

Singapore

**THE STAGE (PAST, PRESENCE AND FUTURE)**

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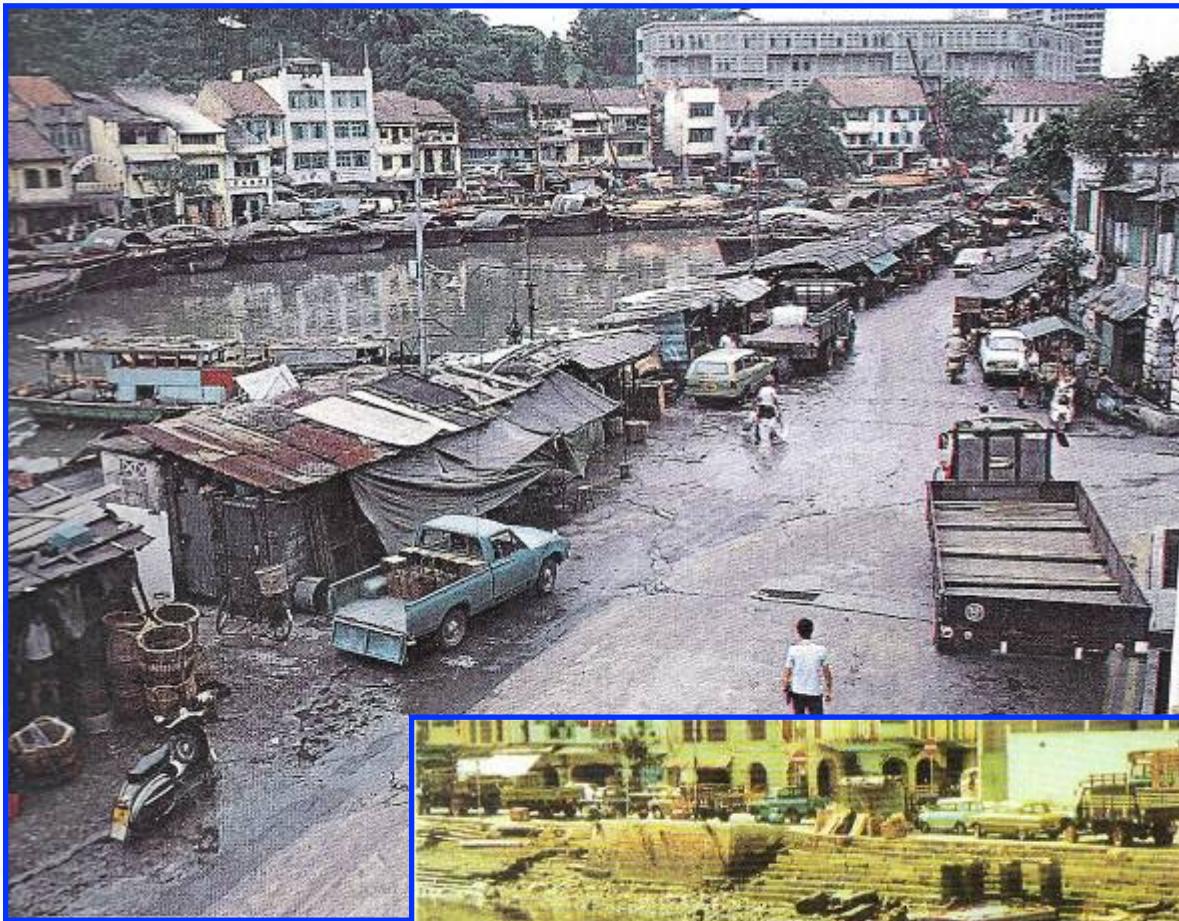


# The Stage

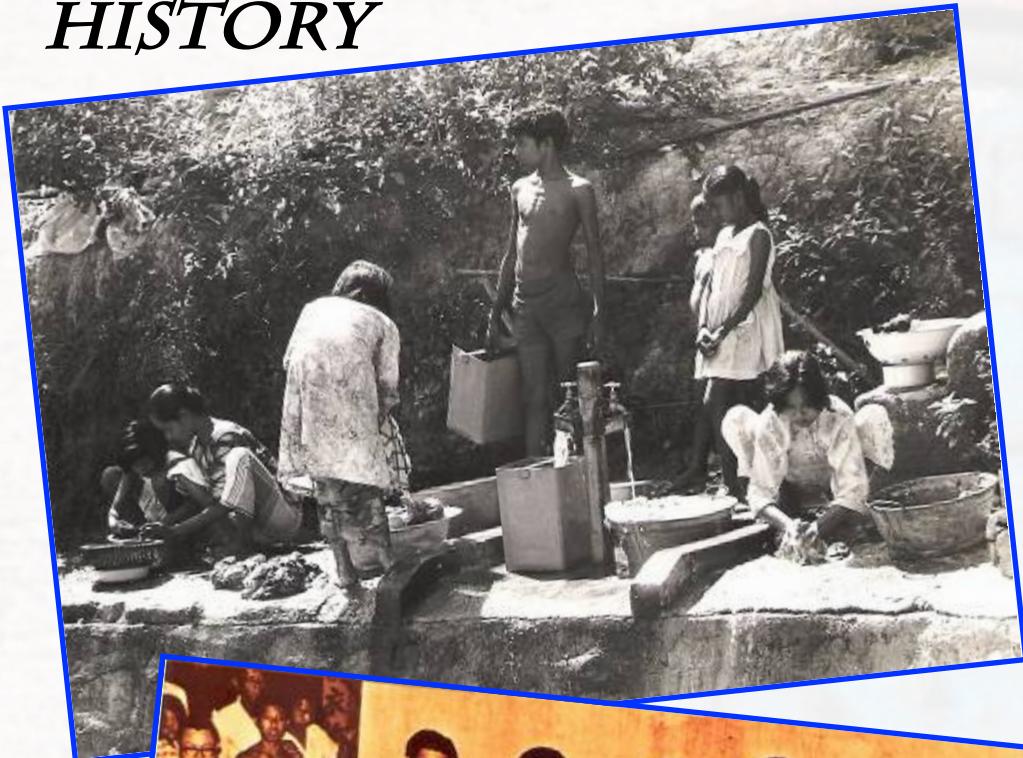
2001

*HISTORY*

*40 YEARS AGO*



# HISTORY



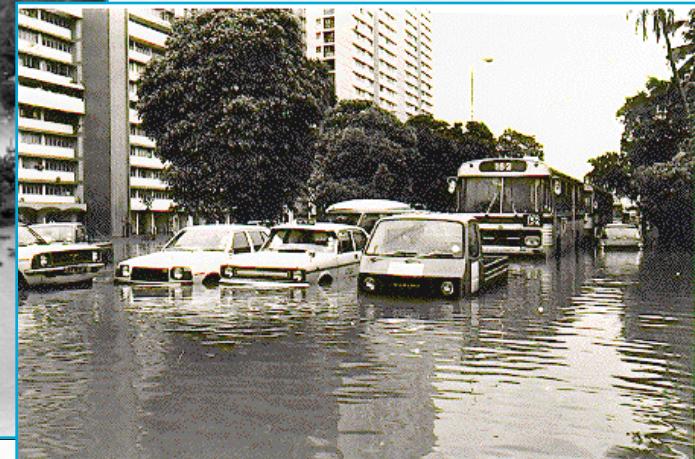
*WATER  
RESOURCES WERE  
SCARCE...*

*THIS IS, AFTER ALL,  
10<sup>TH</sup> MOST WATER  
STRESSED  
COUNTRY IN THE  
WORLD*

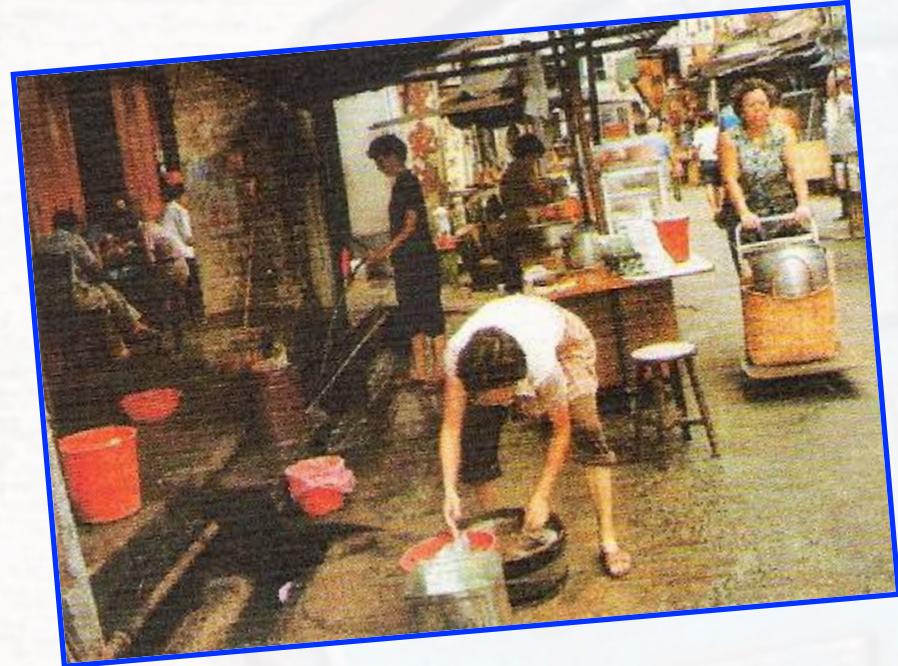
# *HISTORY*



*FLOODS WERE COMMON OCCURRENCES...*

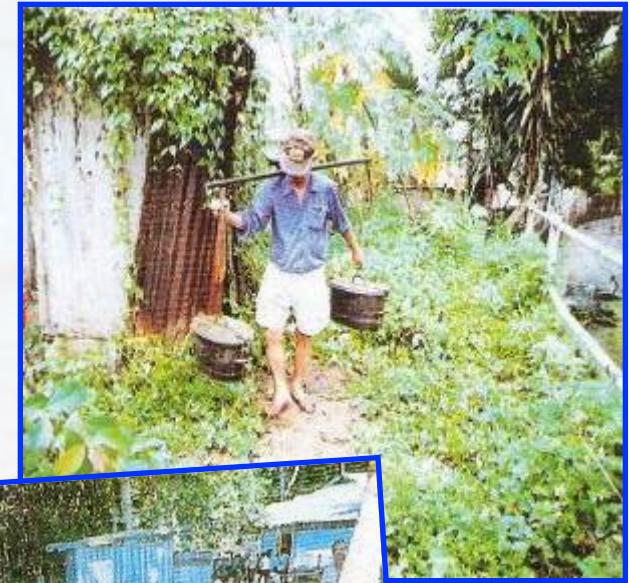


# *HISTORY*



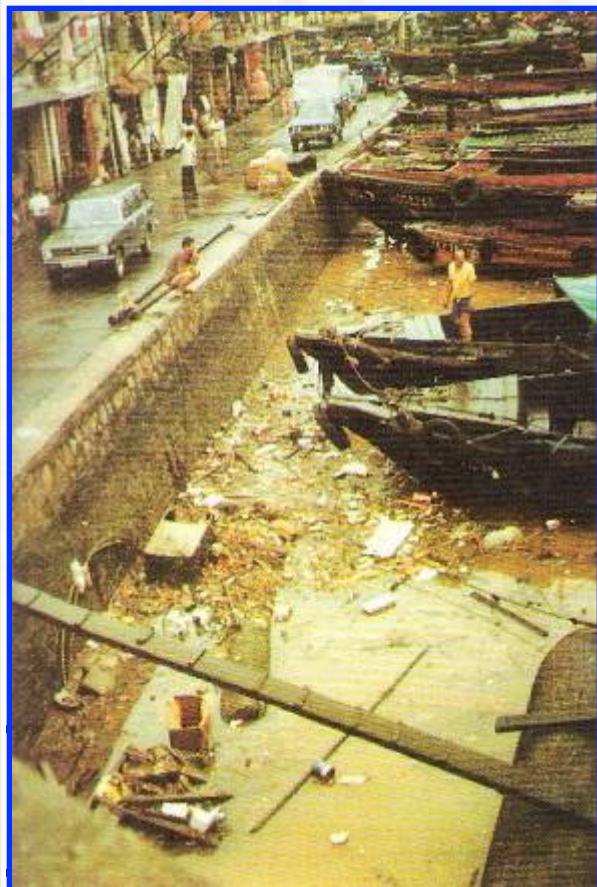
*PUBLIC HEALTH  
CONDITIONS WERE  
POOR...*

*PROPER SANITARY  
FACILITIES WERE  
LACKING...*



# *HISTORY*

*AND RIVERS WERE  
POLUTED.*



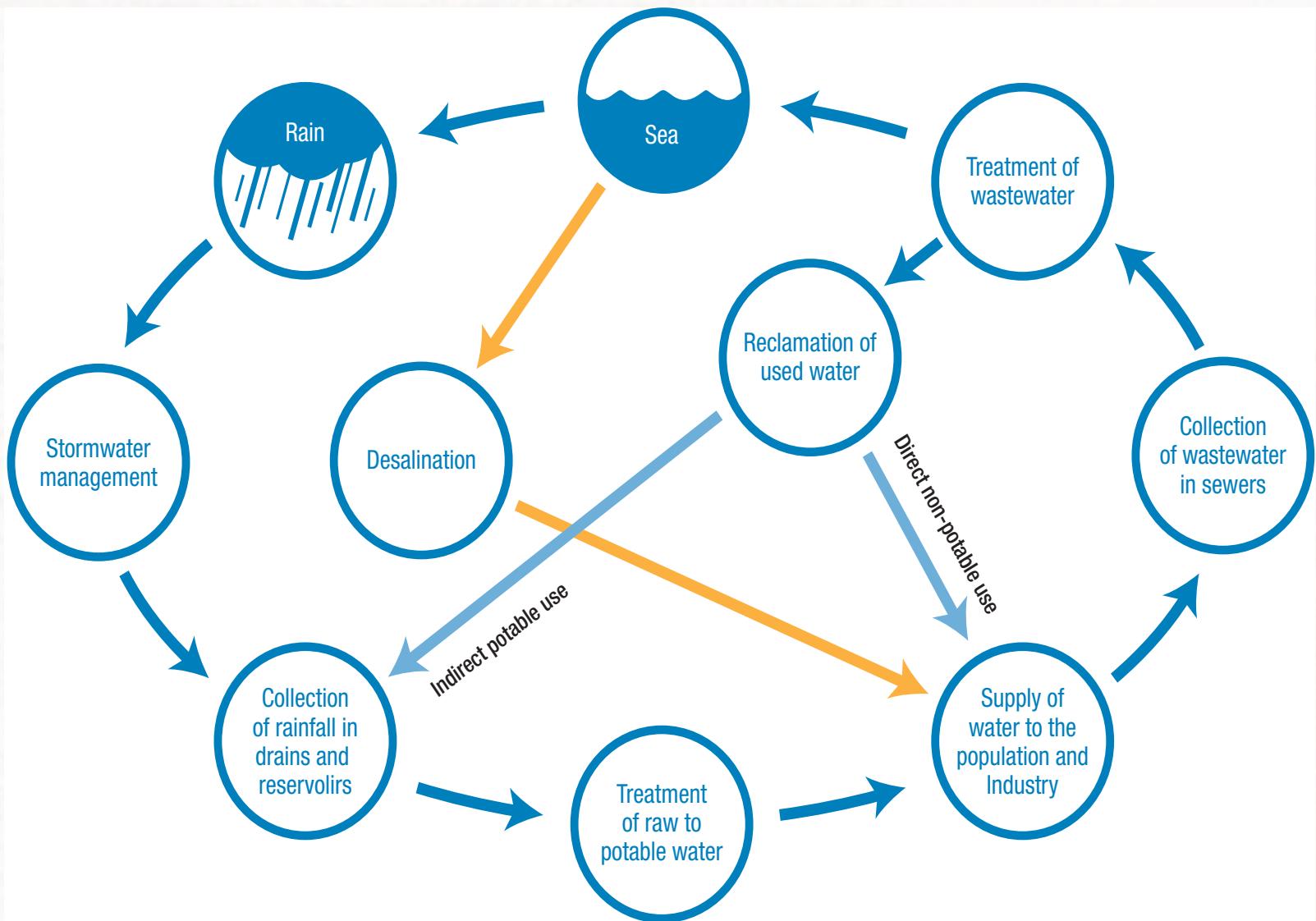


Fig. 1: Singapore's Water Cycle. With desalination and wastewater reclamation, water resources are managed within a closed water loop.

## **History**

*“It should be a way of life to keep the water clean, to keep every stream, every culvert, every rivulet, free from unnecessary pollution..... in ten years let us have fishing in the Singapore River and fishing in the Kallang River. It can be done.”*



Mr Lee Kuan Yew  
Former Prime Minister  
22 February 1977

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*"In 20 years, it is possible that there could be breakthroughs in technology, both anti-pollution and filtration. Then we can dam up, or put a barrage at the mouth of the Marina, the neck that joins the sea. And we will have a huge fresh water lake."*

Mr Lee Kuan Yew, Former Prime Minister, 2 decades ago



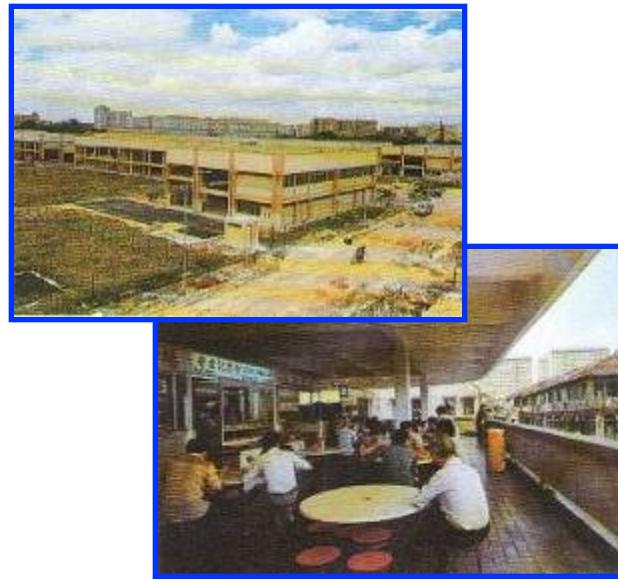
Minister Mentor Lee Kuan Yew (second from right) being briefed on the Marina Barrage.

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*Dredging and improvement works...*



*Laying new sewers...*



*Relocating businesses and industries into proper facilities...*

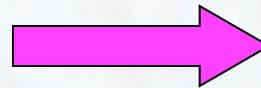


*Resettling squatters into proper public housing...*

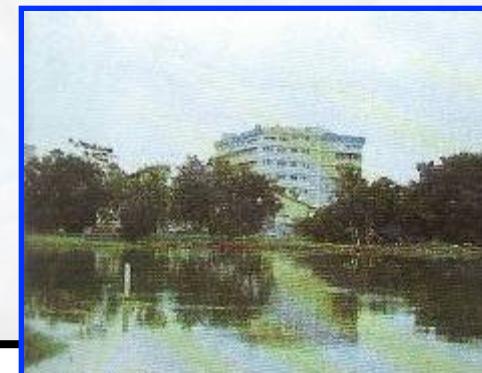
# *HISTORY*



*1970s*

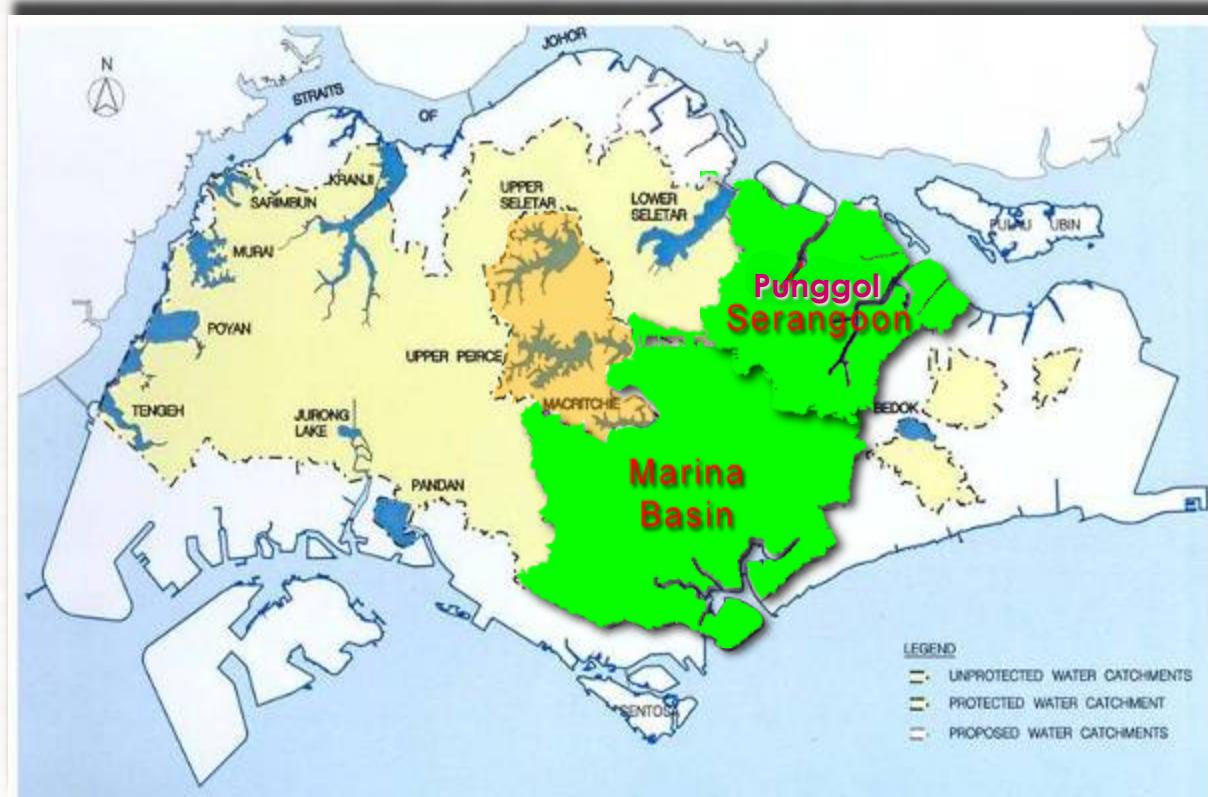


*1990s*



*TRANSFORMATION OF SINGAPORE RIVER*

# *Water from Local Catchment*



Half of Singapore is already water catchment (14 reservoirs)

Catchment area will be increased to two-thirds by 2009 when new schemes are completed



Protected Catchments



Unprotected Catchments



Urbanised Catchments

# Sustainable water resource management

## 4 National Taps



Local catchment

Imported water

NEWater

Desalinated water

**“Water for All”**

## 3P Approach



**“Conserve Water”**

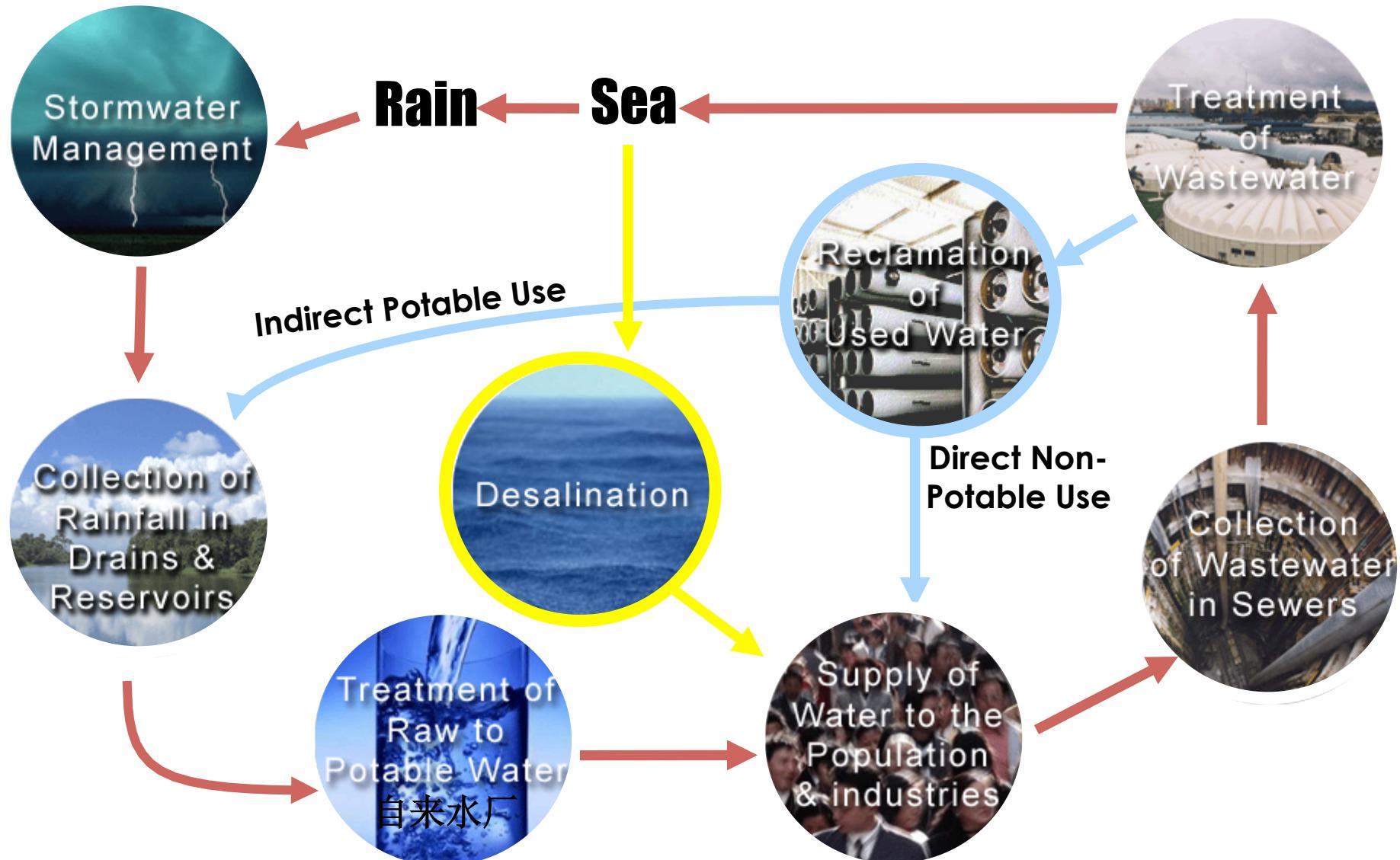
**“Value Our Water”**

**“Enjoy Our Waters”**

**“Conserve, Value, Enjoy”**

# **PUB manages the complete water cycle**

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

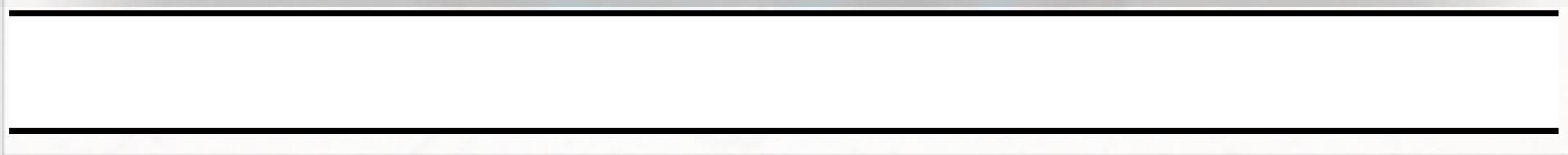






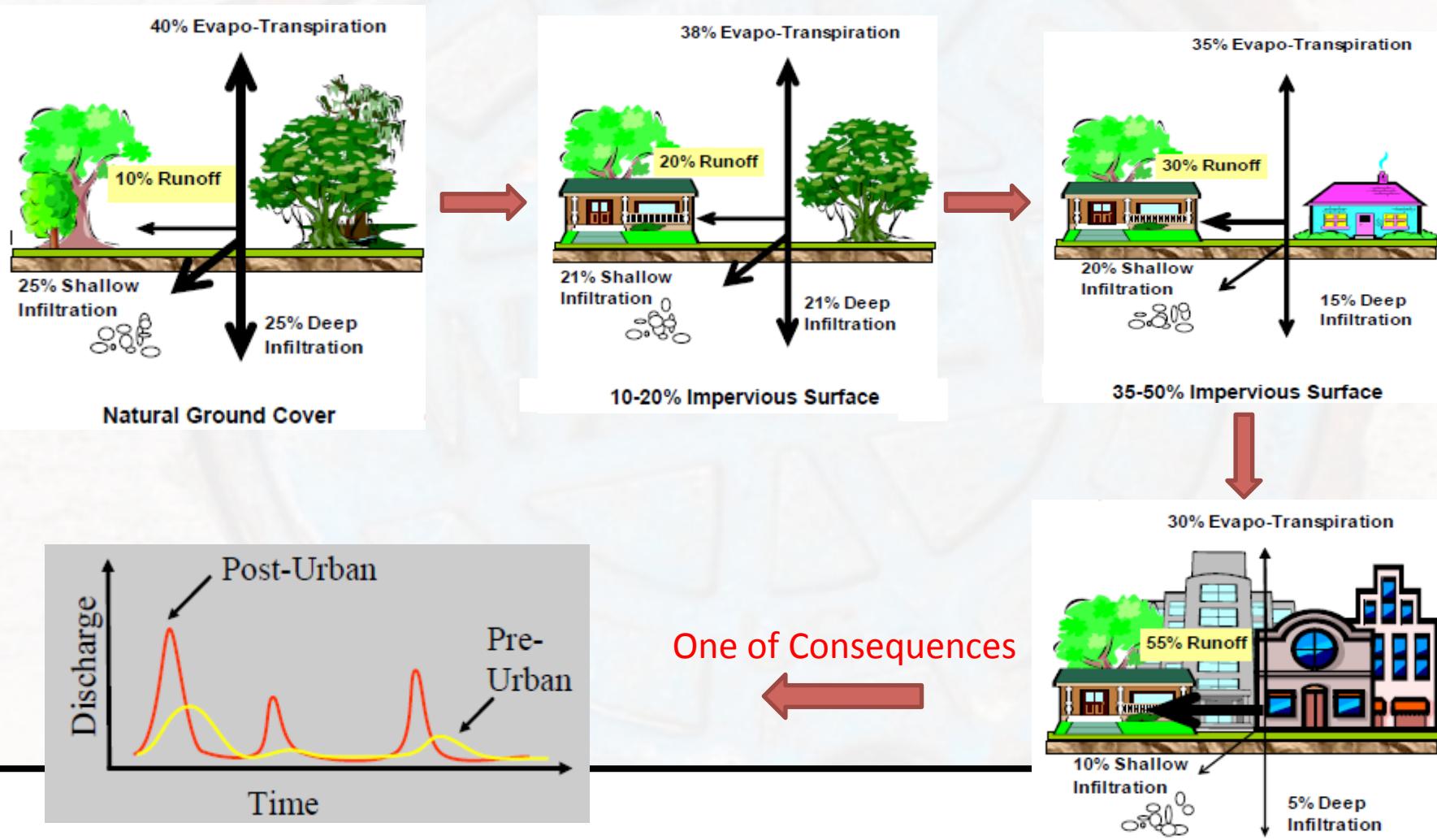






# Introduction

## Example: Urbanization and Hydrological Processes



# Flash Floods

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# Flash Flood, Orchard Road (June 16, 2010)



# Flash Flood @ NUS

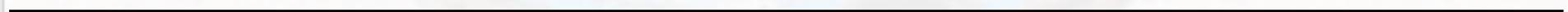
## 28 Nov 2011



# Flood Protection: Issue

Flood Early Warning Systems?

Next Generation Infrastructure?



# Fresh Water Supply

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# Water Supply: Issues

Water-Energy-Temperature Nexus?

What new resources can be developed?

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# Water Quality

Science

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## A river canal in China



Source of pollution





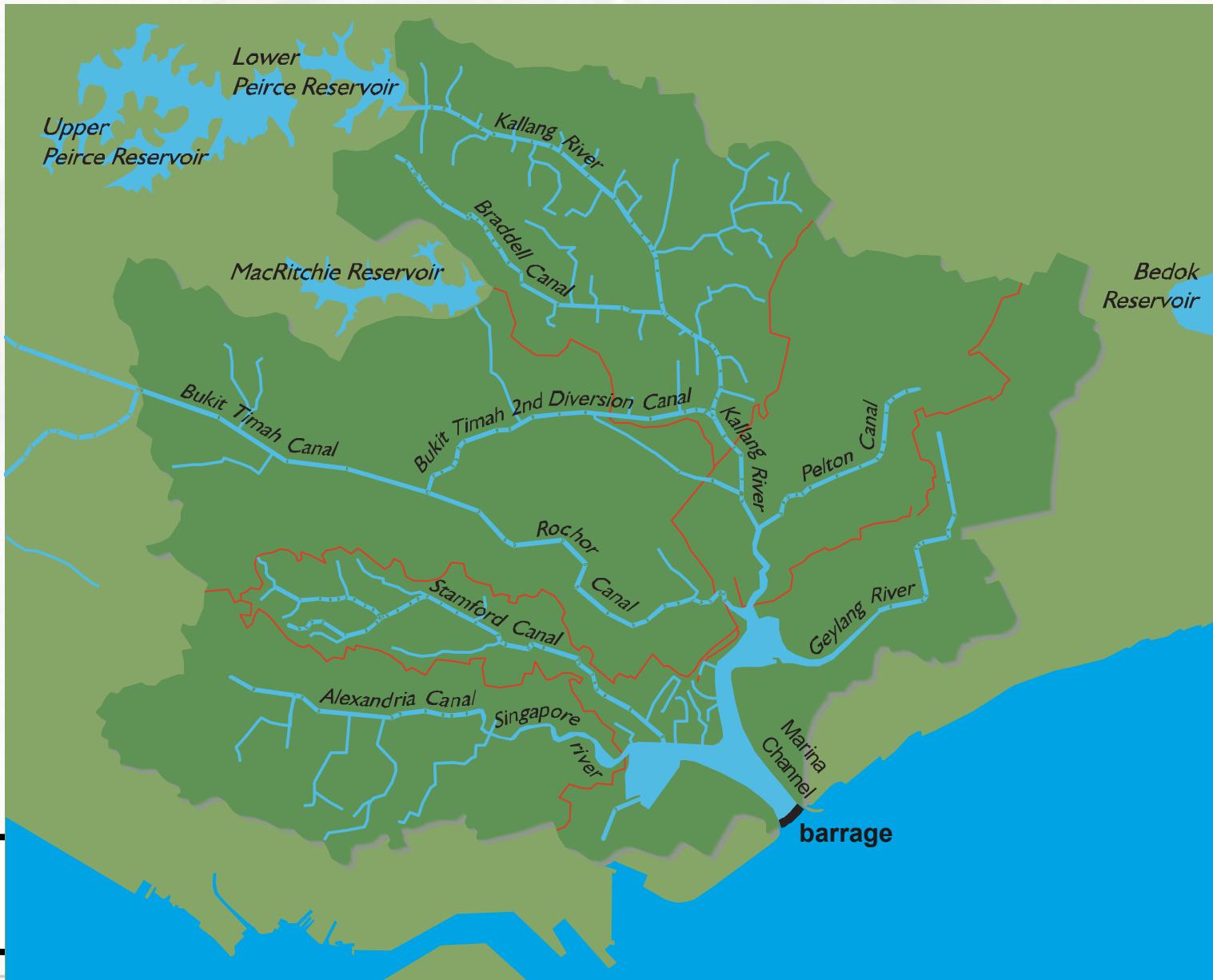
Manila 2009





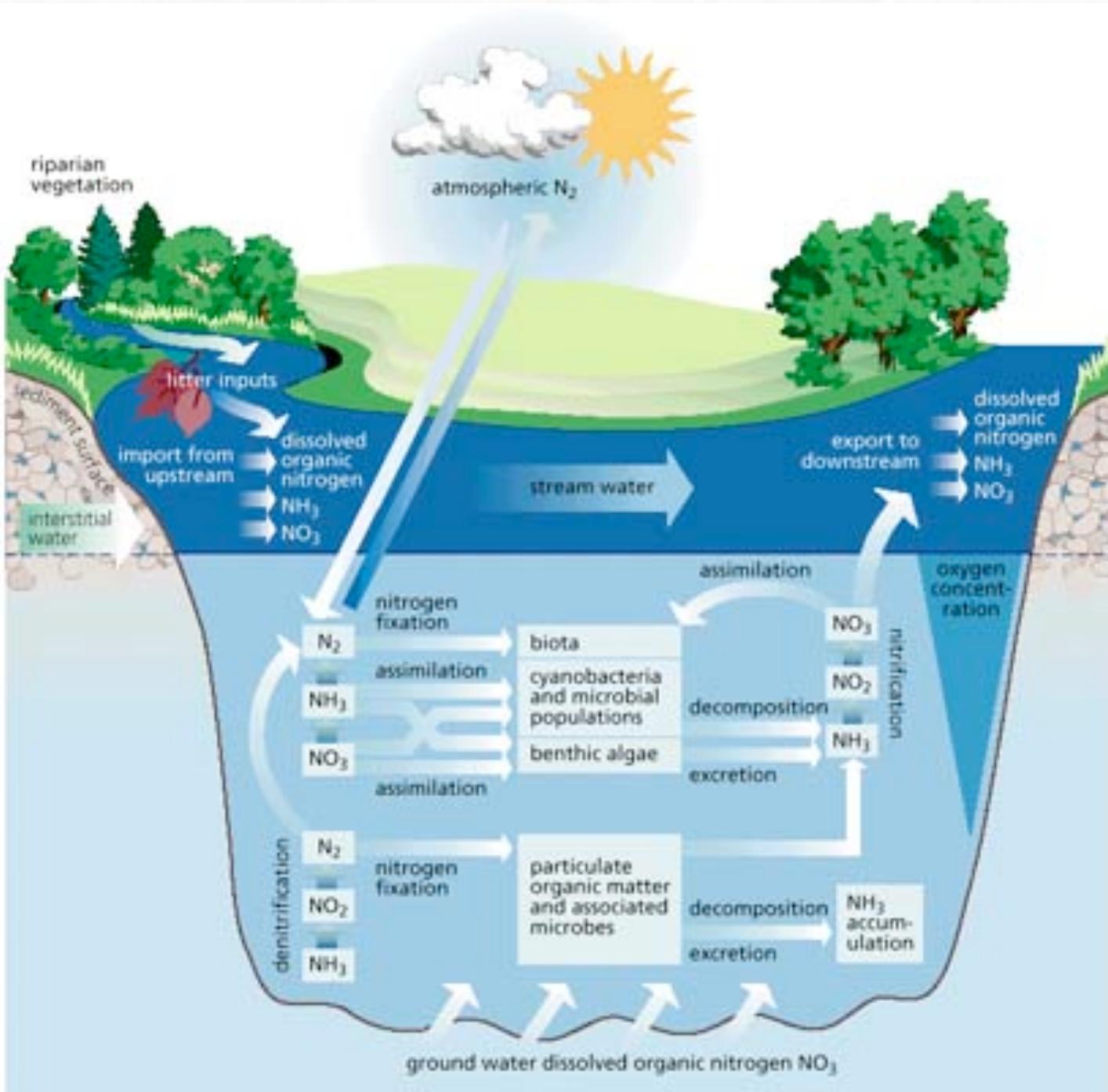
Qingdao in China 2008

# Marina Reservoir Catchment Area



# Expected water quality problems

Pollutants	Nutrients	Faecal Coliform	Silt	Discharges	Litters
Impact	Algae & Plant Growth	Bacterial	Brownish Water	Contaminated Water	Unsightly Water
Sources	  	 	 	 	 
Before Closure	Level : Low (Dilution from Seawater Flushing)				
After Closure	Level : Higher (Without Dilution from Seawater Flushing)				



# Balance of Water Systems: Issues

- Can we effectively manage trade-off between protection, supply and recreational use?
- Is there an objective way to achieve these trade-offs?
- How to plan developments under uncertain (i.e. changing climate) conditions?

Role for hydroinformatics?

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