Hong Kong: 2050 Water and Climate Vision

WP6 – Task 6.6 Buddy System Activities
Webinar 04th October 2019
RINA-C

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European Commission
Horizon 2020
European Union funding
for Research & Innovation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052 | ***Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions***

BUDDY SYSTEM ACTIVITIES

WEBINARS

+

FACE-TO-FACE MEETING WORKSHOPS

+

WEBSITE

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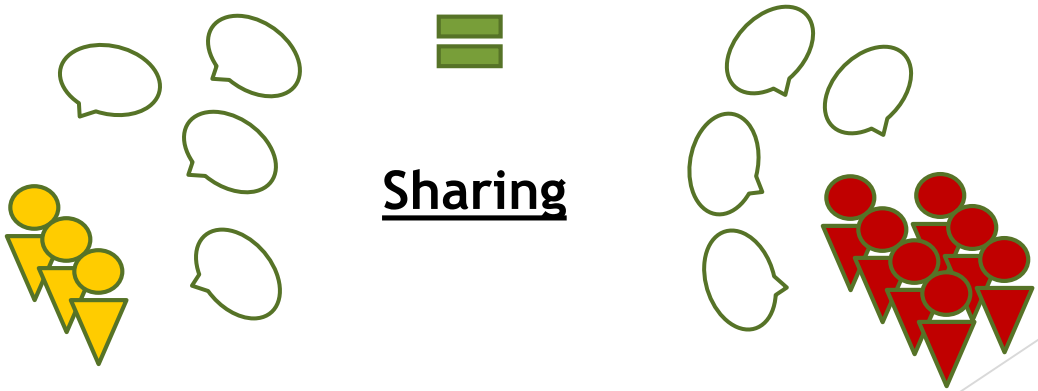

Sharing

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***Topic**: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions*

WEBSITE NEWS

- 3 sections: - NBS for Water Management
  - NBS for Urban Growth and Densification
  - NBS for Biodiversity

  } Information repository

- Document that summarizes all the feedbacks and suggestions received from the cities on the future Buddy System activities
- A template to track the exchange of information and material among the cities

European Commission

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WEBSITE NEWS

COLLABORATIVE ACTIVITIES BETWEEN CITIES	
Cities involved	
City1 Name	
City2 Name	
People involved	
Contact person/s City1	
Contact person/s City2	
Period of time	
Date starting/duration of the collaboration	
Focus on the collaboration	
Topic developed	
Type of activity (e.g. request of information/material)	
Insert documents/images and other materials exchanged	
Summarize the outcomes of this collaborative activity	
Tools	
Specify if particular tools/instruments have been used/shared	
Useful links	

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NEXT BUDDY SYSTEM ACTIVITY

WORKSHOP during Castellòn physical meeting

(25 – 28 November)

European Commission

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***Topic**: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions*

Webinar agenda

TIME	SPEAKER	PRESENTATION
15:00 – 15:05	Sara Botto (RINA-C)	Topic presentation and agenda
15:05 – 15:15	Dr. Yuhong Wang - Hong Kong Polytechnic University	Presentation of the city of Hong Kong (general information/involvement in the UNaLab project)
15:15 – 15:30	Dr. Yuhong Wang and Ms. Yang Chen - Hong Kong Polytechnic University	Assessment of water quality of rivers restored rfom urban drainage channels
15:30 – 15:45	Dr. Yuhong Wang and Ms. Yang Chen - Hong Kong Polytechnic University	How to evaluate the biodiversity of urban green spaces from perspective of AEC practitioners
15:45 – 16:00	Dr. Yuhong Wang/Ms. Siqi Jia/Ms. Yang Chen - Hong Kong Polytechnic University	NBS monitoring measures and results
16:00 – 16:30	-	Interactive sessions with partecipants (Q&A)

European Commission

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HONG KONG FUTURE VISION AND EXPERIENCES

- Have a non European city perspective on the NBS related topics
- Give Hong Kong the possibility to share its researches, good practices and NBS implemented to mitigate the climate change effects
- Learn successful stories, demonstration cases and experiences
- Become aware of tools and methodologies to help the implementation and monitoring of these solutions

European Commission

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The General Introduction to Hong Kong and Our Involvement in the UNaLab Project

Dr. Yuhong Wang

The Hong Kong Polytechnic University

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

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OUTLINE

- >Introduction to Hong Kong
- >Goals and Objectives
- >Monitoring Process
- >Expected Results

Introduction to Hong Kong:

Geographical Location

Hong Kong, which located at 22°17'N, 114°09'E, is a well-known high-density city. The territory of Hong Kong consists of Hong Kong Islands, Kowloon, and New Territories, which are further divided into 18 districts.

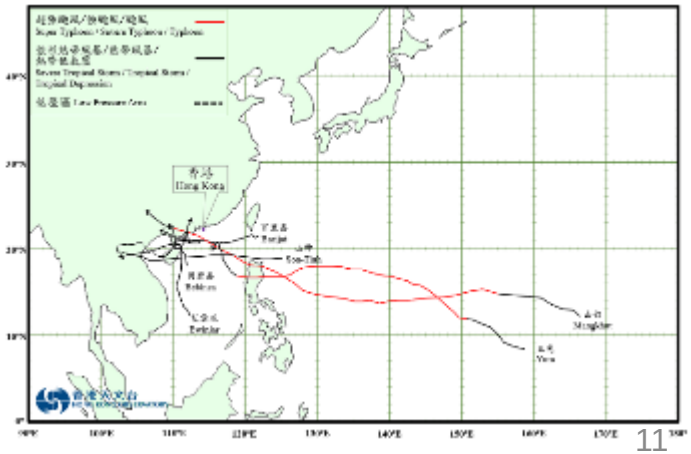
Introduction of Hong Kong:

Climate Conditions

Hong Kong is situated in a humid subtropical climate zone with frequent rainstorms and typhoons.

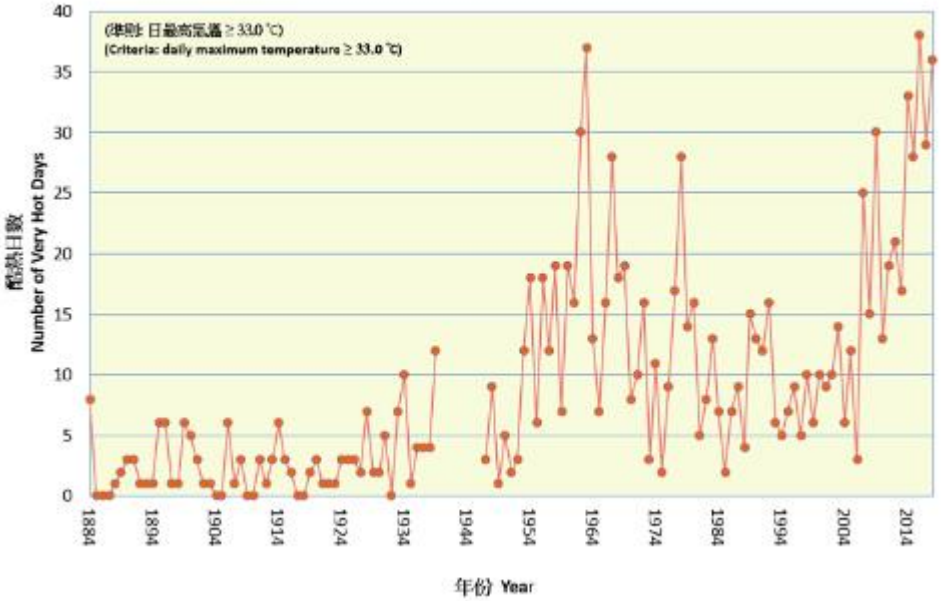
For instance, the super typhoon *Mangkhut* in 2018 with the maximum wind speed at 285 km/h knocked down over 10,000 trees.

In 2018, there are totally six tropical cyclones affecting Hong Kong.



Introduction to Hong Kong:

Climate Condition



Long-term time series of number of very hot days in Hong Kong 1884-2018

One trend about the climate condition in Hong Kong is that it becomes warmer than before.

This climate change and rapid urbanization have created noticeable urban heat island effect (UHI).

In addition, urbanization has created many other environmental problems such as worse water and air quality, storm-water overflows, increased noise and loss of biodiversity.

Introduction to Hong Kong:

Population & Urban development

Hong Kong is one of the most densely populated cities in the world, which ranks between 2nd and 3rd in the world for the population density. The total population in Hong Kong was estimated as 7.5 million people in 2018. Looking back, in the year of 1960, Hong Kong had a population of 3.1 million people.

SOURCE: TRADINGECONOMICS.COM | CENSUS AND STATISTICS DEPARTMENT, HONG KONG

Noticeable Initiatives in Hong Kong

To improve the urban environment, some initiatives have been made in Hong Kong. Noticeable ones include urban river restoration and roof greening.

Introduction to Hong Kong:

River Restoration by Government

The Drainage Services Department (DSD) has been trying to revitalize water bodies by incorporating green and eco-conservation elements into channels and river training works. These include planting in river channels and along river-banks, restoration of natural streams and river ecosystems, enhancing wildlife growth and improving landscape.

Introduction to Hong Kong

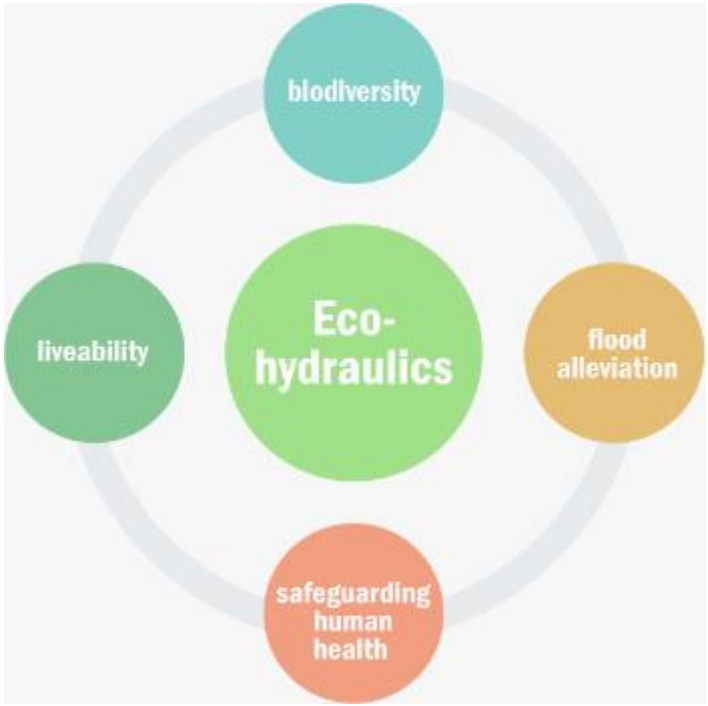
Roof Greening by the Government

Roof greening not only improves air quality, lower indoor temperature and reduce building energy consumption, but also enhances the building's aesthetics, and improves the biodiversity of the surrounding environment. In 2015-16, the DSD completed six roof greening projects.

Data Source:
https://www.dsd.gov.hk/Documents/SustainabilityReports/1516/en/environmental_management.html

Introduction to Hong Kong:

Summary



> The environmental stresses of Hong Kong:
  - Frequent typhoons and rainstorms;
  - Serious urban heat island effect;
  - High population density;
  - Limited open space.

> The Hong Kong government has made some environmental management initiatives such as:
  - River restoration project
  - Roof greening project.

> Hong Kong has potentials to apply some Nature-Based Solutions (NBS) to improve the urban environment.

OUTLINE

>Introduction to Hong Kong

>Goals and Objectives

>Monitoring Process

>Expected Results

Goals and Objectives

The Research Objectives

HK partners are responsible for three research components in *UNaLab*:

(1) To develop integrated porous pavement systems and their components as part of the Nature Based Solution (NBS);

(2) To selectively adopt NBS and implement them locally through “living labs”;

(3) To perform life-cycle cost analysis, life-cycle assessment, and social impact analysis of the developed the NBS demonstration projects.

OUTLINE

>Introduction to Hong Kong

>Goals and Objectives

>Monitoring Process

>Expected Results

Monitoring process:

The monitoring program

Four major monitoring programs are being implemented:

a. Water quality test
b. Biodiversity observation
c. UHI and thermal performance of green buildings
d. Resilience of NBS infrastructures

In addition to the four monitoring programs, we have also conducted social impact study to find how the public responds to the urban nature solutions. Over 150 questionnaires were collected.

OUTLINE

>Introduction to Hong Kong

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Expected Results

- Based on the existing NBS, to evaluate the environmental performance of "living labs" from the perspectives of water quality, biodiversity, thermal comfort and stormwater management.
  - Natural condition – River restoration;
  - Urban condition – Green buildings (e.g. green roofs)
- Based on the local environment of Hong Kong, to propose new NBS which is not only effective, but also adaptive to the local climate condition.
- From environmental, economic and social perspectives, to evaluate the environmental problems and optimize the NBS in the city.

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Thanks for your attention.

Welcome for any comments and questions.

Assessment of Water Quality of Rivers Restored from Urban Drainage Channels

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Outline

- Introduction
- Methodology
- Results and Discussion
- Conclusion

Introduction

Background

Previous:

Concrete drainage channels were implemented for flooding issues →Lose ecological, aesthetic and recreational values

Present:

Revert concrete-lined rivers back to more natural states. (Removal of concrete beds, construction of vegetated, channel embankments, geo-fabric reinforced grass, lining and gabions, Re-creation of the meanders

Figure 1 A comparison of the traditional urban drainage channel (left) and the revitalized one (right)

Research objectives

- Monitor water quality of restored river sections;
- Find correlations between each water quality(WQ) parameter;
- Explain factors behind any change;
- Recommend design and operation improvements.

Outline

- Introduction
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Methodology

- Case I: Ma Wat River (MWR), Case II: Lam Tsuen River (LTR);
- Measure upstream and downstream of the restored section;
- Sampling period from May to Nov. 2018, morning from 7 to 9AM;
- Statistical test: Paired t-test, Wilcoxon Signed Rank test, P=0.05.

(a)Case I : Ma Wat River (MWR)

(b)Case II: Lam Tsuen River (LTR)

Figure 2 Sampling Points for (a) Ma Wat River and (b) Lower Lam Tsuen River: 1 - Upstream, 2 - Downstream

Methodology

Water quality parameters and methods

Table 1 Selected Water Quality Parameters and Corresponding Methods of Determination

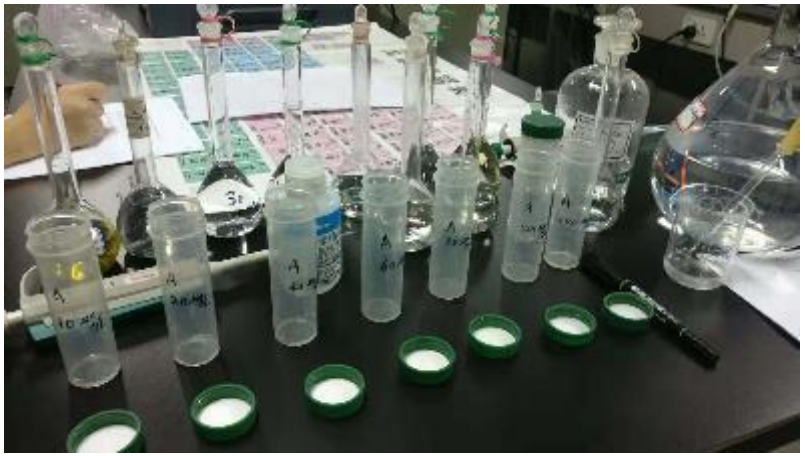
Category	Parameter	Abbreviation	Method
Physico-chemical	pH	pH	Multi-parameter water quality data logger
	Dissolved Oxygen	DO	
	Electrical Conductivity	EC	
Solids Content	Total Suspended Solids	TSS	Gravimetric Determination (APHA 2540D)
Aggregate Organic Constituents	5-Day Biochemical Oxygen Demand	BOD_5	Respirometric Method (APHA 5210B)
Nutrients	Ammonia-Nitrogen	NH_3-N	Salicylate Method (HACH Method 8155)
	Nitrate Nitrogen	NO_3-N	Cadmium Reduction (HACH Method 8039)
	Orthophosphate	OP	PhosVer 3 Ascorbic Acid Method (HACH Method 8048)
Pathogens	Escherichia coli	E. coli	Membrane Filtration Method
Trace Metals	Aluminium, Arsenic, Lead, Zinc, Cadmium, Chromium	Al, Cd, Cr, Pb, Zn	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Methodology

On-site monitoring and lab experiment

Physico-chemical: pH、DO、EC

NH_3-N、NO_3-N、OP



E.coli

Trace metals

Figure 3 On-site and in-lab experiment

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Results and Discussion

Water quality parameters

- Both sites consistently meet HK water policies except for BOD
  - fluctuations due to rainstorm events

Table 2 Statistics of the measured water quality parameters

Parameter	Units	Reference Limit	MW River					LT River				
			Up	Down	Diff.	Paired T-Test	Wilcoxon Test	Up	Down	Diff.	Paired T-Test	Wilcoxon Test
pH	-	6.8-8.5[1]	7.59	7.73	0.14	**0.000**	0.008	7.82	7.78	-0.04	0.207	0.173
DO	mg/L	≥ 4[1]	5.43	5.75	0.32	**0.001**	0.008	6.2	6.07	-0.13	.086*	0.086
EC	µS/cm	≤ 300[2]	182.11	178.78	-3.33	**0.013**	0.013	194	210.78	16.78	**0.021**	0.021
TSS	mg/L	≤ 20 [1]	15.51	12.67	-2.84	.194*	0.139	7.78	9.67	1.89	.258*	0.172
BOD_5	mg/L	≤ 3[1]	3.97	3.21	-0.76	0.143	0.123	7.16	7.40	0.24	0.68	0.314
NH_3-N	mg/L	≤ 1[2]	0.86	0.78	-0.08	**0.007**	0.021	1.55	1.64	0.09	0.261	0.11
NO_3-N	mg/L	≤ 10[3]	8.44	9.49	1.05	0.196	0.314	10.22	12.03	1.81	**0.002**	0.008
PO_4	mg/L	≤ 1[4]	0.77	0.77	0	0.858	0.767	1.49	1.84	0.35	.238*	**0.011**
E. Coli	MPN/ 100 ml	≤ 610[1]	2881	2844	-37	0.954	0.859	3210	3248	38	0.962	0.594
Al	µg/L	≤ 750 [3]	207.6	186.9	-20.7	0.267	0.214	73.7	81.7	8	.683*	0.594
As	µg/L	≤ 340 [3]	2.9	3.1	0.2	.308*	0.441	1	1	0	.635*	0.26
Cd	µg/L	≤ 2 [3]	0.2	0.1	-0.1	0.369	0.889	0.6	0.3	-0.3	0.678	0.889
Cr	µg/L	≤ 16 [3]	0.9	0.9	0	.989*	0.441	0.6	0.6	0	0.804	0.678
Pb	µg/L	≤ 65 [3]	2.4	2.4	0	.972*	0.594	0.9	0.8	-0.1	.934*	0.314
Zn	µg/L	≤ 120 [3]	18	24	6	.452*	0.515	18.9	17.2	-1.7	0.532	0.859

Results and Discussion

Water quality index (WQI)

- MWR: water quality improvement;
- LTR: water quality deteriorated.

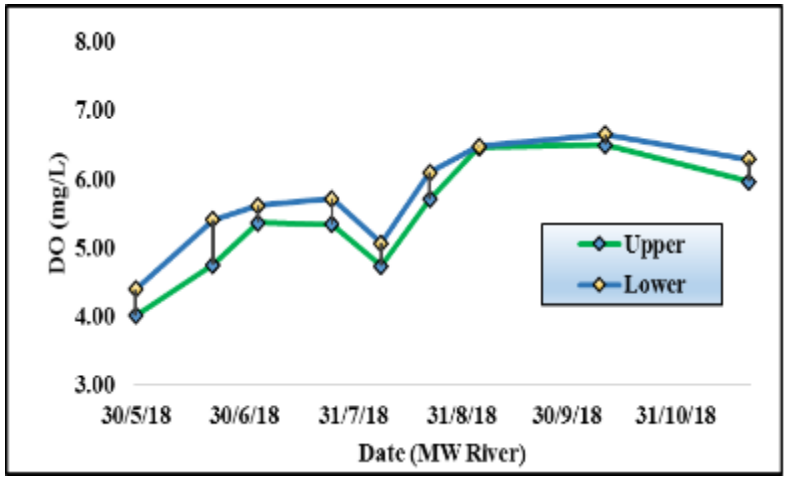
Table 3 Water quality indices and ratings of both case studies

Date	Ma Wat River				Lam Tsuen River			
	WQI		Rating		WQI		Rating	
	Up	Down	Up	Down	Up	Down	Up	Down
5/30/18	11	9	Bad	Fair	12	12	Bad	Bad
6/21/18	8	7	Fair	Good	6	7	Good	Good
7/4/18	5	5	Good	Good	5	5	Good	Good
7/25/18	7	5	Good	Good	5	6	Good	Good
8/8/18	8	7	Fair	Good	9	10	Fair	Fair
8/22/18	4	4	Excellent	Excellent	11	12	Bad	Bad
9/5/18	4	4	Excellent	Excellent	4	4	Excellent	Excellent
11/10/18	6	5	Good	Good	6	6	Good	Good
11/21/18	6	7	Good	Good	4	5	Excellent	Good
Average	6.6	5.8	Good	Good	7.3	7.8	Good	Fair

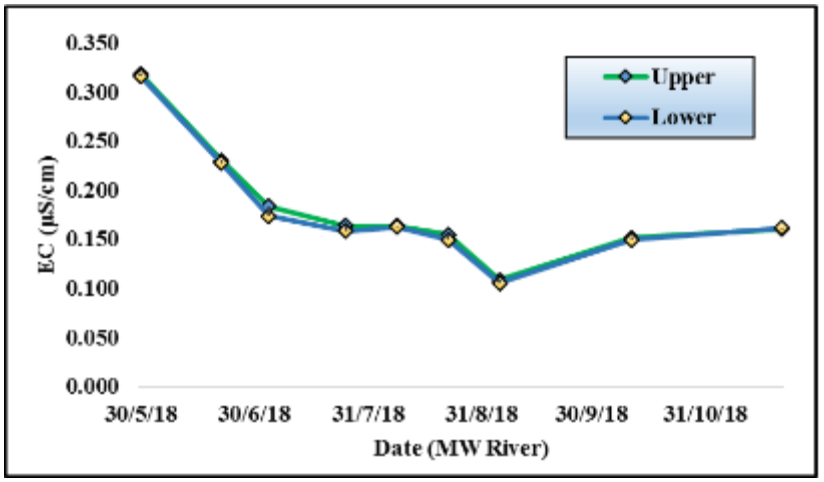
Results and Discussion

Water quality

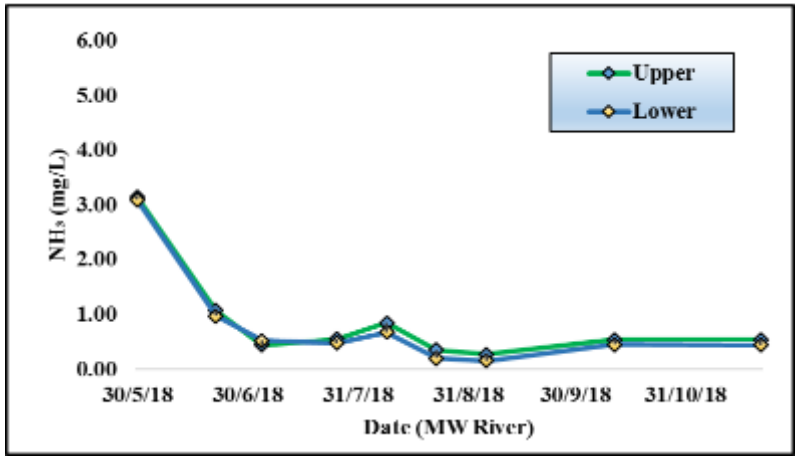
Case I: WQ improvements
- Higher DO
- Lower EC and NH_3-N (pollutants)



(a) DO time series for Case I



(b) EC time series for Case I



(c) NH_3-N time series for Case I

Figure 4 WQ parameters for Case I

Results and Discussion

Water quality

Reason for WQ improvement at Case I:

- **presence of features:** small waterfall (turbulent DO addition)
  pools & riffles (slow DO addition)
  vegetated palm roll 'islands' (nutrient uptake by roots, photosynthesis activities add oxygen)

(a) Small waterfall

(b)Pools & riffles

(c) Vegetated palm roll 'islands'

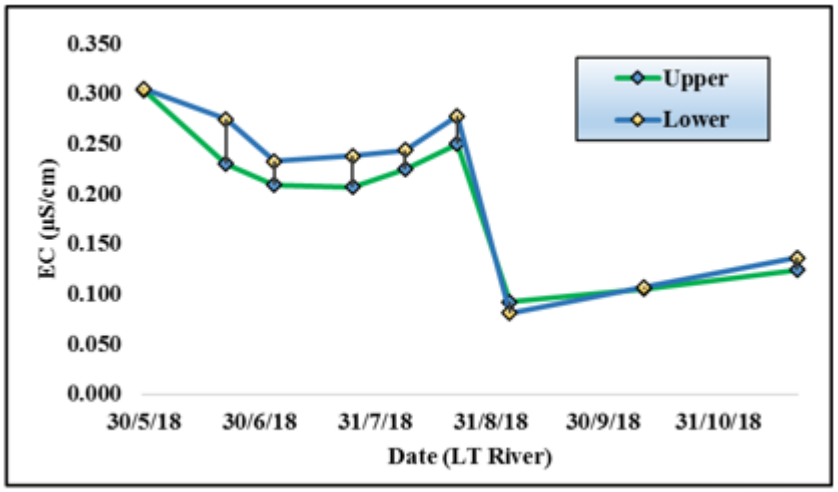
Figure 5 Features of Case I

Results and Discussion

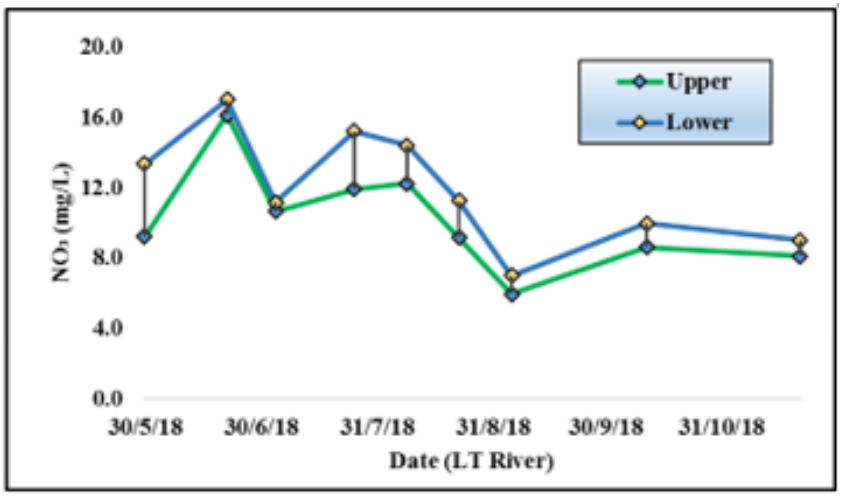
Water quality

Case II : WQ deterioration

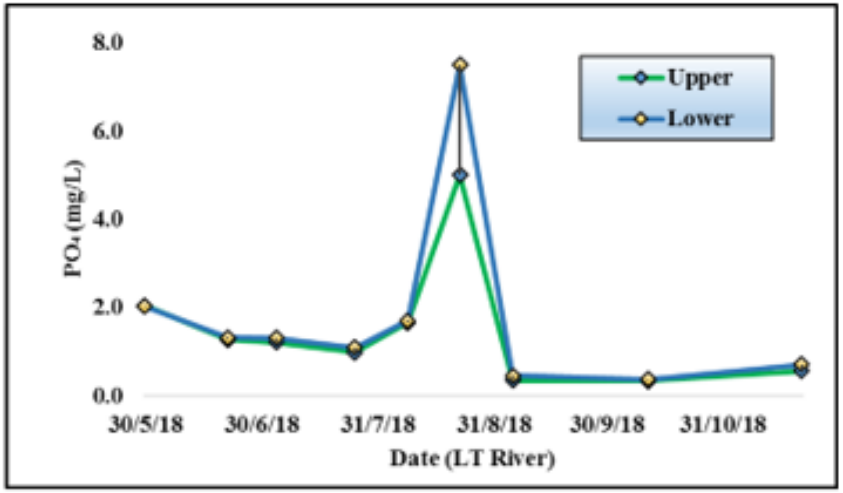
- Higher EC, NO_3-N, PO_4 (pollutants)



(a) EC time series for Case II



(b) NO_3-N time series for Case II



(c) PO_4 time series at Case II

Figure 6 WQ parameters at Case II

Results and Discussion

Water quality

Reasons for WQ deterioration at Case II:

- Beneficial features not present (less heterogeneity),
  Shorter than Case I, less sinuosity
  Two small drainage pipes introduce pollutants

→ Possible eutrophication problems

Small pipes

Figure 7 Features used at the LTR

Outline

- Introduction
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Conclusion

Main findings

- Water quality improvements in DO and pollutant removal were found in one case (waterfall, riffles and vegetated palm rolls) but not the other.
- Fluctuations in pollutant concentrations → importance of improving WQ before entering the restored river system, such as installing better storm drains).
- Water quality parameters show correlations → decrease parameters needed for future studies.
- Importance of maintenance of vegetation (ie. uprooting of vegetation after storm events releases pollutants) .

Conclusions

Future work

- **Long-term continuous monitoring** to provide more precise evaluation and stronger evidence of the effects of the rehabilitation approaches.

- **Include other environmental parameters** (eg. Biodiversity) to assess health and quality of an aquatic ecosystem.

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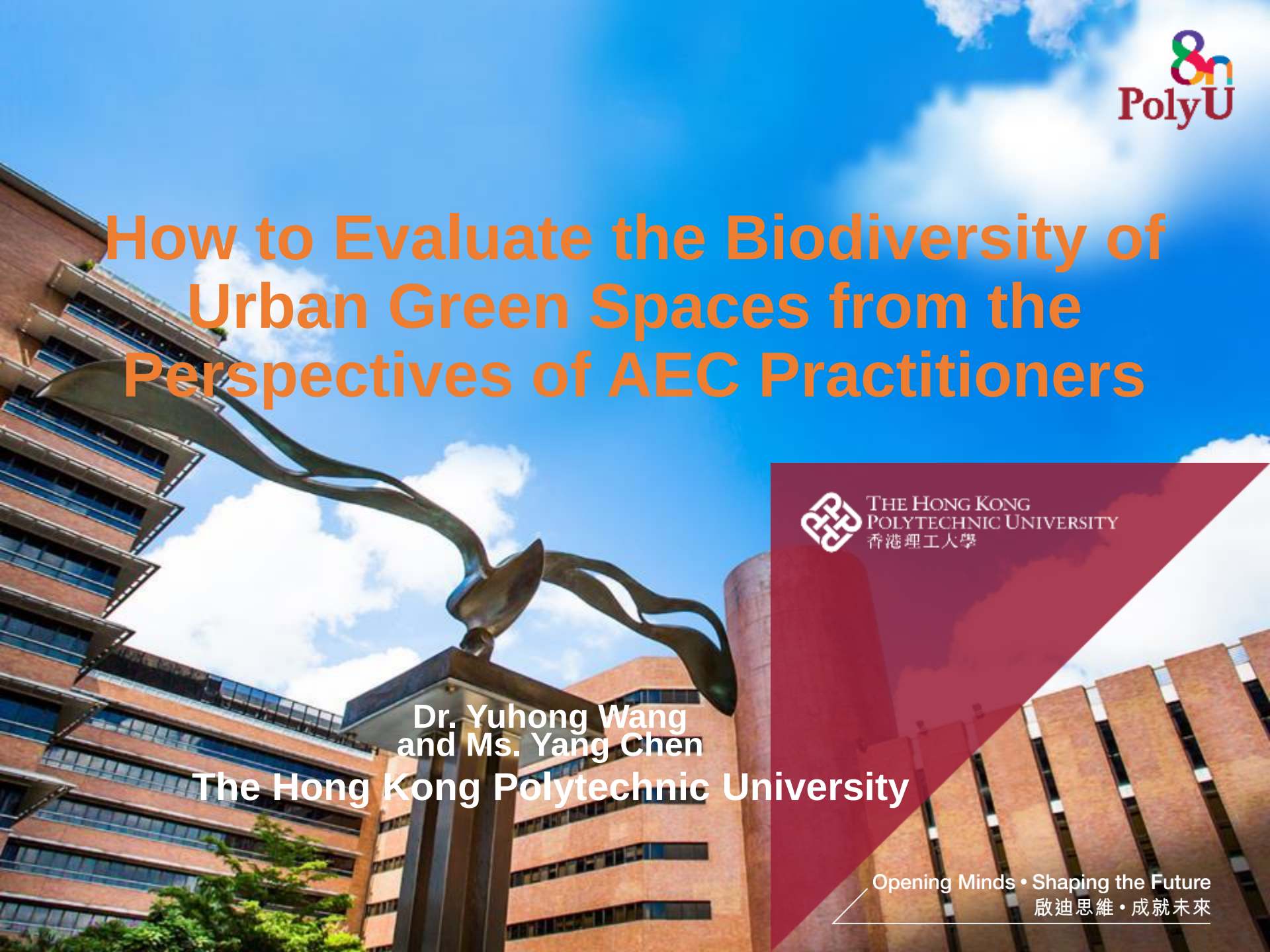
Thank you for your attention!



How to Evaluate the Biodiversity of Urban Green Spaces from the Perspectives of AEC Practitioners

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Outline

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- Literature Review
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Introduction

Background

- Urbanization is one factor causing globally biodiversity loss;
- Urban Green Spaces (UGS) in cities play a critical role in biodiversity protection by providing habitats to wild lives;
- Architectural, engineering, and construction (AEC) practitioners play an important role in designing, constructing, and maintaining UGS.

How can AEC practitioners assess the biological value of the urban facilities designed and built by them?

Research objectives

- Build a framework for organizing the various UGS and the selection criterion;
- Recommend bio-indicators for each UGS via surveying and in-depth interviews, with basis on the selection criterion;
- Demonstrate the bio-indicator monitoring process and biodiversity evaluation methods through case studies.

Outline

- Introduction
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Literature Review

Urban green Spaces (UGS)

- Previous UGS classification: function, structure, and scale.
- UGS in this research: structural and spatial attributes, socio-political-oriented purposes.

Table 1 Commonly man-made UGS

Type	Man-made UGS	Other Names/ Similar Urban Structures
Dry	Green Roof	Roof Garden, Sky Garden, Podium Garden
	Green Wall	Vertical Garden, Window Box Planters, Living Wall, Bio-Wall
	Green Corridor	Wooded Street, Roundabout Landscaping, Roadside Greenery, Vegetation Barrier, Green belt
	Urban Park	Community Garden, Sport/School/Play Ground, Golf Course, Lawn
Semi-dry	Rain Garden	Stormwater Garden, Bioswale, Vegetative Swale, Infiltration Trench
Wet	River Restoration	Stream Restoration, Riparian Forest Buffer, Filter Strip
	Urban Wetland	Wetland Park, Constructed Wetland
	Retention Pond	Retention Lake, Retention Basin, Detention Basin

Biodiversity indicator selection criterion

Table 2 Selection criterion definition

Criterion	Definition
Representativeness	The ability of the bio-indicator to reflect the overall state of the UGS.
Residency	Relatively low motility or high residence time in the habitats.
Relative abundance	Sufficient bio-indicator populations are observed at all times in the target UGS.
Sensitivity	The bio-indicator's ability to react quickly to negative impacts on the habitat.
Cost-effectiveness	The bio-indicator can be easily and quickly surveyed.
Value to society	The bio-indicator is of interest to the general public or poses economic and aesthetic value.

Literature Review

Biodiversity indicators

- Birds
- Amphibians
- Fish
- Vegetation
- Molluscs
- Insects
  - Bees
  - Butterflies
  - Beetles
  - Dragonflies
- EPT

Biodiversity indices

α-diversity

Species richness

Shannon biodiversity index (H')

$$H' = -\sum_{i=1}^{s} P_i \ln P_i \text{, but } P_i = \frac{n_i}{N}$$

Simpson's index of diversity (D)

$$D = 1 - \sum_{i=1}^{s} P_i^2 \text{, but } P_i = \frac{n_i}{N}$$

β-diversity

Sorensen similarity index β_{sor}

$$\beta_{sor} = \frac{2a}{2a+b+c}$$

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Methodology

Survey https://www.esurveycreator.com/s/88d9916

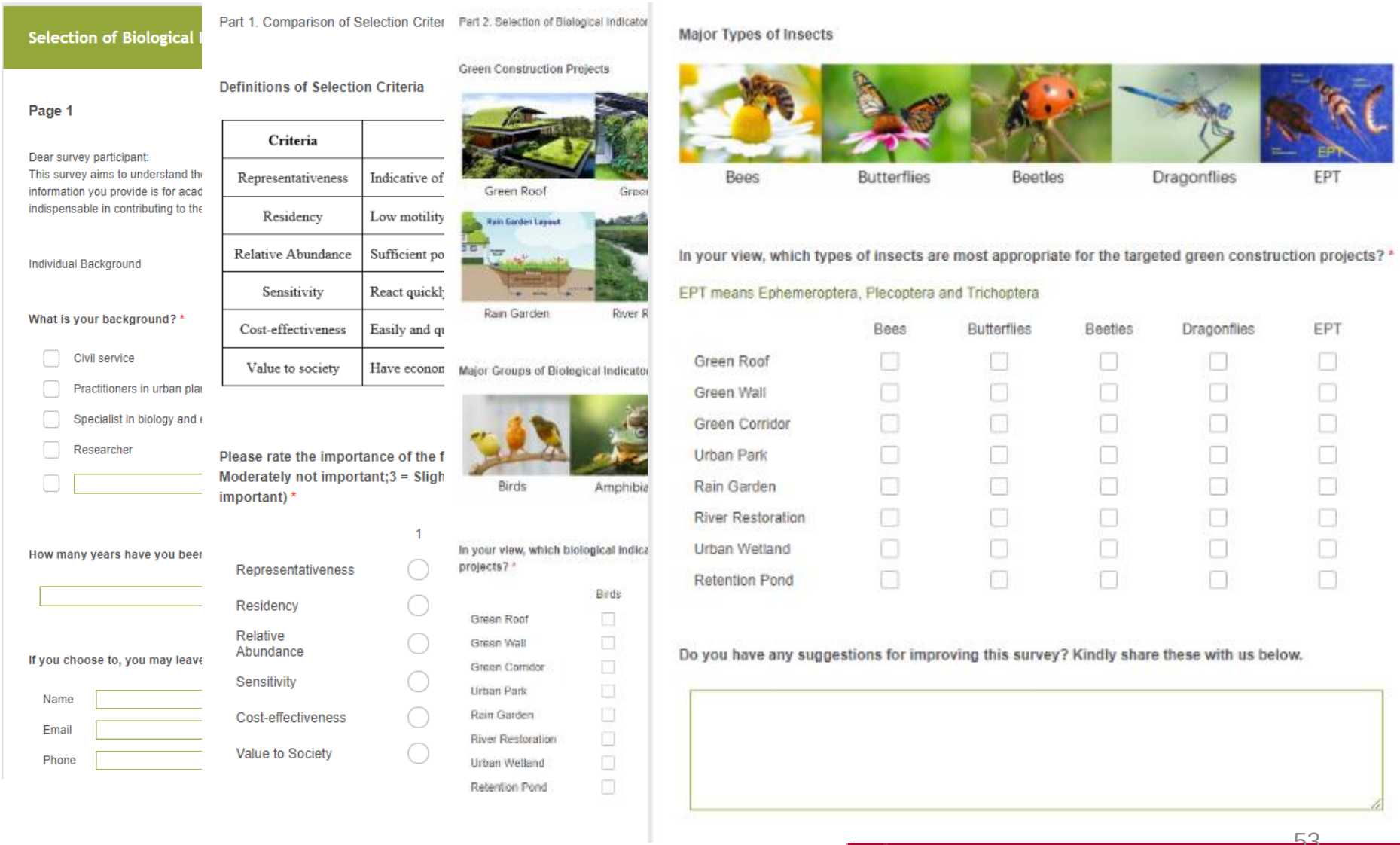


Figure 1 Survey pictures

Methodology

Survey

Online survey & face-to-face survey

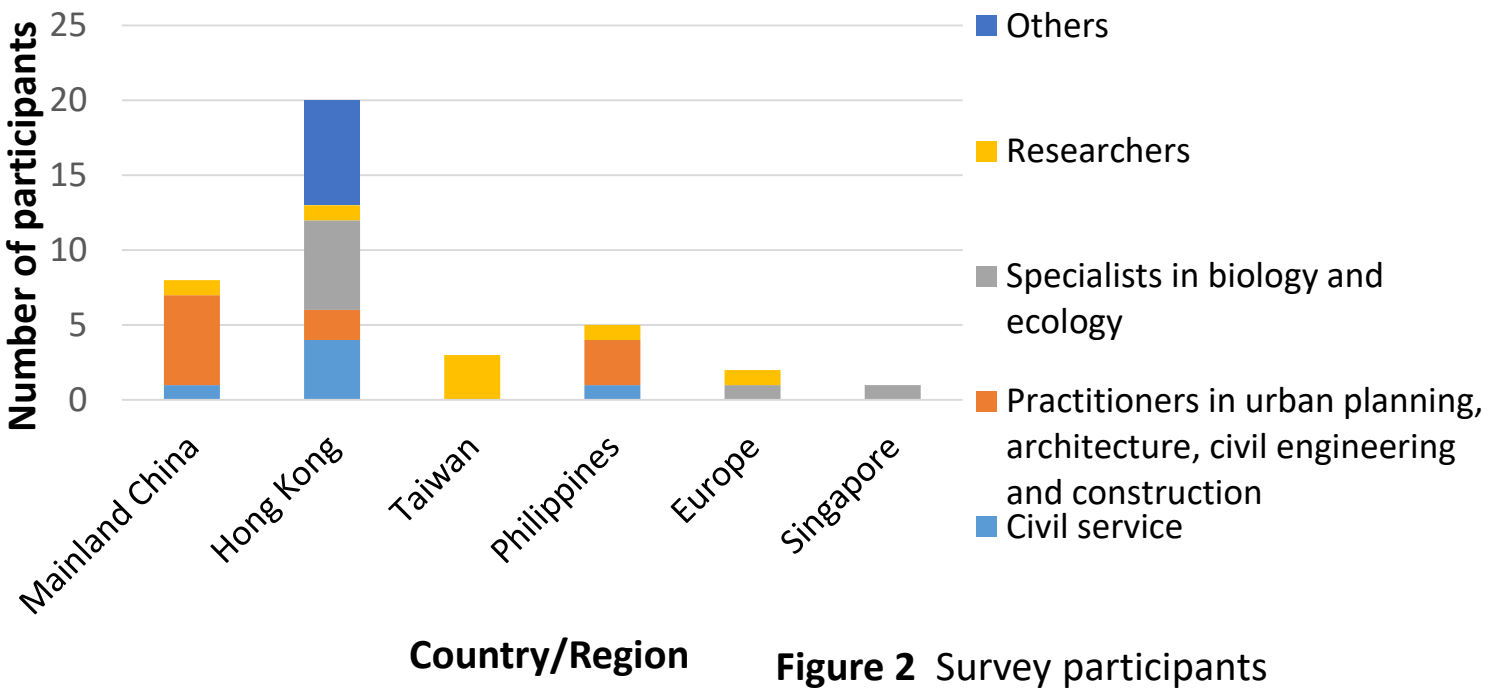


Figure 2 Survey participants

- 5 main stakeholders from the world (Others: professional wildlife photographers, participants with ecology/biology education and/or field experience.)
- 39 participants invited to fill the survey of Part 1: Criterion evaluation.
- 8 participants who have solid biology or ecology background and with rich survey experience to fill Part 2: bio-indicator recommendation for various UGS.

Methodology

In-depth interview

Table 3 In-depth interview participants profile

Name	Region	Stakeholder type	Background	Interview type	Interview content
Mr. A	Hong Kong	Civil servant	30 years of environmental management and 0.5 year site survey experience	Face-to-face interview	The most critical criteria from the perspective of civil servant
Ms. B	Mainland China	AEC practitioner	15 years of urban planning and UGS design experience	Telephone interview	Whether to consider biodiversity protection when design and the most important criteria when selecting bio-indicators
Mr. C	Mainland China	AEC practitioner	9 years of civil engineering experience	Telephone interview	Whether to consider biodiversity conservation in civil engineering process and the most important criteria when selecting bio-indicators
Mr. D	Singapore	Specialist in biology or ecology	10 years of fish, reptiles and amphibians survey and research experience	Face-to-face interview	Bio-indicator selection criterion, fish sampling method and identification
Mr. E	Hong Kong	Specialist in biology or ecology	12 years of biological survey experience, involving birds, reptile, butterfly, dragonfly and vegetation	Face-to-face interview	Birds, vegetation, dragonfly survey methods
Mr. F	Hong Kong	Specialist in biology or ecology	10 years of biological survey experience, involving amphibians, dragonfly and vegetation, majored in environmental protection	Face-to-face interview	Amphibians survey methods, and bio-indicator selection criterion
Mr. G	Hong Kong	Specialist in biology or ecology	19 years of butterfly survey and photography experience	Face-to-face interview	Butterfly survey method, and butterfly identification
Ms. H	Hong Kong	Specialist in biology or ecology	10 years of vegetation survey and research experience, Arborist	Face-to-face interview	Vegetation survey method, and vegetation identification
Mr. I	Hong Kong	Specialist in biology or ecology	20 years of fish sampling experience and also worked as government consultant for river restoration	Face- to-face interview	Fish survey method and tips
Ms. J	Taiwan	Researcher	13 years of city planning design and research in river restoration	Face- to-face interview	Some details regarding to river restoration and bio-indicator selection criterion
Mr. K	Hong Kong	Others	10 years of wildlife photography experience	Face- to-face interview	Photography skills when sampling on sites

Methodology

Case study

- HK Blue-Green Infrastructure： Two river restoration sections in Hong Kong were selected as the case studies.
- Biodiversity monitoring and evaluation on birds, fish, dragonfly and vegetation were conducted at the two sites.

Case I : Ma Wat River (MWR)

- Section long: 80m
- Area:1360m^2
- Water surface area: 480 m^2

Figure 3 Case I : Ma Wat River (MWR)

Case II: Lower Lam Tsuen River (LLTR)

- Section long: 40m
- Area: 746m^2
- Water surface area: 136m^2

Figure 4 Case II: Lower Lam Tsuen River (LLTR)

Outline

- Introduction
- Literature Review
- Methodology
- Results and Discussion
- Conclusion

Results and Discussion

Evaluation of Selection Criterion

- Survey : Likert 7-point scale, 1: extremely unimportant, 7: extremely important

Summarized criterion	Representativeness	Residency	Relative abundance	Sensitivity	Cost-effectiveness	Value to society
Evaluation results	Moderately important	Slightly important	Slightly important	Moderately important	Slightly important	Slightly important

- In-depth interview

Summarized criterion	Representativeness	Residency	Relative abundance	Sensitivity	Cost-effectiveness	Value to society

- Represent the **overall condition** of the habitat
- Local and representative species can **provide suitable and reliable habitats**

- Hard work on site, should be **easily and quickly** surveyed
- Want to know the **quick feedback** of the condition of the habitat

The selection criteria worked as basic principles for the bio-indicator recommendation.

Results and Discussion

Biodiversity Indicator Recommendation

- Survey supplemented with in-depth interview

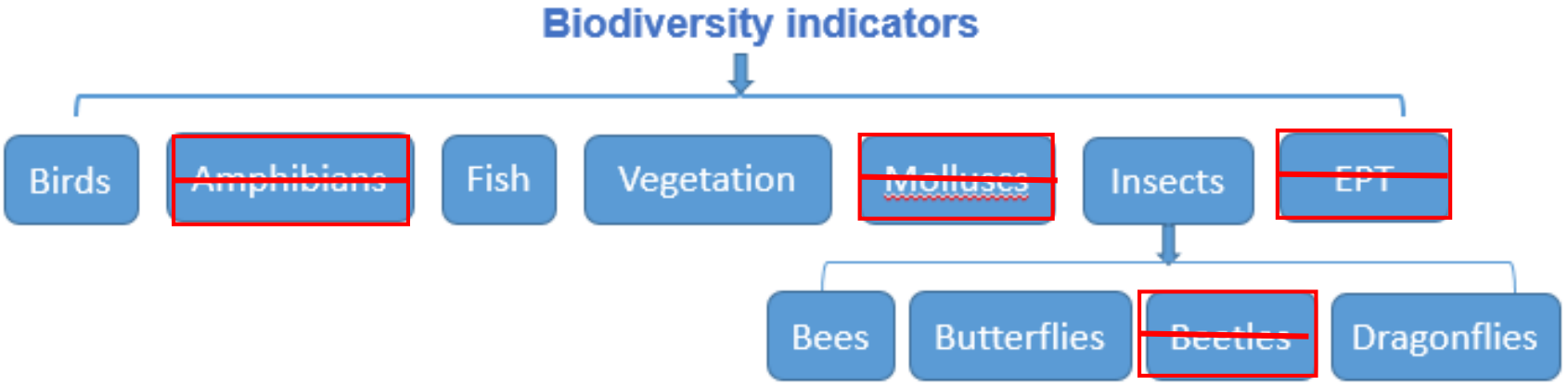


Table 4 Bio-indicator recommendations

Groups		Green Roof	Green Wall	Green Corridor	Urban Park	Rain Garden	River Restoration	Urban Wetland	Retention Pond
Birds		√		√	√	√	√	√	√
Fish							√	√	√
Vegetation		√	√	√	√	√	√	√	
Insects	Bees	√	√	√	√				
	Butterflies	√	√	√	√				
	Dragonflies					√	√	√	√

Results and Discussion

Biodiversity monitoring process

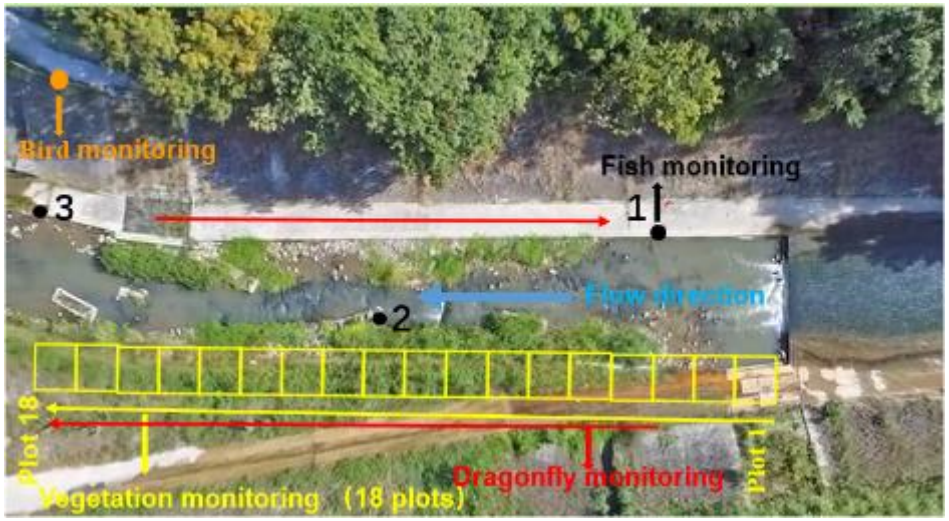


Figure 5 : Case I : Ma Wat River (MWR)

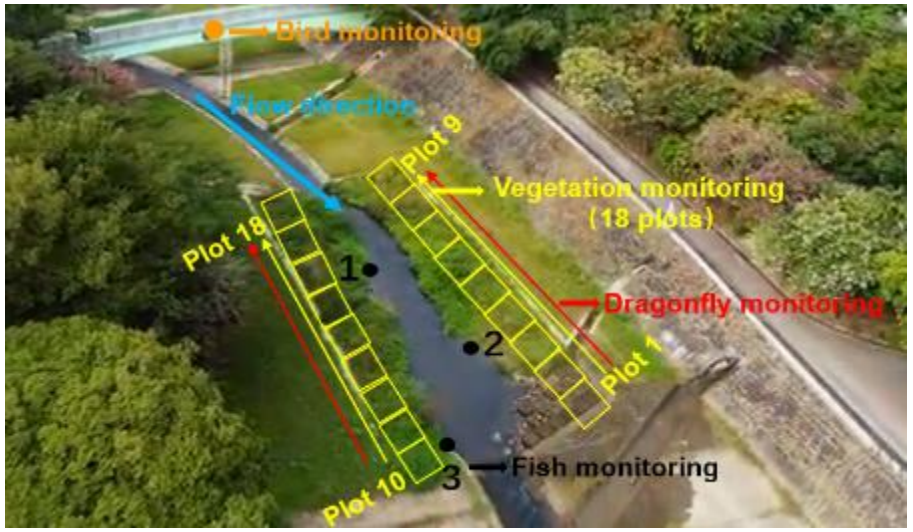


Figure 6 : Case II: Lower Lam Tsuen River (LLTR)

Sampling period

From Mar. 2019-July. 2019

Monitoring method

- **Birds**: point count, in the early morning, 7am-9 am.
- **Fish**: point count, stream is not flooding and the weather is not too cold.
- **Dragonflies**: transect monitoring, on warm and sunny days, 11am-4pm.
- **Vegetation**: standard frame quadrat method, 4m×4m plots.

Equipment

Binoculars (8×40), SLR camera (55mm-250mm), HD video (55x extended zoom), boots

Results and Discussion

Biodiversity monitoring results

Table 5 Populations of bird, fish and dragonfly at Case I and Case II

Group	Scientific name	Property	Case I (Population)	Case II (Population)
Bird	Actitis hypoleucos	Waterfowl	2	0
	Alcedo atthis	Waterfowl	0	1
	Egretta garzetta	Waterfowl	0	1
	Motacilla cinereal		1	0
	Nycticorax nycticorax	Waterfowl	0	1
	Passer montanus		0	2
	Total population		**3**	**5**
Fish	Channa maculate	Exotic	2	0
	Hemiculter leucisculus	Native	40	0
	Oreochromis mossambicus	Exotic	1	2
	Oreochromis niloticus	Exotic	31	13
	Poecilia reticulata	Exotic	1	0
	Total population		**75**	**15**
Dragonfly	Ischnura senegalensis		5	2
	Pseudagrion Pseudagrion		1	0
	Neurobasis chinensis Linnaeus		0	1
	Orthetrum pruinosum neglectum		2	2
	Crocothemis servilia		0	2
	Pantala flavescens		1	0
	Rithemis festiva		5	0
	Total population		**14**	**7**

Results and Discussion

Biodiversity monitoring results

Table 6 Composition and coverage of vegetation at Case I

Serial Number	Scientific Name	Origin	Wetland Dependent	Coverage	Braun-Blanquet scales	Serial Number	Scientific Name	Origin	Wetland Dependent	Coverage	Braun-Blanquet scales
1	Commelina communis	Native		14.93%	2	25	Pontederia cordata L.	Exotic	W	0.43%	rare
2	Mikania micrantha	Exotic		14.31%	2	26	Hymenocallis littoralis	Exotic	W	0.43%	rare
3	Kyllinga polyphylla	Exotic	W	10.49%	2	27	Solanum nigrum	Native		0.39%	rare
4	Brachiaria mutica	Exotic	W	10.39%	2	28	Mimosa pudica	Exotic		0.36%	rare
5	Cyperus involucratus	Exotic	W	9.11%	2	29	Kyllinga brevifolia	Native	W	0.33%	rare
6	Leersia hexandra	Native	W	5.79%	2	30	Sesbania cannabina	Exotic		0.26%	rare
7	Bidens alba	Exotic		5.11%	2	31	Ludwigia adscendens	Native	W	0.16%	rare
8	Leucaena leucocephala	Exotic		4.93%	1	32	Spilanthes paniculata	Native		0.13%	rare
9	Ruellia coerulea	Exotic		4.77%	1	33	Euphorbia hirta	Exotic		0.13%	rare
10	Alternanthera philoxeroides	Exotic	W	3.06%	1	34	Ficus hispida	Native		0.10%	rare
11	Saccharum arundinaceum Retz.	Native	W	2.86%	1	35	Aster subulatus	Exotic		0.10%	rare
12	Carex	Native	W	2.47%	1	36	Begonia grandis	Native		0.07%	rare
13	Wedelia trilobata	Exotic		2.43%	1	37	Cyperus rotundus	Native		0.07%	rare
14	Ageratum conyzoides	Exotic		1.91%	1	38	Tridax procumbens	Exotic		0.07%	rare
15	Asclepias curassavica	Exotic		1.78%	1	39	Persicaria glabrum	Native	W	0.07%	rare
16	Panicum maximum	Exotic		1.51%	1	40	Colocasia esculenta	Native	W	0.03%	rare
17	Amaranthus viridis	Native		0.99%	rare	41	Pilea microphylla	Exotic		0.03%	rare
18	Polygonum barbatum	Native	W	0.86%	rare	42	Pouzolzia zeylanica	Native		0.03%	rare
19	Alisma plantago-aquatica	Native	W	0.72%	rare	43	Erigeron	Exotic		0.03%	rare
20	Microstegium ciliatum	Native		0.72%	rare	44	Lindernia procumbens	Native		0.03%	rare
21	Glycine soja	Exotic		0.55%	rare	45	Hedyotis auricularia	Native		0.03%	rare
22	Cyperus surinamensis	Native	W	0.49%	rare	46	Euphorbia humifusa	Native		0.03%	rare
23	Polygonum lapathifolium	Native	W	0.49%	rare	47	Cyanthillium cinereum	Native		0.03%	rare
24	Ipomoea cairica	Exotic		0.43%	rare	48	Paspalum distichum	Native		0.03%	rare

Results and Discussion

Biodiversity monitoring results

Table 7 Composition and coverage of vegetation at Case II

Serial Number	Scientific Name	Origin	Wetland Dependent	Coverage	Braun-Blanquet scales	Serial Number	Scientific Name	Origin	Wetland Dependent	Coverage	Braun-Blanquet scales
1	Brachiaria mutica	Exotic	W	35.18%	3	17	Mimosa pudica	Exotic		0.69%	rare
2	Commelina communis	Native		21.64%	2	18	Aster subulatus	Exotic		0.52%	rare
3	Ruellia coerulea	Exotic		12.12%	2	19	Solanum torvum	Exotic		0.49%	rare
4	Panicum maximum	Exotic		9.17%	2	20	Impatiens balsamina	Exotic		0.42%	rare
5	Hymenocallis littoralis	Exotic	W	4.93%	1	21	Wedelia trilobata	Exotic		0.52%	rare
6	Carex	Native	W	4.83%	1	22	sapium sebiferum	Native		0.35%	rare
7	Kyllinga polyphylla	Exotic	W	4.83%	1	23	Colocasia esculenta	Native	W	0.28%	rare
8	Cyperus involucratus	Exotic	W	5.38%	1	24	Asclepias curassavica	Exotic		0.17%	rare
9	Polygonum lapathifolium	Native	W	3.96%	1	25	Syzygium jambos	Exotic		0.17%	rare
10	Microstegium ciliatum	Native	W	1.39%	1	26	Alternanthera philoxeroides	Exotic	W	0.10%	rare
11	Saccharum arundinaceum Retz.	Native	W	1.39%	1	27	Cyperus involucratus	Native	W	0.07%	rare
12	Bidens alba	Exotic		1.35%	1	28	Ageratum conyzoides	Exotic		0.07%	rare
13	Leucaena leucocephala	Exotic		1.01%	1	29	Polygonum barbatum	Native	W	0.07%	rare
14	Persicaria hydropiper	Native	W	0.83%	rare	30	Pilea microphylla	Exotic		0.07%	rare
15	Mikania micrantha	Exotic		0.80%	rare	31	Spilanthes paniculata	Native		0.07%	rare
16	Cleistocalyx nervosum	Native		0.76%	rare						

Results and Discussion

Species (part)

Egretta garzetta
小白鹭

Alcedo atthis
普通翠鸟

Nycticorax nycticorax
夜鹭

Neurobasis chinensis Linnaeus
华艳色蟌

Rithemis festiva
庆褐蜻

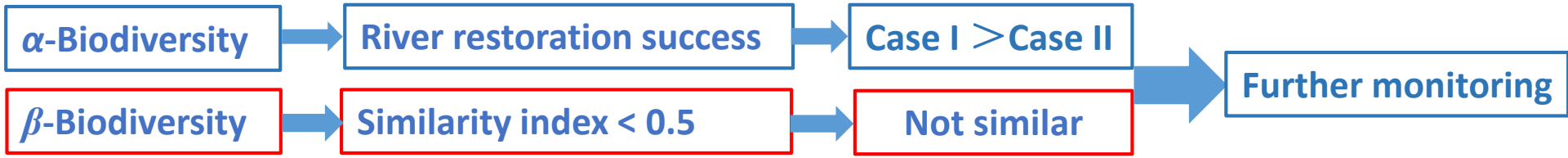
Figure 7: Species taken at the two sites

Results and Discussion

Case studies

Table 8 Summary of total population and biodiversity indices of MWR and LLTR

Items		Birds		Fish		Dragonflies		Vegetation	
Sites		Case I	Case II	Case I	Case II	Case I	Case II	Case I	Case II
Total population/coverage(vegetation)		3	5	75	15	14	7	108.89%	113.63%
α-diversity	Species richness	2	4	5	2	5	4	48	31
	Shannon biodiversity index (H')	0.637	1.332	0.912	0.457	1.390	1.352	2.794	2.332
	Simpson's index of diversity (D)	0.444	0.720	0.544	0.401	0.714	0.735	0.914	0.832
β-diversity	Sorensen similarity index	0		0.364		0.308		0.378	



Results and Discussion

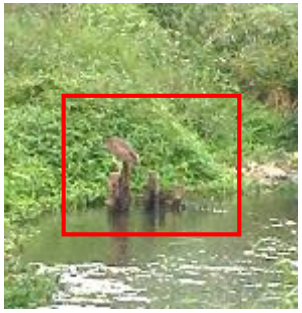
Case studies

Birds result

Case I <Case II

- Noise disturbance 80dB(A)＞57dB(A)
- Wooden poles damage

Case I : damaged wooden poles



Case II: birds resting on wooden poles

Fish result

Case I ＞Case II

- Water body size
- Fish ladder
- Higher diversity vegetation in water

Fish ladder

- Provide connectivity between habitats
- Reduce predation on shoals

Diversity vegetation

- Escaping predators
- Feeding and breeding habitat

Results and Discussion

Case studies

Dragonflies result

Case I ＞Case II

- Vegetation diversity
- Waterfowl disturbance
- Habitat size (diverse features)

Items		Birds		Fish		Dragonflies		Vegetation	
Sites		Case I	Case II	Case I	Case II	Case I	Case II	Case I	Case II
Total population/coverage(vegetation)		3	5	75	15	14	7	108.89%	113.63%
α-diversity	Species richness	2	4	5	2	5	4	48	31
	Shannon biodiversity index (H')	0.637	1.332	0.912	0.457	1.390	1.352	2.794	2.332
	Simpson's index of diversity (D)	0.444	0.720	0.544	0.401	0.714	0.735	0.914	0.832
β-diversity	Sorensen similarity index	0		0.364		0.308		0.378	

Page 14: Habitat size and diverse features

Case I larger area and more irregular shape and diverse features

Vegetation result

Case I ＞Case II

- Site area
- Irregular shape
- Dominant exotic species

Irregular shape at Case I

Dominant exotic species at Case II: *Brachiari mutica*

Recommendations

- 6-month monitoring including wet season for stream courses
- Use species plots curves to decide the number of standard frame quadrat

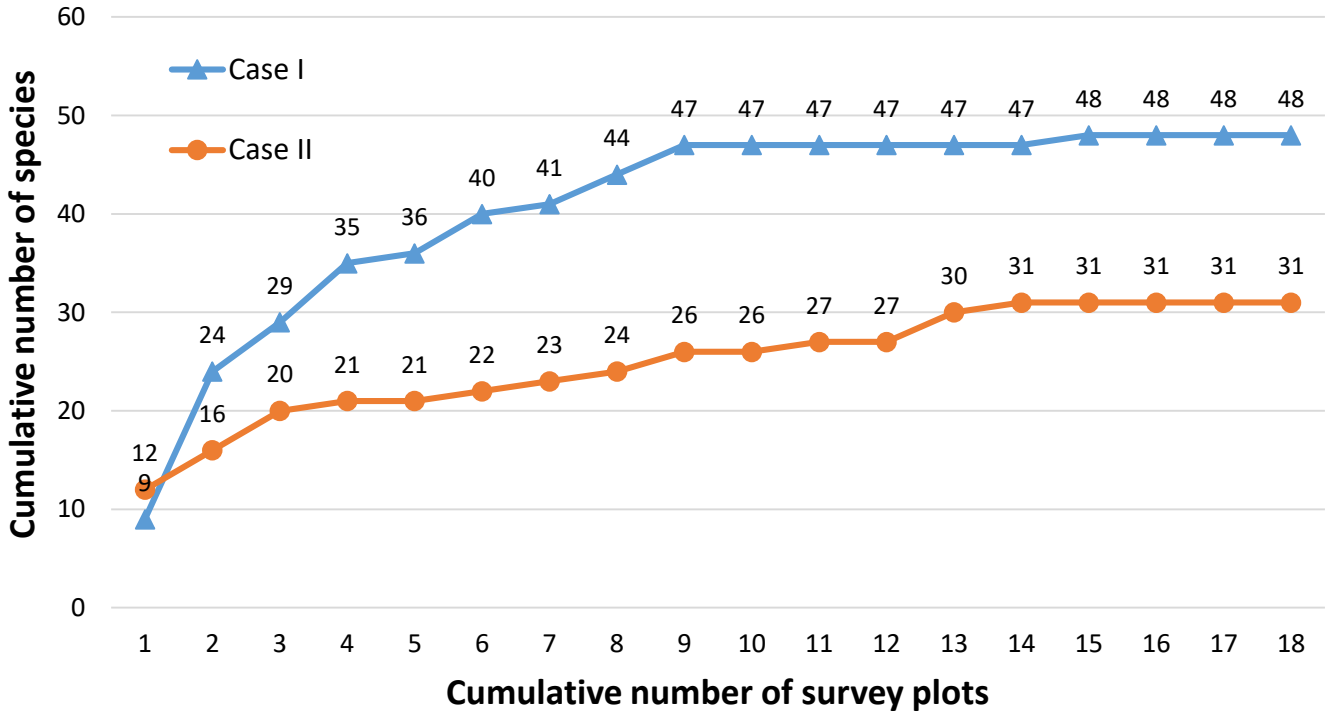


Figure 8 Species plots curve

Outline

- Introduction
- Literature Review
- Methodology
- Results and Discussion
- Conclusion

Conclusion

- An UGS framework worked as a guide and classification basis for the analysis of following bio-indicator recommendation.
- A set of selection criterion worked as basic principles for the bio-indicator recommendation.
- Online survey and in-depth interview served for the selection criterion evaluation and bio-indicator recommendation.
- Case studies demonstrated how to do bio-indicator monitoring and biodiversity evaluation.

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Thank you for your attention!

NBS monitoring measures and results

- UHI and thermal performance of green space

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UHI and thermal performance of green space

Highlights

- To identify the Urban Heats Island (UHI) effects in Hong Kong from high-solution satellite images and remote sensing technique;
- To identify the features of the local environments by thermal camera;
- To identify how land use and local features influence urban UHI effect;
- To optimize the current Nature-based solutions (NBS) in cities.

UHI and thermal performance of green space

Data source and equipment

Satellite image	Landsat 8	Sentinel 2
Application	Estimating LST; identifying hotspots	Identifying LULC
Spatial resolution	Visible band: 30m TIR band: 100m	Visible band: 10m

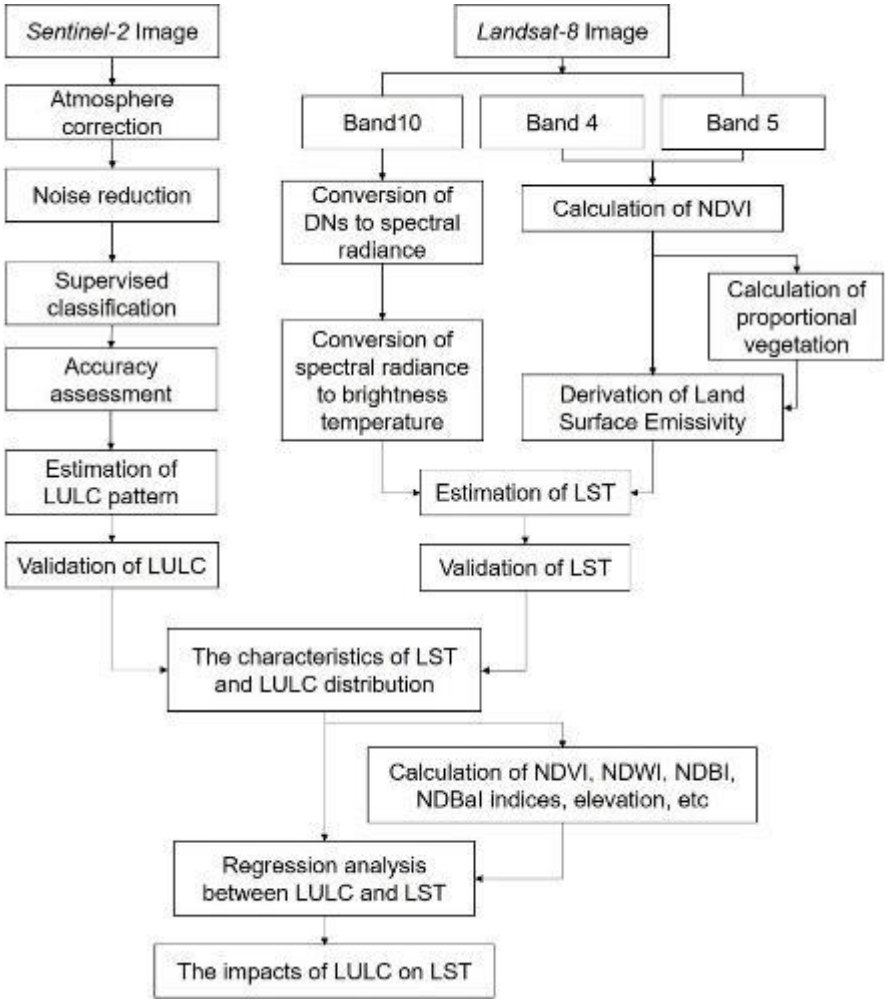
Satellite images obtained from the *U.S. Geological Survey (USGS)* were used to derive land surface temperature (LST) and land use condition in Hong Kong.

Thermal camera

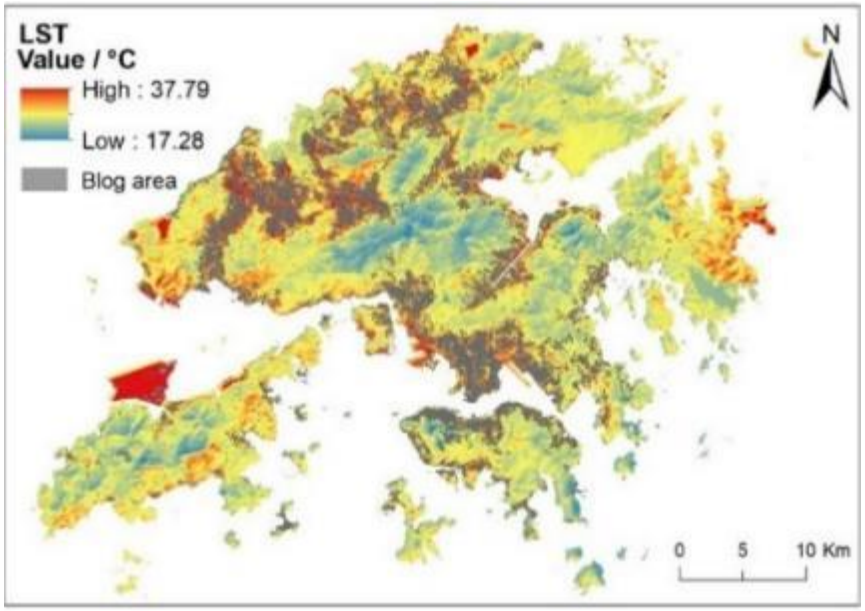
Infrared thermography is a remote sensing technology for capturing the infrared radiation of an object and then visualizing the radiation data as a two-dimensional image.

UHI and thermal performance of green space

Data analysis and measures



The approach to generate the land surface temperature of large-scale area:



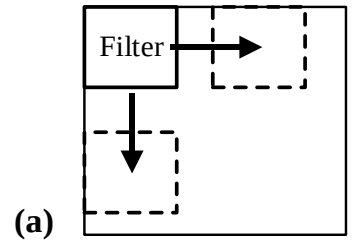
UHI and thermal performance of green space

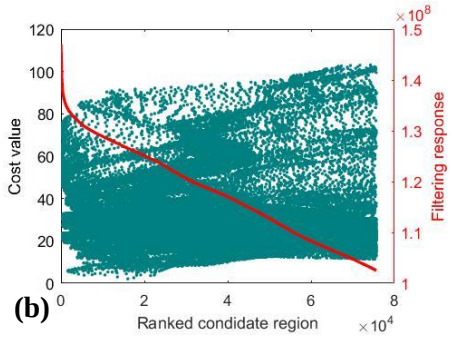
Data analysis and measures

Step 1: Build a filter from the correspondence visual image (explained below) and compute the filtering responses while moving the filter in the original-size visual image.

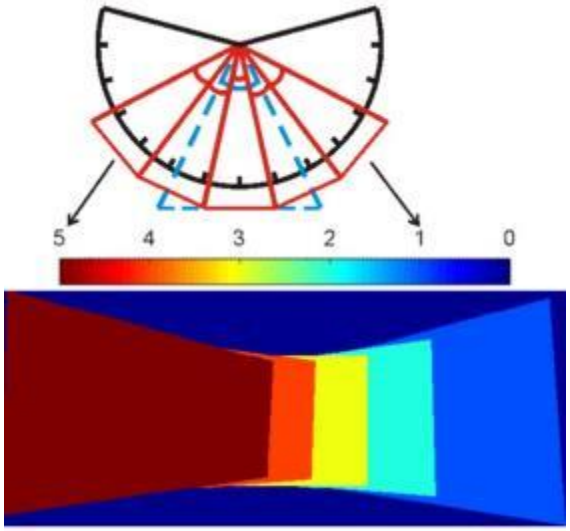
Step 2: Sort the filtering responses of the candidate regions.

Step 3: Select the target region by optimizing the cost values in the candidate regions.



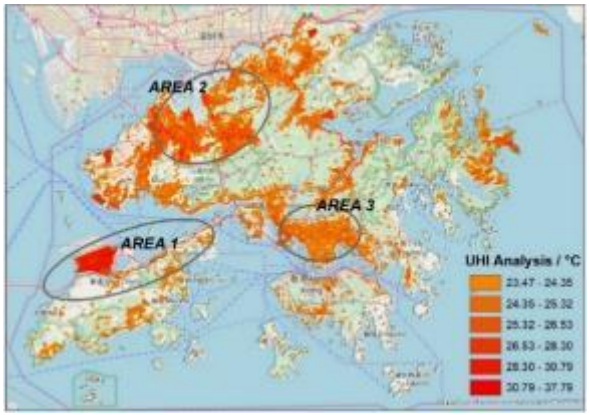


The approach to generate an infrared panoramic image for local-scale area:



UHI and thermal performance of green space

Urban Heat Island (UHI)



Location and potential reasons of three hotspots:

- Hong Kong International Airport;
  Reason: the high heat absorption of pavement materials and gas emission from aircrafts.
- Fanling-Sheung Shui area;
  Reason: dense residential buildings.
- Tsim Sha Tsui area.
  Reason: dense commercial buildings and population.

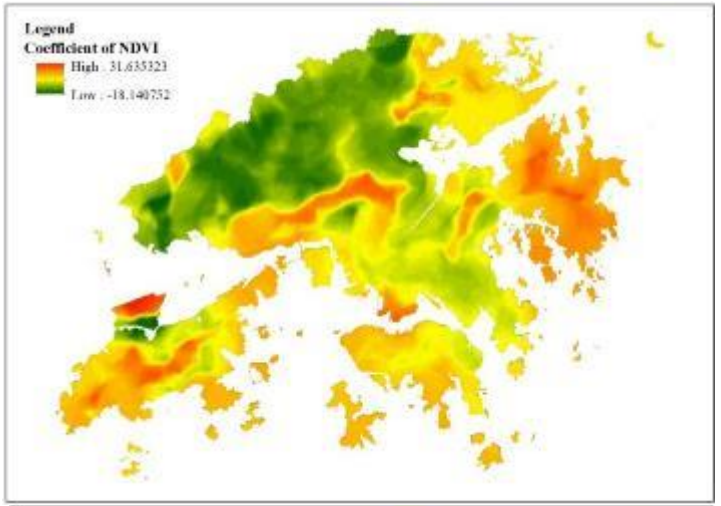
UHI and thermal performance of green space

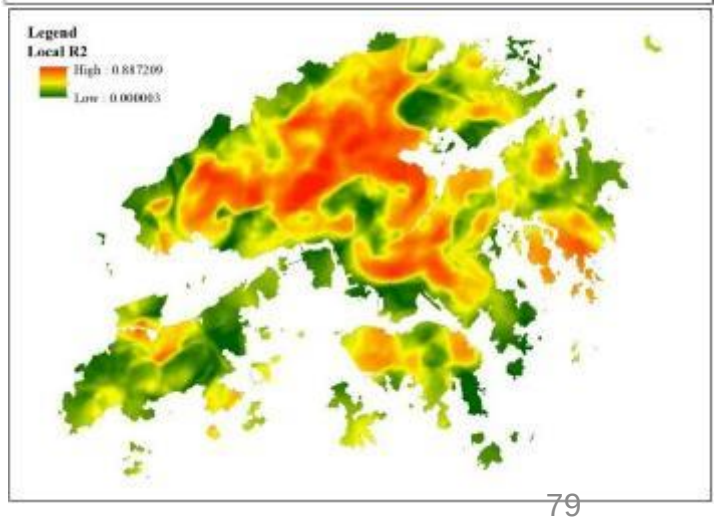
Urban Heat Island (UHI)

Geographic Weighted Regression (GWR) was performed to identify the relationships between the independent variables and LST, by considering the spatial variations of the coefficients of the independent variables.

As compared with the conventional models, the GWR model shows significant improvement in capturing the variations in LST.

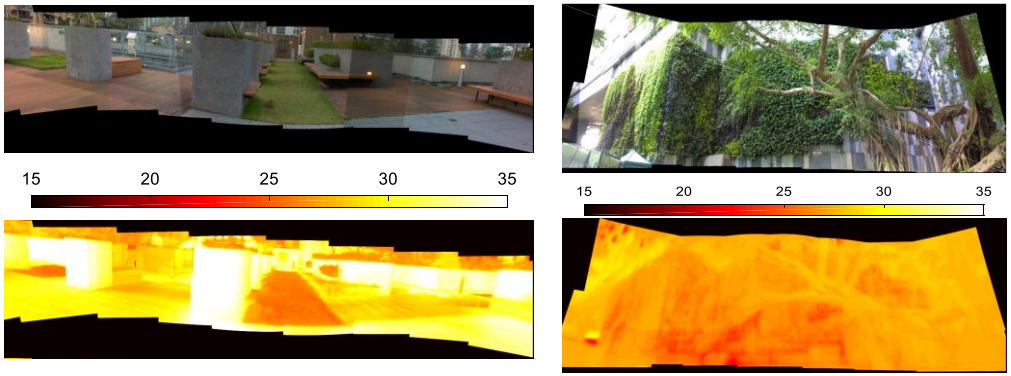
The information provides a guidance to urban planning at the regional scale.

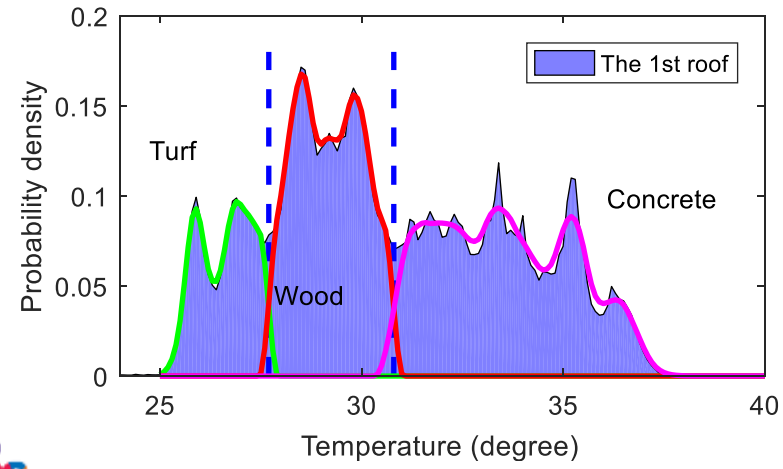




UHI and thermal performance of green space

The thermal performance of greenspace





The thermal performance of different types of greenspaces was evaluated.

We found that the mass, type of green covers, the concrete material and the surface texture all affect the surface temperature.

At the local scale, UHI effect may be mitigated through the selection and development of better materials.

UHI and thermal performance of green space

Large & Local scale thermal environment

The analysis results indicate that

Areas with relatively high temperature in Hong Kong are mainly located in the urban built-up zones, roads, and industrial zones.

↓

The beneficial roles of water body and greenspace in reducing UHI effect.

↓

The necessary to focus on the local thermal environment, and to analyze the performance of different kinds of green spaces on thermal comfort.

↓

Some micro factors - the mass, type, leaf area of green covers, the concrete material and the surface texture all affect the UHI effect.

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Thanks for your attention.

Welcome for any comments and questions.

Monitoring of the Nature-based Solutions

- Resilience of the River Restoration Projects in a Subtropical Climate- Case studies in Hong Kong

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and Ms. Yang Chen

The Hong Kong Polytechnic University

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

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啟迪思維 • 成就未來

Outline

- Introduction
- Methodology
- Resilience Analysis of Case Studies
- Resilience assessment
- Conclusion and recommendations

Background

- Most of Hong Kong's river channels were straightened and lined with concrete to maximize their drainage capacities.
- The ecological and aesthetic values of the channels were lost.
- Some nature-based solutions have been introduced to revitalize the rivers to meet engineering, ecological and aesthetic demands.

When heavily engineered rivers are modified to resemble their natural states, are they still as resilient as the traditional engineered ones?

Research objectives

- Develop a robust framework for evaluating the resilience of infrastructure projects.
- Apply the framework to assess the resilience of two river restoration projects in Hong Kong.
- Through results analysis, give out proactive design and adaptive operation management strategies recommendations.

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Methodology

The framework of resilient analysis

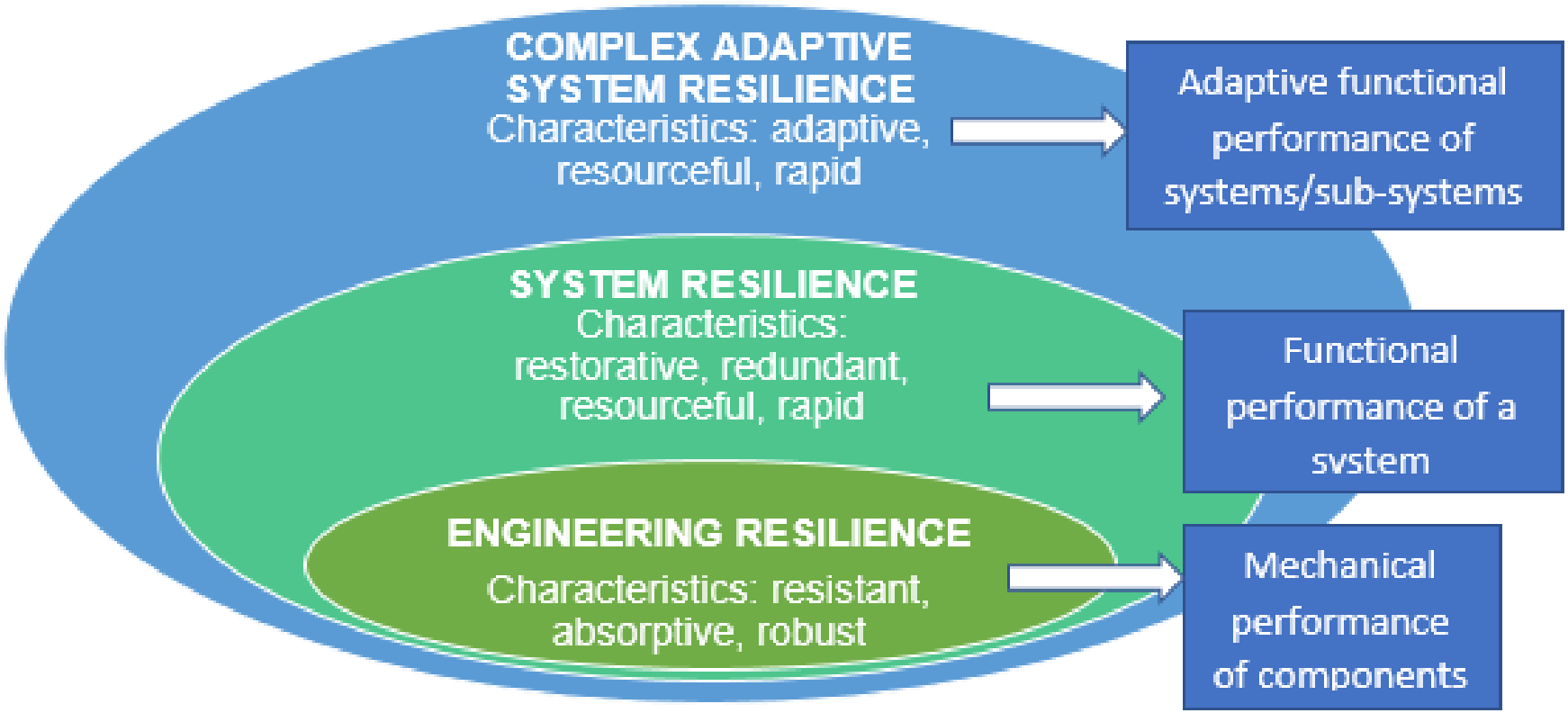

Figure 1 Interrelationships between resilience concepts in the analysis framework

Methodology

The process of resilient analysis

Henry & Ramirez-Marquez (2012)'s five steps resilience management

1. Description of the system.
2. Identification of the 'figure-of-merit'.
3. Definition of the disruptive event(s);
4. Evaluation of the component restoration;
5. Identification of the overall resilience strategy.

Identification of resilience measurement method;

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Resilience Analysis of Case Studies

Description of the systems

(a) Case I : Ma Wat River (MWR)

(b) Case II: Lower Lam Tsuen River (LLTR)

Figure 2 Case studies in Hong Kong

Monitoring period

From May. 2018 -April. 2019

Monitoring content

- Structural features: maintain structural integrity (surface stability and erosion control).
- Ecological enhancement features: provide habitat to biota in the restored river channels.

Resilience Analysis of Case Studies

Description of the systems

Table 1 Enhancement features in case studies (Adapted from Chan (2017)).

Function	Feature	Case I (MWR)	Case II (LTR)
Ecological Enhancement; Aesthetics	Eco-Friendly Substrates	✓	✓
	Fish Ladder	✓	-
	Pools & Riffles	✓	✓
	Riparian Vegetation	✓	✓
	Sinuosity Configuration	✓	✓
	Vegetated Ledge	✓	-
	Wooden Poles	✓	✓
	Climbers Mesh	✓	✓
Drainage Stabilization	Palm Fibre Concrete Block	✓	✓
	Current Deflector	✓	✓
	Gabion Baskets	✓	-

Resilience Analysis of Case Studies

Identification of figure-of-merit (system functions)

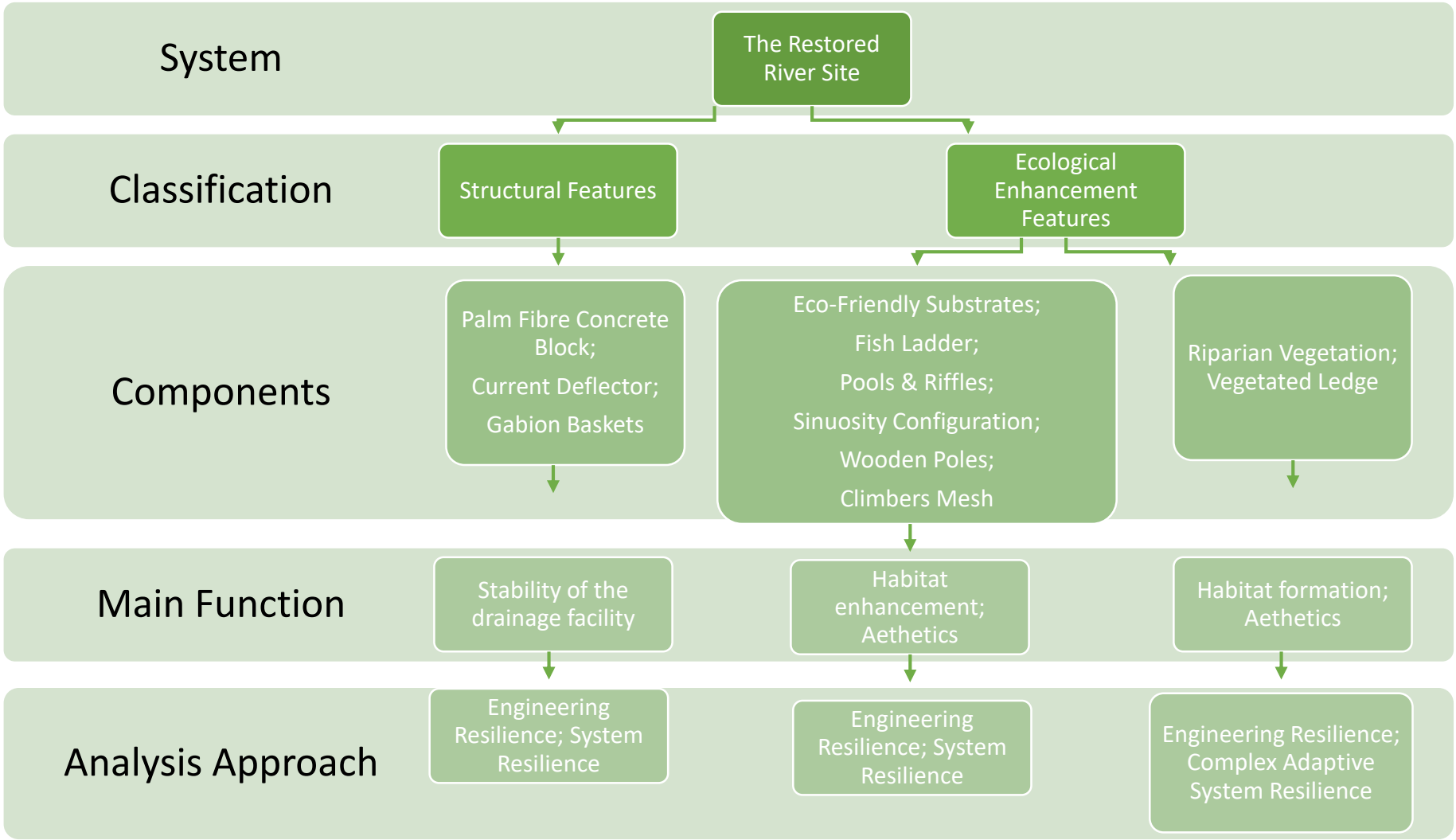

Figure 3 Resilience analysis framework adapted to the case studies

Identification of figure-of-merit (system functions)

Characterization of the disturbances and their impacts

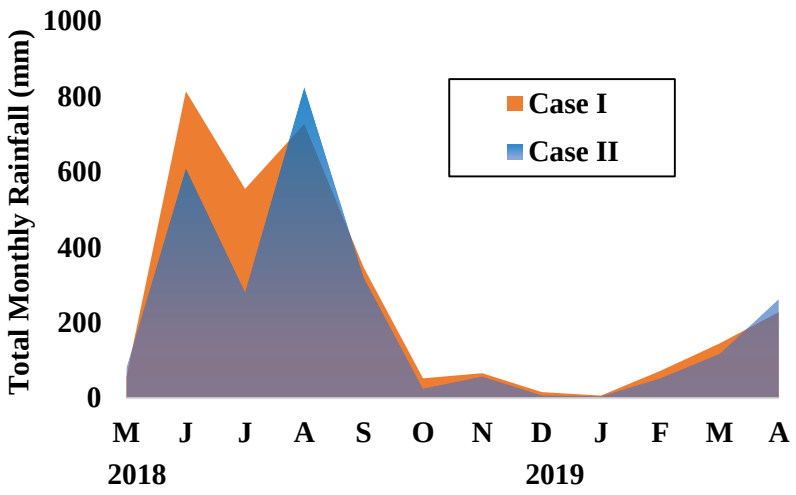

Figure 4 Approximate monthly rainfall at the catch basin of each site

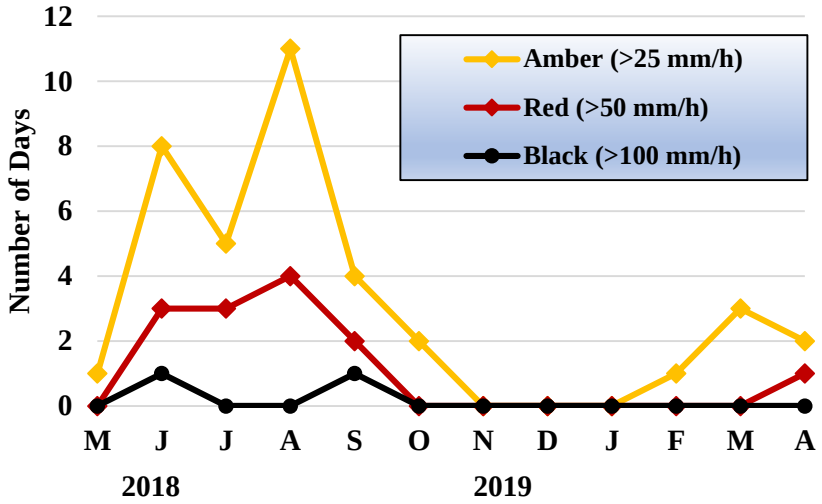

Figure 5 Number of days with rainstorm signals

- The main disturbance factor of the restored sites is flood risk.
- The most precipitation events took place between June(J) to September (s).
- Use the colored (Amber, Red in Figure 5) signals as a simpler method to predict the level of flooding disturbances to the sites.

Identification of resilience measurement methods

Measurement of engineering resilience

- Based on their physical conditions before and after disturbance

  “Failure, “ Impaired”, “ Successful”

- Based on the resilience concepts

  “Robust”, “Restorative”, “Resistant”

Measurement of system resilience

- Effects of the restored features: observation method
- Social and recreational function: Observation method

Measurement of complex adaptive system resilience

- Detailed riparian vegetation surveys: impacts of disturbances on the flora

  A mobile application XingSe®, camera

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Assessment of engineering resilience

Structure features

Resistant to heavy flooding stresses
Robust with high absorptive capacity
Meet intended functions of site stability

→ **Successful**

(a) Post-enhancement

(b) Currently

Palm fibre concrete block

(a) Post-enhancement

(b) Currently

Current deflector installation

(a) Post-enhancement

(b) Currently

Gabion baskets

(a) Post-enhancement

(b) Currently

Climber mesh

Figure 6 Structure features

Resilient assessment

Assessment of engineering resilience

Ecological enhancement features

Features for habitat enhancement functions:

Less resistant compared with structural features

Less restorative compared with the 'green' features

→ **Impaired**

(a) Post-enhancement

(b) Currently

Wooden poles

(a) Post-enhancement

(b) Currently

Fish ladder

(a) Post-enhancement

(b) Currently

Pools & Riffles

(a) Post-enhancement

(b) Currently

Sinuosity configuration

Figure 7 Ecological enhancement features

Resilient assessment

Assessment of engineering resilience

Table 2 Evaluation of enhancement features at the post-disturbance (P-D) and post-recovery

Feature	Case I		Case II	
	P-D	P-R	P-D	P-R
Eco Substrates	S	S	S	S
Fish Ladder	I	I	-	-
Pools & Riffles	F	I*	-	-
Riparian Vegetation	I	S	I	S
Sinuosity	I	I	S	S
Vegetated Ledge	F	I	-	-
Wooden Poles	F	F	I	I
Palm-Fiber Concrete Block	S	S	S	S
Climbers Mesh	S	S	S	S
Current Deflector	S	S	S	S
Gabion Baskets	S	S	-	-

S: successful, F: failure, I: impaired.

Resilient assessment

Assessment of system resilience

(a) Permanently altered fish ladder (Case I)

(b) Permanently inundated pathway(Case I)

(c) Aesthetic loss after heavy storms (Case II)

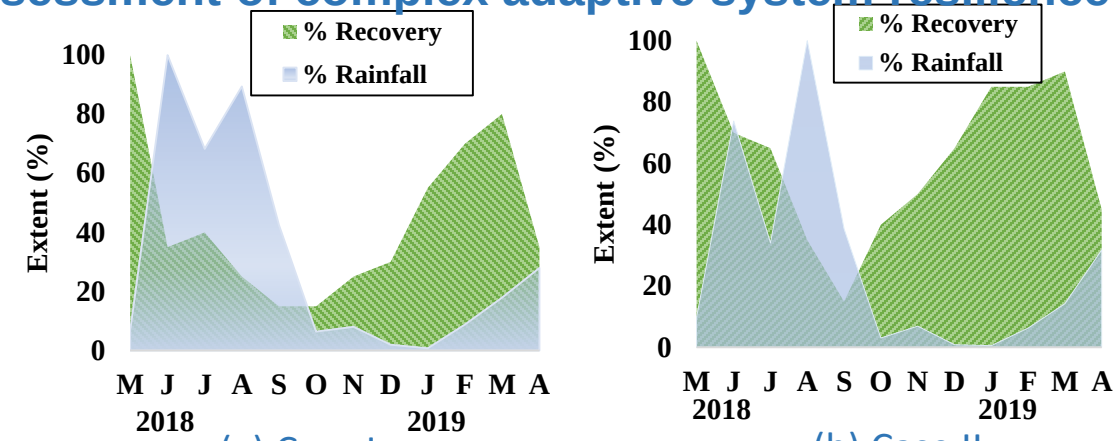
(d) The restoration of aesthetic appeals (Case II)

Figure 8 The changes of aesthetics and accessibility of the sites

- Effects of the restored features ⟹ "restorative"
- Social and recreational function ⟹ "restorative"

Resilient assessment

Assessment of complex adaptive system resilience

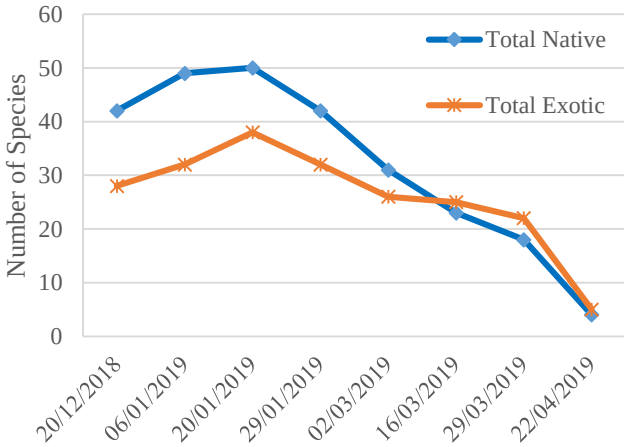


(a) Case I

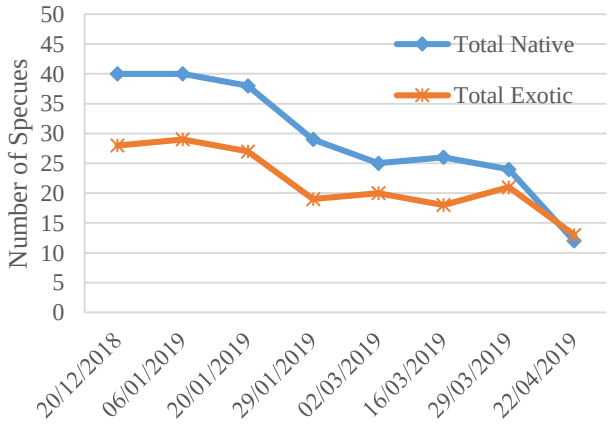
(b) Case II

Figure 9 Extent of Vegetation recovery

- Began to recover from Oct. and Sep.;
- regained to a maximum extent in March.



(a) Case I



(b) Case II

Figure 10 Native and exotic species in two cases

- Species richness decline;

Vegetation ⟹ "restorative", but diversity decline

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Conclusions and recommendations

- A framework and process for resilient analysis is proposed based on existing literature.
- The framework and process for resilient analysis are found to be helpful in generating technical and managerial insights on the resilience of the river restoration projects.
- Proactive design and adaptive operation management strategies are recommended, eg. Exclude vulnerable and non-restorative design features, appropriate plant selection, continuous monitoring.

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Thanks for your attention!