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Eco-hydraulics study on green channels of Hong Kong

A case study of ecological enhancement
at Lower Lam Tsuen River

Theme 3 – Water for Liveability
and Resilience



Introduction

The Drainage Services Department (DSD) of the Government of the Hong Kong Special Administrative Region has implemented a wide range of green channels under flood prevention projects in Hong Kong, which enhance the environment and promote biodiversity.

To systematically evaluate the effectiveness of the design on ecological enhancement, DSD commissioned Mott MacDonald to review the latest ecological conditions of some selected green channels. Rapid Stream Evaluation (RSE) method was developed specifically for the green channels in Hong Kong.

The physical, biological and chemical conditions of 22 river sections were evaluated using RSE. According to the results, Lower Lam Tsuen River (Tai Po, Hong Kong) was selected for further ecological enhancement trial (Figure 1).

In January 2017, an approximately 65m-long concrete channel section was replaced with a more natural river bed and the riparian zone was enhanced (Figure 2). Diverse aquatic habitats such as pools, riffles, resting ground for birds and emergent vegetation were successfully established. Based on the post-enhancement monitoring, more wetland-dependent avifauna species were recorded at the enhanced channel section (Figure 3 to 7).

Further post-enhancement monitoring is recommended to further review the effectiveness of the implemented ecological enhancement features and for the recommendation of long-term operation and maintenance in upkeeping the ecological value of the channel.



Figure 1
Site condition of Lower Lam Tsuen River before the ecological enhancement trial (Photo taken during 4th quarter of 2015)



Figure 2
Site condition of Lower Lam Tsuen River after the ecological enhancement trial (Photo taken during 2nd quarter of 2017)



Figure 3
Utilisation of enhancement measures by wetland dependent species (Photo taken during 3rd quarter of 2017)

Methodology

Rapid Stream Evaluation (RSE) is an approach to review the ecological status of green channels in Hong Kong.

It was developed by making reference to similar local and overseas methods and expert advice from academics and green groups. It comprises a set of physical, chemical and biological criteria including water quality, type of bed substrate, quantity and quality of in-stream habitats, ecological connectivity of the river channels, level of biodiversity as well as the type and quantity of native aquatic flora and fauna found (Table 1).

22 green channel sections in Hong Kong were evaluated using RSE and Lower Lam Tsuen River at Tai Po was selected for further ecological enhancement trial.

The trial was conducted at an approximately 65m-long section of Lower Lam Tsuen River to improve the ecological value of the in-stream channel and to enhance the liveability of the nearby area (see Figure 1). The existing concrete base was replaced with a more natural river bed (see Figure 2). Soft landscape works for riparian vegetation were also carefully implemented (Table 2).

The effectiveness of the trial was reviewed based on site observations, water quality monitoring and ecological survey conducted before and after the trial. The changes in biodiversity and species composition were compared and the findings were analysed.



RSE Criteria	
1 Physical and chemical factors (Total 32%)	
(a) Water quality (8%)	(i) pH (2%) (ii) DO (% saturation) (2%) (iii) BOD ₅ (2%) (iv) NH ₃ -N (2%)
(b) Instream habitat - Substrate (6%)	
(c) Embankment profile (6%)	
(d) Aquatic habitat quality - Aquatic habitat diversity and longitudinal connectivity (6%)	
(e) Stream-riparian ecosystem - Lateral inundation of stream-riparian zone (6%)	
2 Biological factors (Total 68%)	
(a) Species richness (12%)	
(b) Species of conservation concern (12%)	
(c) Freshwater/estuarine fish species (12%)	
(d) Freshwater invertebrates (12%)	
(e) Riparian habitat conditions (10%)	
(f) Riparian vegetation at water margin & channel embankment (10%)	

Table 1 Rapid stream evaluation criteria developed for the review of ecological value of green channels for Hong Kong

Enhancement Objectives	Enhancement Measure
<ul style="list-style-type: none"> • Improve Water Quality • Reduce ammonia-nitrogen 	<ul style="list-style-type: none"> • Increase dilution of ammonia-nitrogen in the waterbody • Selective planting to promote ammonia uptake from the water column
Increase substrate naturalness and complexity	<ul style="list-style-type: none"> • Placement of natural bed materials along the river channel • Creation of sinuous flow features through vegetation planting and natural structures
Improve habitat for wetland dependent species, fish and aquatic fauna <ul style="list-style-type: none"> • Increase habitat complexity • Increase species diversity • Increase proportion of native fish species • Increase aquatic invertebrates 	<ul style="list-style-type: none"> • Plant submerged vegetation • Remove invasive species
Increase ecological connectivity of the river <ul style="list-style-type: none"> • Increase streamside vegetation • Enhance horizontal connectivity and enhance longitudinal connectivity 	<ul style="list-style-type: none"> • Plant riparian vegetation along the river banks • Install geotextile/ more natural material over existing concrete structures to enhance connectivity

Table 2 Proposed enhancement measures for Lower Lam Tsuen River

Results and discussion

The ecological enhancement works at Lower Lam Tsuen River were completed in January 2017 (see Figure 2). Two rounds of dry and wet season post-enhancement ecological surveys and water quality monitoring were conducted. From the preliminary observations in the first 6 months, the overall RSE scoring for Lower Lam Tsuen River has been improved from “Fair” to “Average” due to the improved water quality and habitat condition and also the increased number of species recorded within the river channel.

The ranking of physical and chemical factors has been improved from “Fair” to “Average”. The reduced BOD5 and ammonia-nitrogen indicate less organic pollution in post-enhancement stage. The slightly increase in DO saturation can better support the in-stream fauna.

After the enhancement, aquatic micro-habitats including pools, riffles, submerged and emerged vegetation and wood debris were observed along the enhanced section, which provides a diverse and complex habitat for wildlife.

For the biological factors, more birds, dragonflies, herpetofauna, freshwater fish and aquatic invertebrate species were recorded during the post-enhancement survey (Table 3).

More native and wetland dependent fauna species were recorded (Figures 3 to 7). The scoring for riparian vegetation has been improved due to more native and wetland dependent species in the riparian zone.

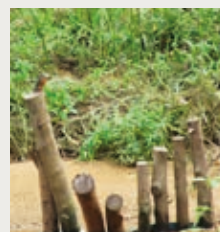
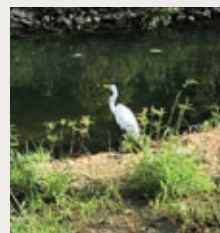
The ranking of biological factor has been improved from “Average” to “Good”, which indicates that the implemented measures are effective in increasing the biodiversity.

Table 3

Summary of ecological field survey findings during pre-enhancement and post-enhancement survey in Lower Lam Tsuen River

No. of species recorded within, upstream and downstream of the enhanced site	Pre-enhancement	Post-enhancement
All flora species	84	157
Wetland associated plant species	31	61
Native plant species	58	109
All fauna species	80	105
Avifauna species (wetland dependent species)	38 (6)	43 (9)
Dragonflies species	12	17
Herpetofauna species (wetland dependent and native)	9 (5)	12 (8)
Freshwater fish species (native species)	17 (6)	23 (7)
Freshwater invertebrate species (bio-indicator of poor water quality)	4 (3)	11 (2)
Native and wetland dependent fauna species, excluding fish and freshwater invertebrates	23	34
Species of conservation concern which are both native and wetland dependent	7	13
Habitat types within 30m riparian zone (habitats with ecological value)	2(0)	2 (0)

Figure 4, 5, 6 & 7
Utilisation of enhancement measures by wetland dependent species
(Photos taken during 2017)



Conclusions

The water quality, in-stream habitat complexity and the ecological value of Lower Lam Tsuen River have been significantly improved after the site trial and the objective to enhance the liveability of the nearby area was achieved.

Furthermore, more data would be collected from the post-enhancement monitoring activities. This study provides an important reference for drainage channel design in future and contributes to the sustainable blue-green infrastructure development in Hong Kong.

Opening opportunities with connected thinking.

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