RGC Ref. No.:
UGC/FDS25/M05/19
(please insert ref. above)

RESEARCH GRANTS COUNCIL
COMPETITIVE RESEARCH FUNDING SCHEMES FOR
THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report
(for completed projects only)

Submission Deadlines:	1. *Auditor's report with unspent balance, if any: within **six** months of the approved project completion date.* 2. *Completion report: within **12** months of the approved project completion date.*

Part A: The Project and Investigator(s)

1.   Project Title

Soil Properties and Microbial Communities in Relation to Tree Performance across Urban

Green Space (UGS) Types in Hong Kong

2.   Investigator(s) and Academic Department(s) / Unit(s) Involved

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator	Dr. ZHANG Hao / Assistant Professor	Faculty of Design and Environment / THEi
Co-Investigator(s)	Miss WANG Sifeng / Research Assistant	Faculty of Design and Environment / THEi
Others		

3.   Project Duration

	Original	Revised	Date of RGC / Institution Approval *(must be quoted)*
Project Start Date	1 Jan 2020	1 Jan 2020	N/A
Project Completion Date	31 Dec 2021	30 Jun 2022	12 Oct 2021
Duration *(in month)*	24 months	30 months	12 Oct 2021
Deadline for Submission of Completion Report	31 Dec 2022	30 Jun 2023	12 Oct 2021

4.4   Please attach photo(s) of acknowledgement of RGC-funded facilities / equipment.
Hollow cathode lamps x 10 nos.

Part B: The Final Report

5.   Project Objectives

5.1   Objectives as per original application

1. Assess the growth performance of trees in the UGS of Hong Kong
2. Quantify soil physiochemical properties and metal contaminants in UGS of Hong Kong
3. Describe the taxonomic diversity as well as the metabolic functions of soil microbial communities in UGS of Hong Kong
4. Evaluate mutual effect among tree performance, soil physicochemical properties, microbial communities, and metal contaminations in soils of different UGS types
5. Provide information to improve the quality of the UGS and tree performance in a technical way: design, planning, and management for policy-makers and the management section

5.2   Revised objectives

Date of approval from the RGC: N/A

Reasons for the change:

1.

2.

3. ....

5.3   Realisation of the objectives
(Maximum 1 page; please state how and to what extent the project objectives have been achieved; give reasons for under-achievements and outline attempts to overcome problems, if any)

A total of 40 sites from five regions of Hong Kong, covering eight different UGS types,   were selected. One woodland site was also selected as reference site. To achieve objective 1, tree survey for 161 trees found on the sampling sites was conducted, with tree height, tree spread, DBH, foliage density, foliage color, leaf size, presence of epicormics, tree vigor, leaning condition, crown condition, branch condition, trunk condition and root condition recorded. The overall tree performance was assessed based on the data collected. To achieve objective 2, 164 soil samples from the selected sites were collected. The permits for taking soil samples were obtained from the respective government departments. The soil physiochemical properties and metal contaminants were measured through laboratory analysis. The variations of soil properties across the habitats (parks and roadside), USG types and regions were compared. To achieve objective 3, metagenomics sequencing for the soil samples collected from the selected sites was conducted. The abundance and functional profile of the soil microbial communities were obtained using the Majorbio Cloud platform. To achieve objective 4, the data obtained from objectives 1-3 were analysed to observe the relationships between tree performance, soil properties and microbial communities. To achieve

objective 5, suggestions for soil management based on the findings from the previous objectives were derived. Some of the findings and suggestions were presented at a local conference (Appendix 1) and delivered via local news articles (Appendix 2).

5.4   Summary of objectives addressed to date

Objectives (as per 5.1/5.2 above)	Addressed (please tick)	Percentage Achieved (please estimate)
1. *Assess the growth performance of trees in the UGS of Hong Kong*	√	100%
2. *Quantify soil physiochemical properties and metal contaminants in UGS of Hong Kong*	√	100%
3. *Describe the taxonomic diversity as well as the metabolic functions of soil microbial communities in UGS of Hong Kong*	√	100%
4. *Evaluate mutual effect among tree performance, soil physicochemical properties, microbial communities, and metal contaminations in soils of different UGS types*	√	100%
5. *Provide information to improve the quality of the UGS and tree performance in a technical way: design, planning, and management for policy-makers and the management section*	√	100%

6. Research Outcome

6.1 Major findings and research outcome
(Maximum 1 page; please make reference to Part C where necessary)

In total, 251 trees of 44 species were recorded in the sampling sites of the eight different UGS. *Melaleuca leucadendra* (11%)*, Lagerstroemia speciosa* (11%), *Aleurites moluccana* (石栗) (7%), and *Ficus microcarpa* (細葉榕) (6%) were the most common species (Table 1). In general, most of the trees were observed with several defects, but those defects did not pose severe impacts on the health condition.

In terms of physical properties, park soils had a higher soil bulk density than roadside soils by planting sites. Across habitats, tree pits had a higher sand content. In terms of chemical properties, roadside soils showed a better performance in general, with higher TOC, conductivity, available N, available K, Mg and Ca. Across habitats, highest TOC and conductivity were observed at planting strip of roadside, Within park, soil TOC at tree pits was higher than that of grassland and remnant. At roadside, slope soils had the lowest pH. Remnant and slope showed the lowest available P. Tree pit of roadside showed the highest calcium content, while remnant of park showed the lowest calcium content. The heavy metal concentrations were measured in the study, but were all at undetectable level, implying a very low concentrations of heavy metals in urban soils.

Overall, soils of tree pits, particularly at roadside, were with poorer soil physical properties. Meanwhile, the roadside soils showed better nutrient conditions. The soil physical properties were poorer in Hong Kong Island (Central and West) but better in New Territories. The soil nutrient conditions were better in Kowloon (West) but poorer in Hong Kong Island (East). The differences may be contributed by the different land use and development history of the different areas.

In total, 2097 species with 44 phylum were found in the selected sites of UGS. The most abundant bacteria at class level were *Actinobacteria* (19%-48%), *Alphaproteobacteria* (13%-32%), *Acidobacteria* (3%-11%), *Thermoleophilia* (3%-9%) and *Betaproteobacteria* (2%-11%). In general, the microbial community composition across different UGSs was similar. *Alphaproteobacteria* and *Actinobacteria*, which accounted for the largest proportion among the microbial communities in UGS soil, were not significantly different across different UGS. Most of the bacteria were responsible for metabolism in soils (78%-79%).

The mutual effects among the tree performance, soil physicochemical properties, microbial communities, and metal contaminations in soils of different UGS types were not significant as observed in the study.

Poor soil nutrient condition was one of the main problems of urban forestry management in Hong Kong based on the findings. Meanwhile, the variations of soil properties as observed among different habitats, UGS types and regions indicated the need for devising targeted strategy for soil management.

6.2 Potential for further development of the research and the proposed course of action
(Maximum half a page)

1. Given the poor nutrient condition of urban soils, a field experimental study on the effects of incorporating different types and levels of soil amendments on the nutrient level of urban soils across different UGS can be conducted.

2. The current research focused more on the spatial variation of the soil properties. The temporal changes in soil properties in urban soils can be studied through field monitoring and comparing soil properties among more regions with different development history. It can further facilitate the understanding on factors affecting the urban soil properties and management strategies for urban soils.

Research proposals based on the above two directions can be developed to secure funding for conducting the research studies.

7. Layman's Summary
(Describe <u>in layman's language</u> the nature, significance and value of the research project, in no more than 200 words)

This study evaluated the tree performance, the physiochemical properties, soil metal contaminants, and soil microbial communities across the eight major UGS types (grassland, level planting bed, tree pit and remnant in urban parks, and planting strip, level planting bed, tree pit and slope at roadside) of Hong Kong from five regions (Central and West Hong Kong Island, East Hong Kong Island, East Kowloon, West Kowloon and New Territories), and their interrelationships. There was a lack of local studies that comprehensively investigated the soil characteristics across different UGS types. The study revealed the soil characteristics of a range of local urban soils and demonstrated the variations of the local urban soils among different UGS. This study enhances the understanding of the often overlooked, but indeed important, soil management issues in urban forestry management and propose evidence-based management suggestions. It contributes to the improvement of soil management strategies and hence the quality of urban forestry management, particularly of the local region.

Part C: Research Output

8. **Peer-Reviewed Journal Publication(s) Arising Directly From This Research Project**
   (Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Author(s) *(denote the corresponding author with an asterisk*)*	Title and Journal / Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this Report *(Yes or No)*	Acknowledged the Support of RGC *(Yes or No)*	Accessible from the Institutional Repository *(Yes or No)*
Year of Publication	Year of Acceptance *(For paper accepted but not yet published)*	Under Review	Under Preparation *(optional)*						
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

9. **Recognized International Conference(s) In Which Paper(s) Related To This Research Project Was / Were Delivered**
   (Please attach a copy of each conference abstract)

Month / Year / Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this Report *(Yes or No)*	Acknowledged the Support of RGC *(Yes or No)*	Accessible from the Institutional Repository *(Yes or No)*
03/2022/ Hong Kong	Soil Properties in Relation to Tree Performance across Urban Green Space Types in Hong Kong (Abstract in Appendix 1; only PPT was delivered)	Hong Kong 2022 International Urban Forestry Conference	No	Yes	Yes	No

10. **Whether Research Experience And New Knowledge Has Been Transferred / Has Contributed To Teaching And Learning**
(Please elaborate)

Two students were participated in the Final Year Project that was in relation to this research study, They were trained in field data collection, conducting laboratory experiments, and data analysis. They developed knowledge in conducting research study of soil sciences and in the local soil management.

11. **Student(s) Trained**
(Please attach a copy of the title page of the thesis)

Name	Degree Registered for	Date of Registration	Date of Thesis Submission / Graduation
████	██████	█	████
████	██████	█	████
████	██████	█	████
████	██████	█	████

12. **Other Impact**
(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, teaching enhancement, etc.)

The PI gave a presentation on the topic "Soil Properties in Relation to Tree Performance across Urban Green Space Types in Hong Kong" in the Hong Kong 2022 International Urban Forestry Conference (Appendix 1).

News articles related to the research findings were released (Appendix 2)

13. Statistics on Research Outputs

	Peer-reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Research Outputs (please specify)	
No. of outputs arising directly from this research project	In progress	N/A	N/A	N/A	Type	No.
					Conference presentation	1
					News articles	4

14. Public Access Of Completion Report

(Please specify the information, if any, that cannot be provided for public access and give the reasons.)

Information that Cannot Be Provided for Public Access	Reasons
Student name	Privacy concern