for people to connect with the river. In North London, the River Brent runs through Tokyngton Park and its restoration has been instrumental in bringing together previously divided communities. See pages 13 and 17.



The restored Tokyngton Park has helped to reconnect people to nature and each other?

River Quaggy, Chinbrook Meadows: A once neglected park and river now provides a focal point for local residents!

ADAPTING TO CLIMATE CHANGE (THROUGH RIVER RESTORATION, BRINGING NATURE BACK TO RIVERS)

Climate change brings the threat of increasing temperature, more intense air and water pollution, increased episodes of droughts and floods, and loss of wildlife. It may also result in a poorer quality of life, particularly for people living in degraded urban areas. Even if all possible steps were taken today to reduce the emissions of carbon dioxide and other greenhouse gases, past human activities will bring inevitable climate change for fifty years or more. There is an urgent need to demonstrate how society can adapt to this change.

Impacts on river systems

The predicted scenarios of wetter winters, drier summers and increased temperatures will have a profound impact on rivers. Excessive fluctuations in flow (from trickle, to flood, as a result of drought or downpour), water temperature and water chemistry will have a significant impact on the management of flooding; the timing of natural events (such as fish spawning periods); and people's opportunity to enjoy and access riverside walkways and green spaces.

To date, extreme flood and drought events have been relatively infrequent in London and river systems usually recover. However, if the frequency and intensity of these events increase as predicted, then the cumulative impacts will reduce the ability of river systems to recover, especially where they are confined to a narrow corridor.

Restoration to manage climate change

River restoration, as part of a package of changes to the way we design and manage the green spaces in London, can make a significant contribution to lessening the unpleasant impacts of climate change for both humans near rivers and the wildlife that relies on the habitats they provide.

Building climate change adaptation into river restoration projects can produce multiple benefits including:

- Better flood management;
- Improving habitats and corridors for river wildlife;
- Ensuring that urban development recognises that rivers and associated green spaces are an important part of urban regeneration.



River Ravensbourne at Norman Park, during drought conditions!



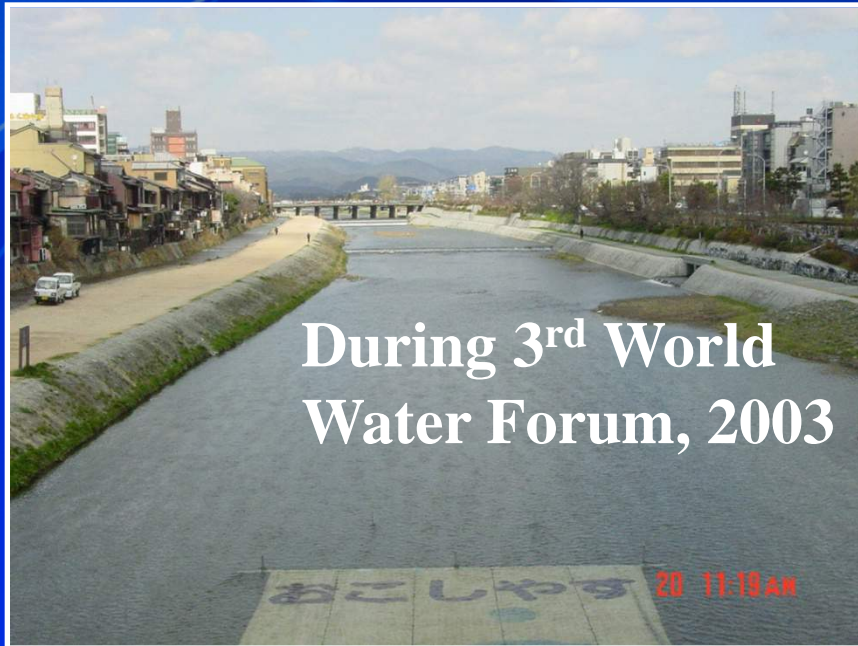
Mayes Brook: An opportunity for integrating climate proofing through restoration!

Climate change is the new challenge for river restoration in urban areas. The Mayes Brook, Barking, Essex has been identified as an opportunity to demonstrate best practice river restoration principles that integrate climate proofing with other key aspirations outlined in this document. See page 12.

An aerial photograph of a wide, winding river flowing through a lush green landscape. The river is the central focus, with a small boat visible in the lower-middle section, leaving a white wake. The surrounding land is divided into green fields and patches of trees. In the distance, the river continues to wind through the landscape under a blue sky with light clouds. The text "Giving rivers back their natural space" is overlaid in the center in a bold, yellow font.

**Giving rivers back their
natural space**

River in City: Kyoto, Japan

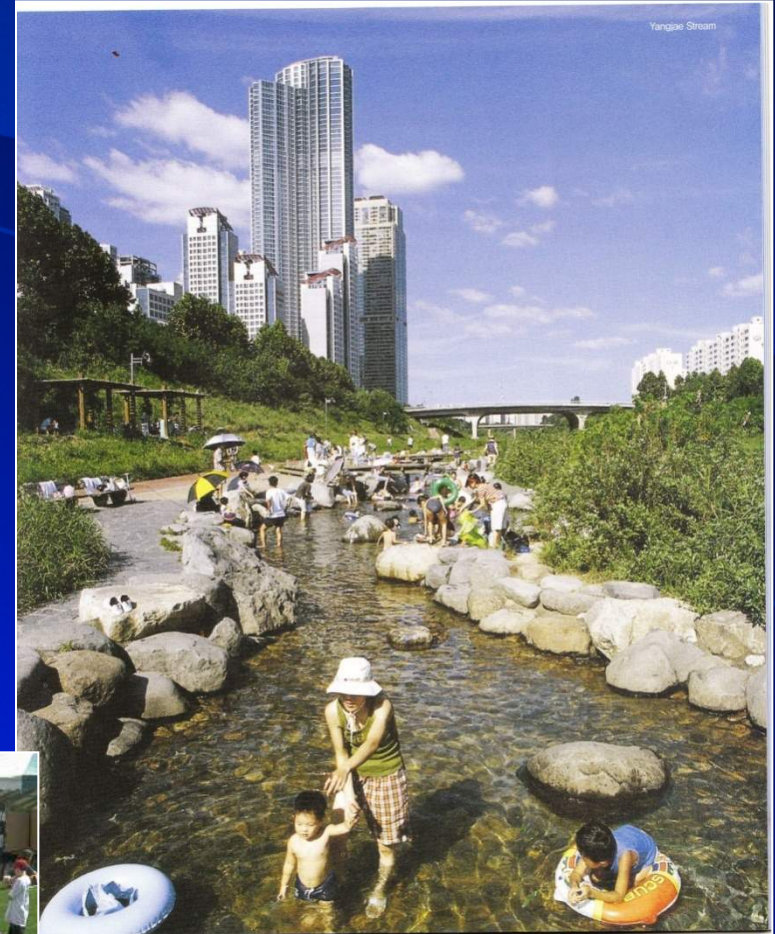


Techniques to increase river/stream aeration; example in Osaka and Kyoto, Japan



Examples of Rivers used for Recreational Activities in Urban/Periurban area

In Japan



**Yangjae
Stream, Korea**

**In
Australia**





United Nations
Educational, Scientific and
Cultural Organization

PROPOSED UPSCALING BIOTECHNOLOGY INTEGRATED STORMWATER MANAGEMENT ECOHYDROLOGY AT LANGAT-HELP RIVER BASIN PERIURBAN AREA BY HTCKL





United Nations
Educational, Scientific and
Cultural Organization



Labuan Island, M'sia: Urban/Periurban /Village (Photos taken on 2.10.2015)



Famous for seafood



Enhancement of mangrove swamp/forest at river corridor



Maintaining river ecosystem



Recognition from UNEP



**Labuan Sand Filter
Block – increasing
amount of sand along
the coastline**



**The old Labuan
Block – protecting
coastal area from
erosion**



**The new Labuan
Block– protecting
coastal area from
erosion**



United Nations
Educational, Scientific and
Cultural Organization

LIVABLE AND GREEN CITIES: river with excellent ecosystem

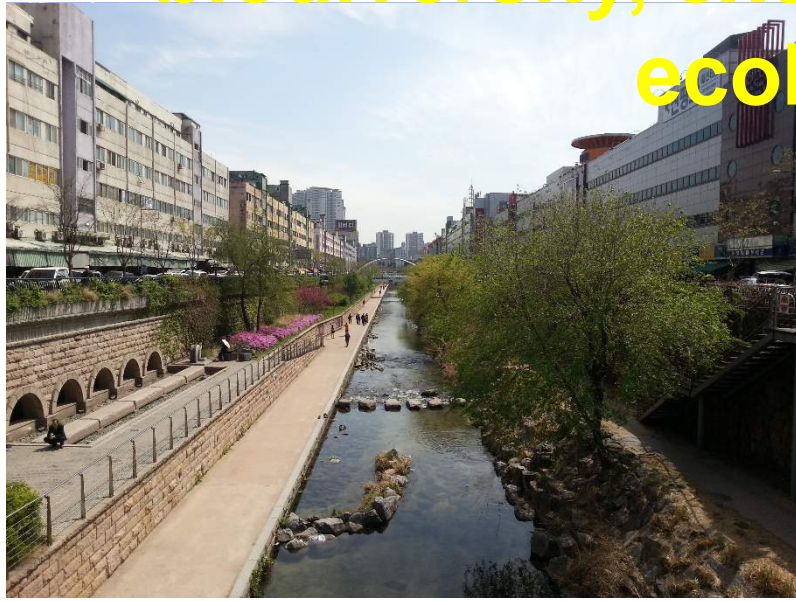


San Antonio, Texas



United Nations
Educational, Scientific and
Cultural Organization

LIVABLE AND GREEN CITIES: River with biodiversity, excellent ecosystem and ecohydrology



Cheong-Gye-Cheon River, Seoul, Korea

A sustainable future is within reach





Picture the City of the Future



Imagine Water in the city of the future





United Nations
Educational, Scientific and
Cultural Organization



United Nations
Educational, Scientific and
Cultural Organization



UNESCO



Partner in Building
The future we want for all

Thank You!



Email: drroseli@water.gov.my

H/P: 019 2709677

website: <http://htckl.org.my>

HUMID TROPICS CENTRE

KUALA LUMPUR

No. 2, Jalan Ledang off Jalan Duta,
50480 Kuala Lumpur

Tel. 603 20958700 Fax 603 20953366

Email : htckl@water.gov.my

