Eco-hydraulics Study on Green Channels

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1. Background & Project Introduction




Why we have this project?




Need for Flood Prevention

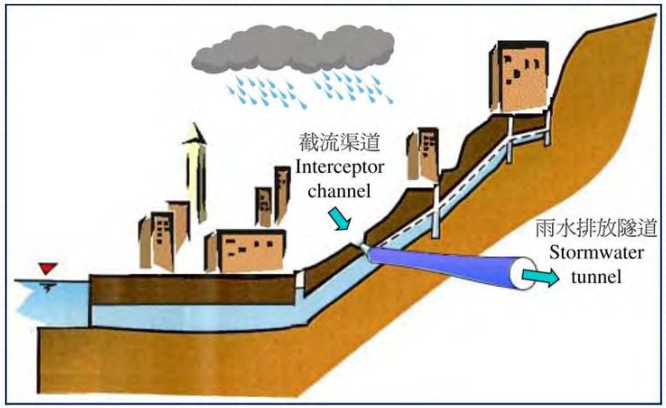
Historic Rainstorm Data

Period	Rainfall (mm)	Effect	Cause
1960			
9/JUN	236.1 in 1 day	**45 dead**; 11 missing; 127 injured; 15000 affected	T. Mary
1962			
1/SEP	203.0 in 1 day	**130 dead**; 53 missing; 72000 homeless	T. Wanda
1964			
12-13/OCT	333.1 in 2 days	**26 dead**; numerous landslides	T. Dot
1965			
26/SEP-1/OCT	534.2 in 6 days	**6 dead**; 200 homeless; widespread flooding; numerous minor landslides	T.S. Agnes
1966			
4/APR	190.2 in 1 day	**15 dead**	Thunderstorms
12/JUN	382.6 in 1 day; 108.2 in 1 hour; 157.0 in 1 hour; a record high at Aberdeen	**64 dead**; 29 injured; disastrous landslides and washouts on Peak Road, Stubbs Road and Ming Yuen Street; 8561 evacuated from their homes	Prolonged period of rain (2-15 Jun)

Drainage Improvement Works

Completed **river training works** at Ng Tung River near Tin Ping Shan, Sheung Shui

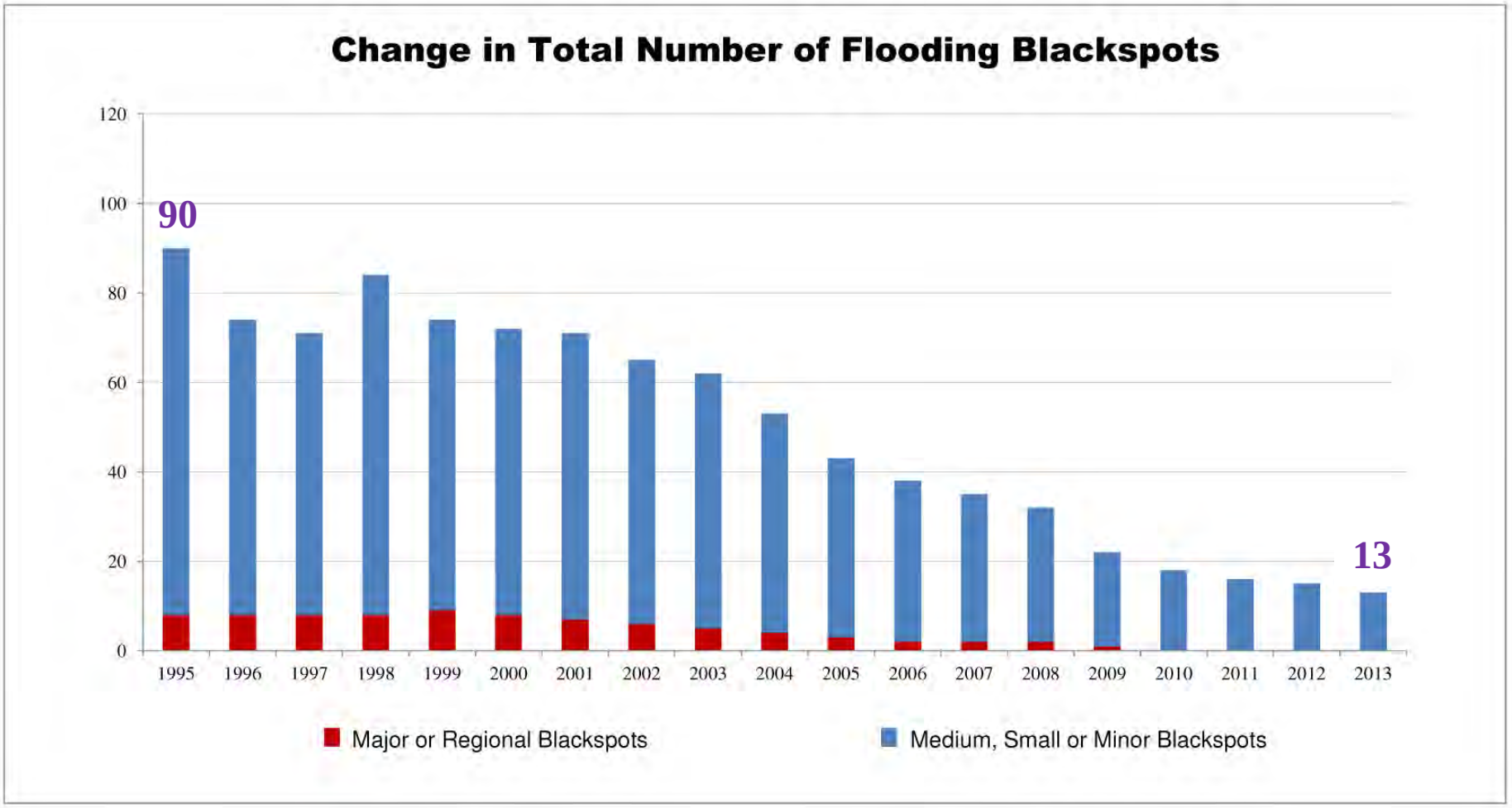
Village flood protection scheme in Ma Tin Tsuen, Yuen Long



Stormwater diversion by drainage tunnel

Tai Hang Tung Stormwater Storage Tank

Contributions from DSD's works



Hydraulics

can help to **prevent** and **reduce flood**




What is the most important things in our lives?

We LOVE because He first LOVED us.

1 John 4:19


What is the source of life?

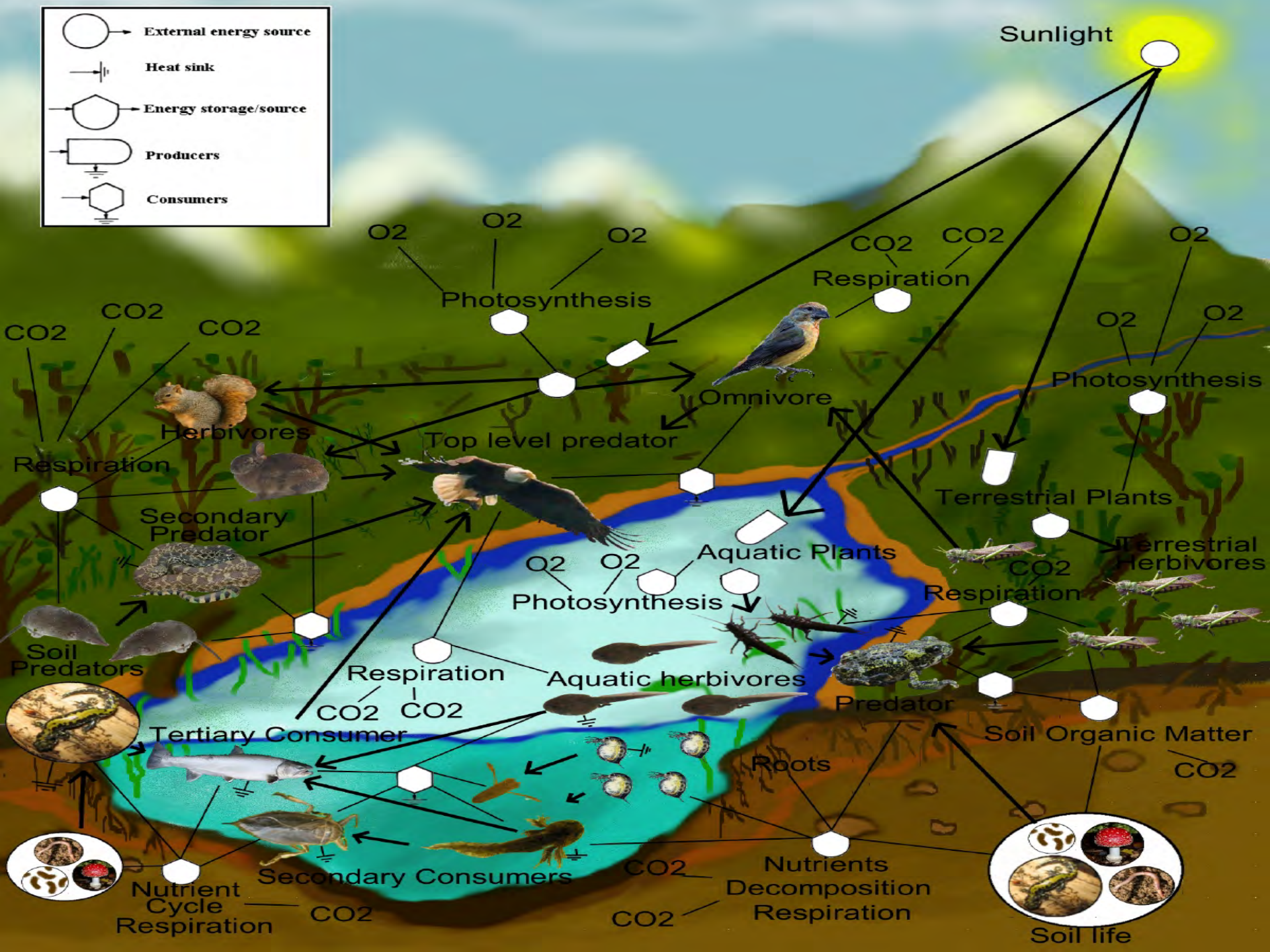
Sun, Air and Water

are the major elements for us to survive




Habitat and Adaptation are vital to living things





External energy source
Heat sink
Energy storage/source
Producers
Consumers
Sunlight
O2
O2
O2
Photosynthesis
CO2
CO2
Respiration
O2
O2
Photosynthesis
CO2
CO2
CO2
Respiration
Herbivores
Top level predator
Omnivore
Secondary Predator
Terrestrial Plants
Terrestrial Herbivores
Aquatic Plants
O2
O2
Photosynthesis
CO2
Respiration
Soil Predators
Respiration
CO2
CO2
Aquatic herbivores
Predator
Tertiary Consumer
Soil Organic Matter
CO2
Roots
Secondary Consumers
CO2
Nutrients
Decomposition
Respiration
Nutrient Cycle
Respiration
CO2
CO2
Soil life

Sources of food

1. **Autotrophs (自營生物)**

   - **Phytoplankton (浮游植物)**
   - **Periphyton (附生物)**
   - **Macrophytes (水生植物)**

2. **Microbial Heterotrophs (異營微生物)**

(Source: Allan, J.D. (2007) – Stream Ecology)

Autotrophs (自營生物)

&

Plankton (浮游生物)

is **tiny** but **vital**

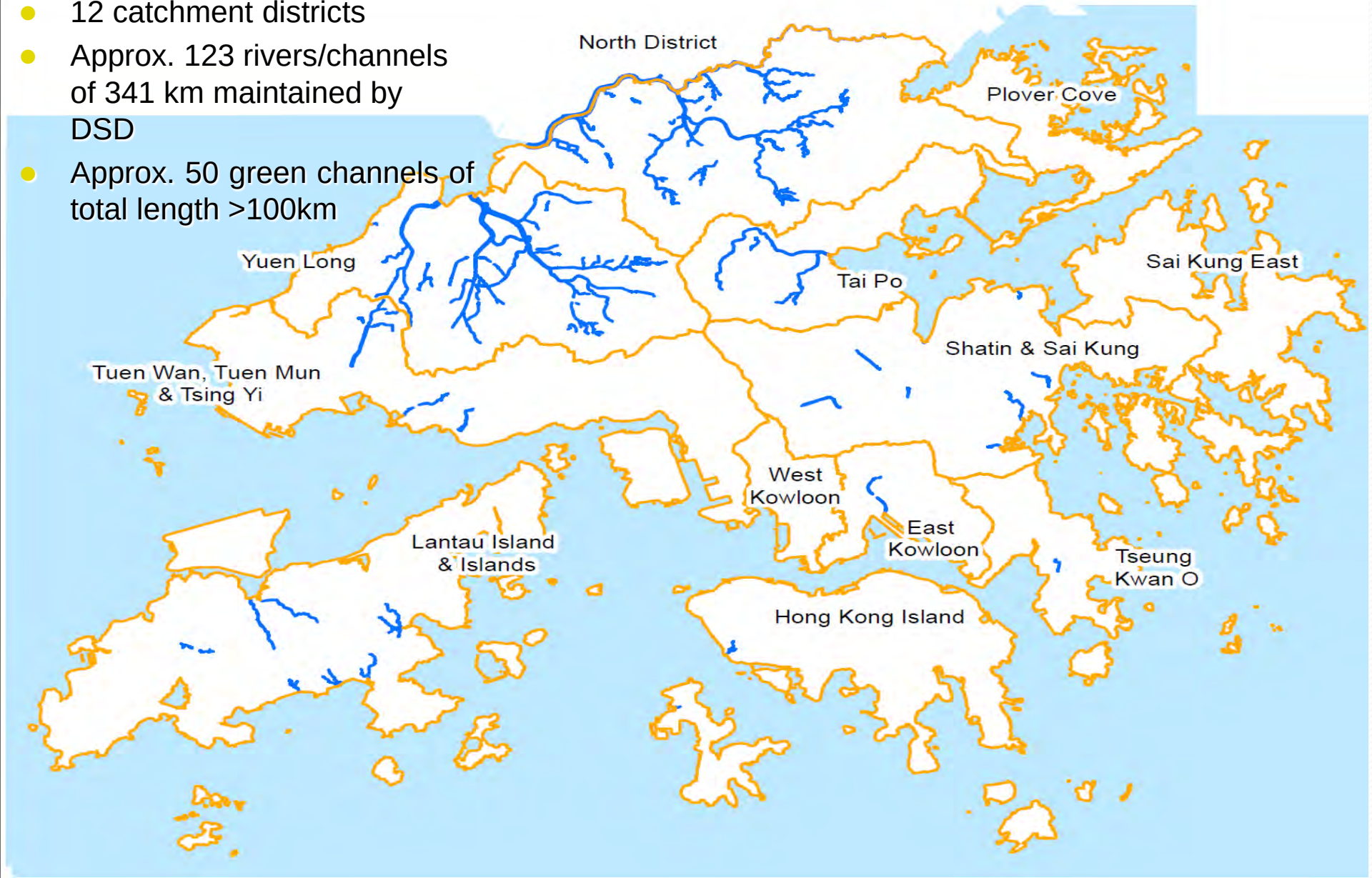
to stream ecology

3. Inventory of Rivers/Channels

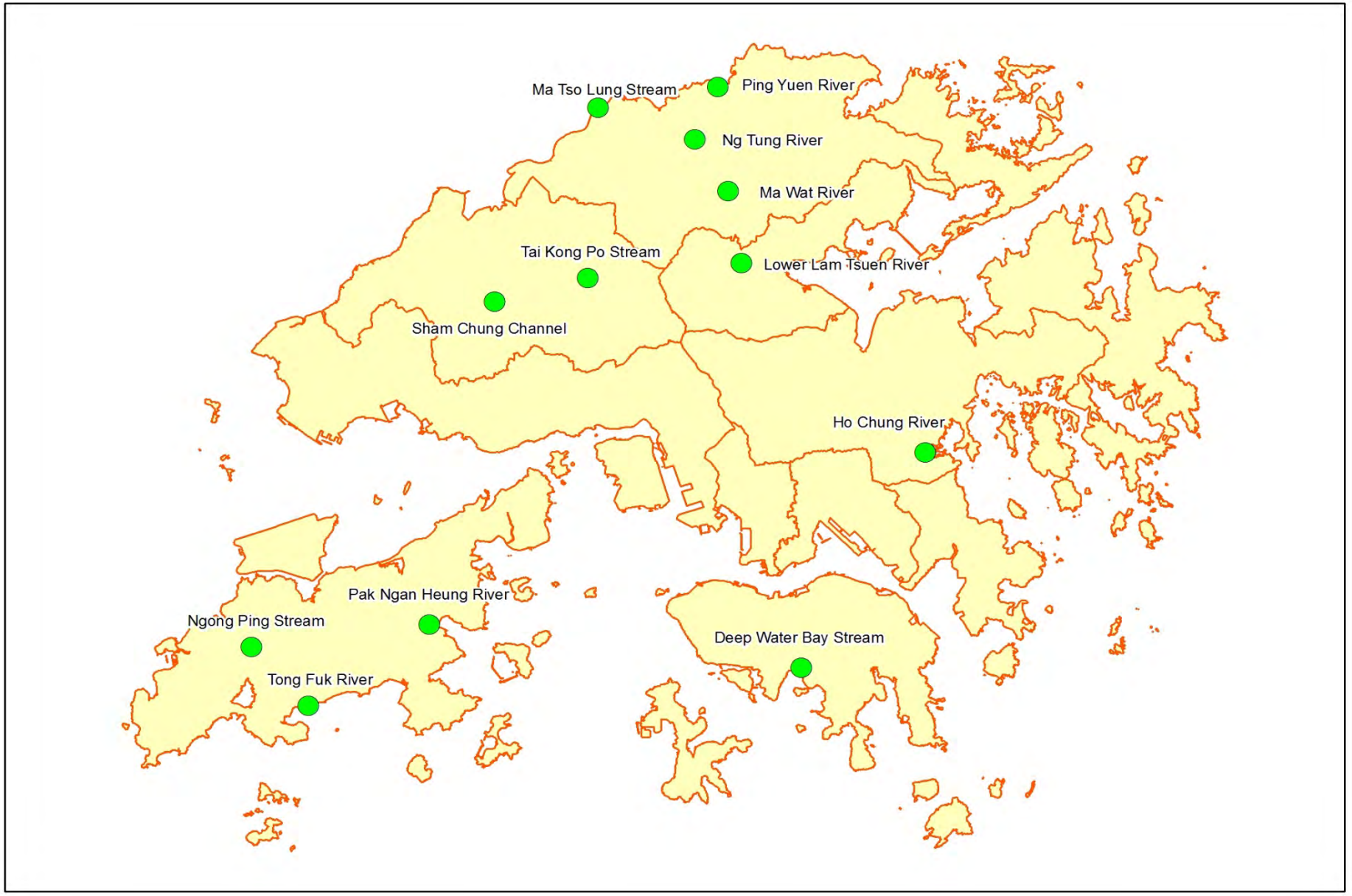



Inventory of Rivers/Channels

- 12 catchment districts
- Approx. 123 rivers/channels of 341 km maintained by DSD
- Approx. 50 green channels of total length >100km



Pilot Study: Selected Channels



Pilot Study : Selected Channels

- **12 channels** in different catchments with different channel characteristics and enhanced ecological features were chosen

Yuen Long District

Sham Chung Channel

- Concrete
- Water Quality only

Tai Kong Po Stream

- Grasscrete
- Gabion
- Water Quality only

Pilot Study : Selected Channels

North District

Ma Tso Lung Stream

- Gabion

Ma Wat River

- Grasscrete

Ping Yuen River

- Grasscrete (downstream)
- Natural (upstream)

Ng Tung River (Abandon Meanders)

- Wetland

Pilot Study : Selected Channels

Shatin & Sai Kung District

Ho Chung River
- Gabion
- Natural bed
- Fish ladder

Tai Po District

Lower Lam Tsuen River
- Grasscrete
- Tree Islands

Hong Kong Island District

Deep Water Bay Stream
- Natural (upstream)
- Gabion / Masonry (downstream)

Pilot Study : Selected Channels

Lantau Island & Islands District

Ngong Ping Stream

- Gabion
- Natural bed

Tong Fuk River

- Gabion
- Boulder / rock bed

Pak Ngan Heung River

- Gabion
- Rip rap

4. Water Quality and Ecology Survey

Water Quality Monitoring and Flow Measurement

- Site Measurements & Laboratory Testing

In-situ measurement:

- water temperature
- pH
- Turbidity
- DO and DO%
- Salinity
- Conductivity
- Flow & Depth

Water sampling for laboratory analysis:

- Suspended Solids
- Ammonia-nitrogen (NH4-N)
- Total Nitrogen
- Total Phosphorus

Water Quality Monitoring and Flow Measurement

Water Quality Monitoring Team at Work

Direct in-situ monitoring
at Deep Water Bay Stream

Water sample collection
at Ho Chung River

Indirect in-situ monitoring
at Lower Lam Tsuen River

Flow metering
at Ma Wat River

Water sample collection
at Tai Kong Po Stream

Flow metering
at Ping Yuen River

Water Quality Results

- Nutrients – highest at Sham Chung Channel and Tai Kong Po Stream, due to effluent discharges from nearby land uses
- Dissolved Oxygen – tends to be higher in the dry season, and highest at the abandoned meanders at Ng Tung River
- Turbidity – excessively high at Tai Kong Po
- pH – relatively large fluctuations between wet and dry season at Tai Kong Po Stream and Ma Tso Lung Stream
- Temperature – largest difference between wet and dry season at the streams in Lantau Island (ranging from 12^{o}C to 28^{o}C)
- Conductivity – highest at Ho Chung River due to estuarine influence. Also relatively high at Tai Kong Po due to effluent loading

Ecological Field Survey

- Habitat Survey
- Vegetation Survey
- Bird Survey
  - Walk transect
  - Auditory and visual detection
- Freshwater Fish Survey
  - Bankside transect count
  - Hand netting
  - Pot trapping
- Herpetofauna Survey
  - Daytime and nighttime
  - Active searching
- Dragonfly Survey
  - Transect survey
- Aquatic Invertebrate Survey
  - Kick sampling
  - Bankside net sweeps
  - Grab sampling / hand dredging
- Streambed Property Sampling
  - Quadrat sampling

Ecological Survey

Ecology Team at Work

Fish netting
at Ma Wat River

Fish identification
at Ng Tung River

Pot trapping
at Ho Chung River

Bankside net sweeping
at Ho Chung River

Kick sampling
at Ma Wat River

Pot trapping
at Ng Tung River

Survey Results

- Habitat – various, including channel, woodland, shrubland, developed area, cultivation land, bare ground, village, fish pond, ditch and marsh

- Species – 380 flora species and 249 fauna species are recorded

- Rare species / species of conservation concern
  - 4 flora species
  - 1 dragonfly species
  - 4 herpetofauna species
  - 5 freshwater species
  - 34 birds species

Native Species of Conservation Concern

綠鷺

三索錦蛇

菲律賓枝牙鰕虎魚

水松

異鱲

麻鷹

Native Species of Conservation Concern

赤斑曲鉤脈蜻

藍翡翠

赤胸鶇

灰卷尾

銀環蛇

側條光唇魚

Native Species of Conservation Concern

池鷺

虎紋蛙

蒼鷺

花鰻鱺

鸕鷀

藍刀

5. Channel Classification

Habitat Evaluation

- **11 Criteria**
  - Naturalness
  - Size
  - Age
  - Diversity of species
  - Rarity
  - Abundance of wildlife
  - Nursery / Breeding ground
  - Potential value
  - Recreatability
  - Fragmentation
  - Ecological linkage

Rapid Stream Evaluation

Criteria		Description	Ranking*	Description
(1) Physical and chemical factors of importance to the biota				
(a) Water quality	**(i) pH**	Provided indication of anthropogenic pollutants. Acidification had been **harmful** when pH falls much **below 5.0** (Allan, 2007).	**0**	**pH < 3.0 or >12.0: industrial and municipal wastewater pollution**
			1	**pH 3.0 – 5.0: polluted surface water that harmful to most organisms**
			2	**pH 8.6 – 11.9: polluted surface water supporting only those less susceptible biota.**
			3	**pH 5.0 – 6.4: supporting less susceptible biota**
			4	**pH 6.5–8.5: unpolluted surface water supporting most of the aquatic biota.**
	(ii) DO (%)	DO supported aquatic fauna for respiration and maintenance of life. Ranking based on WQI of EPD.	**0**	**<30% or >130%: very poor water quality**
			1	**31 – 50%: poor water quality**
			2	**51 – 70% or 121 – 130%: fair water quality**
			3	**71 – 90% or 111 – 120%: good water quality**
			4	**91 – 110%: excellent water quality with dissolved oxygen near or at saturation**
	(iii) NH3-N	Indicated the **extent of organic contamination** of the river channel. Nutrient concentrations **predicted phytoplankton abundance** and had been useful in characterizing the productivity of riverine ecosystems. Ranking based on WQI of EPD.	**0**	**>5.0 mg/L: high level of contamination by municipal and industrial discharge or fertilizer runoff from agricultural land**
			1	**2.1 – 5.0 mg/L: medium level of contamination by municipal and industrial discharge**
			2	**1.1 – 2.0 mg/L: low to medium level of contamination by nutrient**
			3	**0.5 – 1.0 mg/L: low level of contamination by nutrient**
			4	**<0.5mg/L: limited contamination by nutrient**

Rapid Stream Evaluation

Criteria		Description	Ranking*	Description
(1) Physical and chemical factors of importance to the biota				
(b) Instream habitat	**(i) Substrate**	Substrates could be separated as **inorganic substrates** and **organic substrates**. In general, cobbles and boulders were dominant in the bed of mountain stream, and the silts and sands were more typical of lowland rivers. Submerged logs to plant stems were larger organic substrate, while autumn-shed leaves on streambed were substrate to insects. **Invertebrates diversity and abundance** had been **increased with substrate stability**, **heterogeneity** and the presence of **organic detritus** (Allan, 1995)	**0**	Dominant by **artificial substrate** with smooth surface (e.g. concrete bed)
			1	Dominant by **silt** and **finer sediments** or substrate of uniform particle size with limited detritus.
			2	Dominant by **sandy substrates** or dominant by **substrate size larger than cobbles** but with **limited aquatic vegetation**.
			3	With **70% or more** of the bed for a lowland river composed of **sand and wood** that provide nourishment from a **mix of algae, microbes** and decomposing wood fibre found on wood surfaces. Or A **variable mix of substrates** with **variable of particle size** that dominant with **gravel and pebbles of median particle size** but with some **aquatic plant**.
			4	A **mixture of substrates** ranging from **sandy and woody with aquatic plants** that provides organic substrates, to **gravel, pebble and cobble** that provides a variety of habitats for feeding and spawning.

Rapid Stream Evaluation

Criteria	Description	Ranking*	Description
(1) Biological factors			
(a) Species diversity and species density	**Wetland dependent species** (excluding fish and aquatic invertebrates). The more diverse the species assemblages and higher species density, the higher the ranking.	**0**	Insignificant diversity (0-2) and density
		1	Low diversity (3-10) and density
		2	Moderate – low diversity (11-20) and density
		3	Moderate diversity (21-30) and density
		4	High diversity (>30) and density
(b) Species of conservation concern	Channel with more **species of conservation concern** recorded will be ranked higher	**0**	No species of conservation concern recorded
		1	1 – 2 number of species of conservation concern recorded
		2	3 – 5 number of species of conservation concern recorded
		3	6 – 10 number of species of conservation concern recorded
		4	>10 number of species of conservation concern recorded

Rapid Stream Evaluation

Criteria	Description	Ranking*	Description
(1) Biological factors			
(c) Freshwater/ estuarine fish species	Channel with a higher number of **native fish species** recorded will be ranked higher	**0**	Insignificant number of fish species recorded (0-2) or dominated by 0-2 exotic species
		1	Low number of native fish species recorded (3-4) or dominated by 3-4 exotic species
		2	Moderate – low number of native fish species recorded (5-8)
		3	Moderate number of native fish species recorded (9-12)
		4	High number of native fish species recorded (>12)
(d) Aquatic invertebrates	Channel with a higher number of **aquatic species** recorded will be ranked higher	**0**	Very low species diversity recorded. Generally dominated by midgeflies, aquatic worms, pulmonates and apple snails.
		1	Low species diversity recorded. Generally dominated by pollution-tolerant midgeflies, aquatic worms, pulmonates and apple snails.
		2	Low-moderate species diversity of macroinvertebrate community present. Pollution-tolerant caddisflies e.g. hydropsychids, snails, midgeflies, aquatic worms dominant.
		3	Moderate species diversity of macroinvertebrate community present. Dominated by mayflies, and caddisflies.
		4	Moderate-high species diversity of macroinvertebrate community present. Present of flathead mayflies, stoneflies and cased caddisflies, atyids, *Macrobrachium* sp., crabs, water pennies, Elmidae and *Eulichas* sp. and gomphid dragonflies.

Rapid Stream Evaluation

Criteria	Description	Ranking*	Description
(1) Biological factors			
(e) Riparian habitat conditions	The **ecological connectivity** with **adjacent habitats** within **30m riparian buffer** may affect the ecological value of the channel.	**0**	Containing no natural habitats or habitats which are of no ecological value
		1	Containing habitats which are highly degraded
		2	Containing one to two habitats with ecological value
		3	Containing three to four habitats with ecological value
		4	Containing five or more habitats with ecological value

* Ranking: 0 – Very poor; 1 – Poor; 2 – Fair; 3 – Good; 4 – Excellent.

Reference:

- New Nature Conservation Policy of the Government of HKSAR (2004)
- Rapid Stream Assessment Technique (RSAT) of the Metropolitan Washington Council of Governments (1996)
- Qualitative Habitat Evaluation Index (QHEI) of the Environmental Protection Agency of Ohio State in USA (2006)
- Stream Ecological Valuation (SEV) of Auckland Council in New Zealand (2011)

Rapid Stream Evaluation

- Categorization of Ecological Value and Habitat Quality for Channels

Categories	Overall Score
Excellent	28 – 36
Good	19 – 27
Fair	10 – 18
Poor	6 – 9
Very Poor	0 – 5

Rapid Stream Evaluation

Criteria		Ping Yuen River	Ng Tung River Abandoned Meanders	Ho Chung River	Ngong Ping Stream	Pak Ngan Heung River
(1) Physical and chemical factors of importance to the biota						
(a) Water quality	(i) pH	4	4	4	4	4
	(ii) DO (% saturation)	2	2	4	3	4
	(iii) NH3-N	2	3	3	3	4
(b) Instream habitat	(i) Substrate	0	1	2	2	3
(2) Biological factors						
(a) Species diversity and species density		2	2	2	1	2
(b) Species of conservation concern		4	3	2	1	2
(c) Freshwater/estuarine fish species		0	0	2	0	3
(d) Aquatic invertebrates		0	0	1	0	2
(e) Riparian habitat conditions		2	2	2	2	2
Overall Scores		**16**	**17**	**22**	**16**	**26**
Overall Categories		**Fair**	**Fair**	**Good**	**Fair**	**Good**

Rapid Stream Evaluation

Criteria		Ma Tso Lung Stream	Ma Wat River	Tong Fuk River	Lower Lam Tsuen River	Deep Water Bay Stream
(1) Physical and chemical factors of importance to the biota						
(a) Water quality	(i) pH	4	4	4	4	4
	(ii) DO (% saturation)	3	3	4	4	4
	(iii) NH3-N	3	2	4	2	4
(b) Instream habitat	(i) Substrate	1	1	2	0	1
(2) Biological factors						
(a) Species diversity and species density		2	3	2	1	1
(b) Species of conservation concern		2	3	2	1	1
(c) Freshwater/estuarine fish species		0	1	2	0	2
(d) Aquatic invertebrates		1	0	0	0	1
(e) Riparian habitat conditions		3	0	2	0	2
Overall Scores		**19**	**17**	**22**	**12**	**20**
Overall Categories		**Good**	**Fair**	**Good**	**Fair**	**Good**

Green Channels Design

Green Channels Design

Objectives

- **Existing rivers/channels**
  - Review the success of existing channel design
  - Identify opportunities for channel enhancement
  - Develop river revitalization plan

- **New rivers/channels**
  - Use of avoidance / minimization / compensation approach
  - Provide ecological enhancement measures
  - Provide due consideration on hydraulic resistance
  - Consideration of historical information

Green Channels Design

- **Ecological considerations** for river channel design

Creation of **sinuosity**

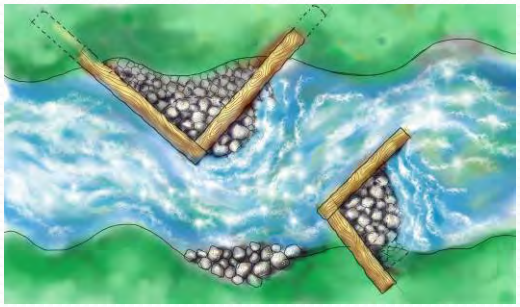
Preservation and enhancement of cut-off meanders

Provision of **fish passages**

- **Natural / unlined bed**
- Preservation / reinstatement of bed substrates

Preservation of **riparian vegetation**

Enhancing channel complexity by microhabitat creation

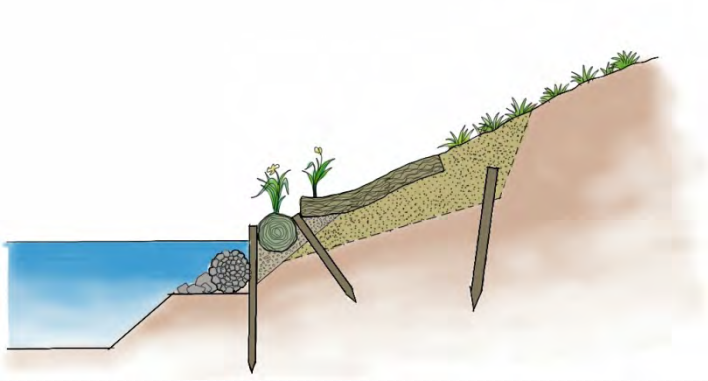


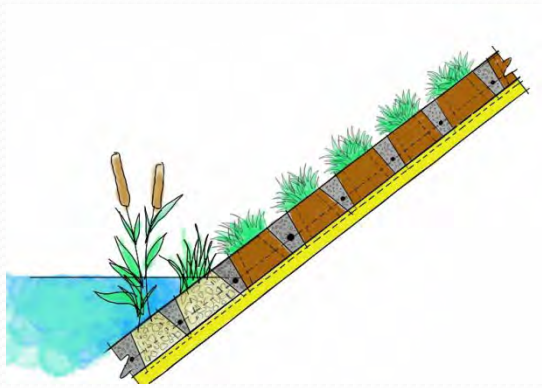
Current deflectors to create riffles and pools

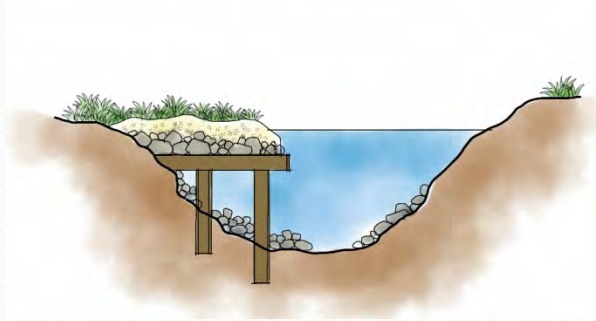
Green Channels Design

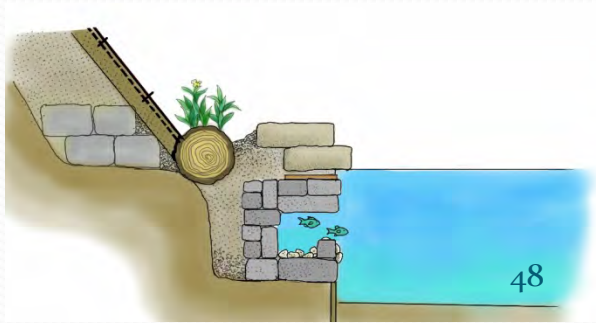
Minimization

- Clearing and removal of obstructions to minimize the extent for river channelization
- Minimize the extent for channel widening to minimize habitat loss
- Landscape enhancement by planting along river corridor
- Provision of animal passage to enhance connectivity
- Use of natural materials for bank stabilization
- Provision of fish shelter









Green Channels Design

Compensation

Restoration and enhancement of fish ponds

Mangrove planting

Long-term management

- Set up improvement / performance indicators
- Monitoring requirements
- Control of long-term changes in river channels (aggradations / erosion)
- Vegetation / channel bed maintenance (alternation of vegetation maintenance)
- Weed control / exotic species control

Biodiversity Enhancement

Review of River Biodiversity

Ma Tso Lung Stream

Ma Wat River

Pak Ngan Heung River

Tong Fuk River

Thank You

Discussion