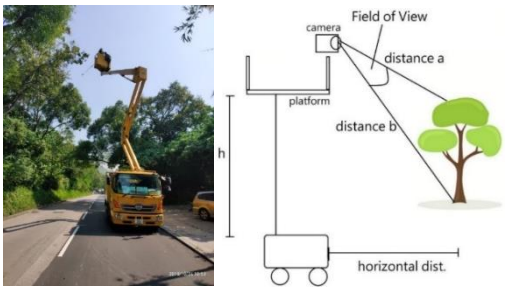
News Article for RISUD Strategic Focus Area (SFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Charles M.S. Wong	LSGI
2.	**Name of SFA:**	Urban Ecology	
3.	**Project Title:**	New Technologies for Smart Management of Urban Trees	

4. **Second Year Progress/Achievement (***in layman's language, no more than 2 pages***)**

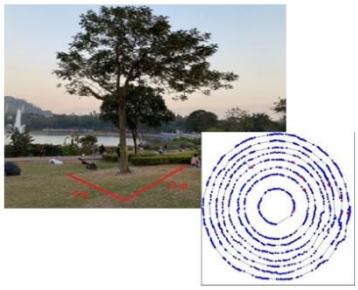
Urban tree is substantially affected by both physical and biological factors, including inherent properties of species, confined planting space and unprecedented environmental changes. As such, the growth of every individual tree is ubiquitous and vary in some degrees which greatly increases the challenge for the tree management as well as to determine tree risk level through the traditional method. A variety of new technologies assisted to monitor and manage urban trees is introduced in this project to achieve our ultimate research outcome. In the second year, the scheduled progress was carried out smoothly, and the progress of individual objective is generalized as below:

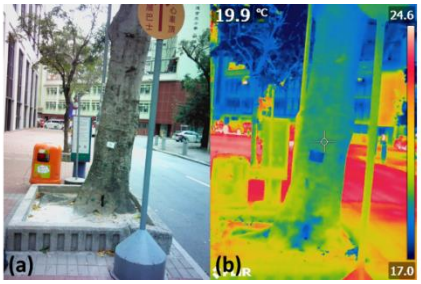
1) Identification of potentially dangerous trees using remote sensing techniques, including hyperspectral and near infra-red imaging, tree attributes retrieval and 3D model development from LiDAR and InSAR, phenology monitoring and its interaction with climate change were conducted. Several field surveys were accomplished for acquiring the trial set of hyperspectral images and the development of a spectral library for 19 common tree species in Hong Kong was completed. The project team has developed both field and satellite approaches to monitor vegetation phenology.



The UAV airborne LiDAR and field survey were set out in four sample plots at Kowloon peninsula to acquire airborne LiDAR data in late-2018 and early-2019, where the results are fairly promising as compared to the ground-truth result yet further enhancement of the in-depth experiment i.e. backpack LiDAR, is planned to conduct in the coming year.

2) Field verifications of the causes of tree risk through non-invasive sensing techniques including GPR assessment of main structural roots alongside visual inspection have been carried out. GPR was used to study tree root distribution in four sites. The results are promising, that distribution of tree roots up to about 1.5m depth could be mapped. In particular for site 1 and 2, the identified wet-dry boundary and tree root distribution clearly illustrate that the trees are absorbing water which indirectly suggests the healthy status of the trees. On the other hand, such boundary was not observed in site 3 and 4. In general, it is the only non-destructive method to study tree root distribution in the near-surface, and definitely worth further research for application.

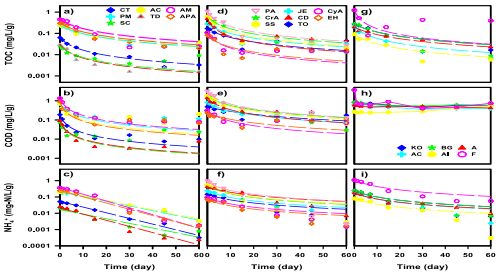




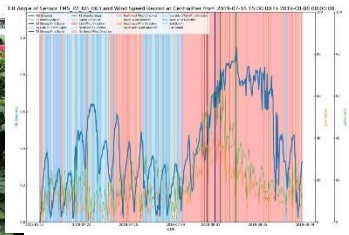
To investigate the relationship between the structural defect and corresponding surface temperature of trees, fieldwork was conducted to acquire the thermal images over 12 of the selected trees. In Stage 1, thermal images were captured on five sample trees with known defects and seven sample healthy trees in Hong Kong Island and Kowloon Park in January and February 2019. The images were used to develop an algorithm for detecting tree defects with known cavity size and area. The acquired images would be thereafter processed by the developed algorithm to

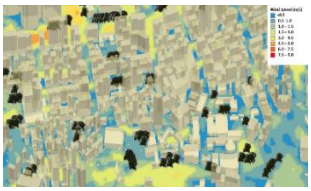
detect the suspicious defected area on all selected trees in Stage 2 in the coming funding period.

3) Procedural laboratory testing through sampling by expert determines the actual health of trees and tree dangers to the surroundings. The ability of the plants to purify the wastewater was demonstrated. COD was the most difficult to remove from stormwater by the mangrove plants. In most cases, removal rate of ammonia was significantly faster in the continuous flow process than the batch process. Plant species such as *Phragmites australis*, *Crinum asiaticum* and *Scaevola sericea* can be used for pollutants removal process in synthetic stormwater treatments. *Commelina diffusa* should not be used in saline environment. More detailed laboratory testing will be conducted in the coming year



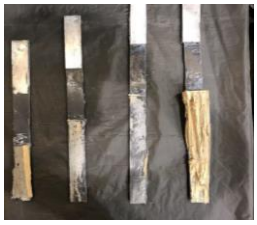
4) Acquisition of Big Data of static tree attributes and dynamic tree movement data by collecting near real-time data from tree sensors. Ongoing calibration of thresholds is being conducted by our team and the sensors have been tested in various locations under a variety of environmental conditions to have a comprehensive analysis for the whole system. Over the past studying period, our team has studied the pattern of tree stability in multilateral directions, in a bid to understand the correlation of pattern such as the species with smooth and rough bark, the effect of the sunlight intensity and sun orientation, and the moving trajectory of a particular tree.

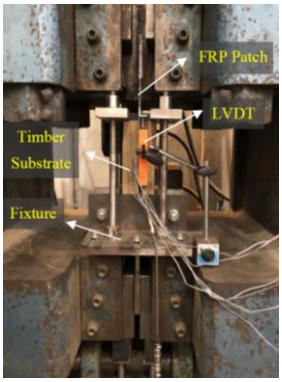


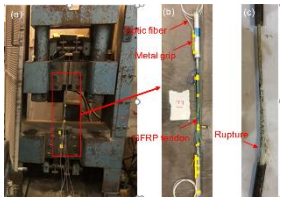


A Digital Elevation Model (DEM) of 0.5-meter spatial resolution, 3D building model with height attribute and 3D geometry of trees were used to simulate airflow in the study area using Airflow Analyst. The Big Data analytics and machine learning will be carried out to study the tree risk index in the coming year.

5) Rectification of potential dangerous trees using the fabricated FRP implant with a customised adjustable testing frame has been designed to fix the specimens. In general, two types of failure modes have been observed. First, the failure happens in the wood base. For this failure mode, it is seen that a remaining part of the wood is bonded to the FRP on the pulled out FRP strip. Therefore, the bond in such case is stronger than the wood base indicating sufficient bond strength. For the second type, the failure occurs at the adhesive/ FRP interface. In this case, the strength of the wood base is larger than the interface between FRP and the adhesive indicating insufficient bond strength.







The fabricated GFRP tendon was tested under tension to evaluate its mechanical properties and the performance of the embedded BOTDA fiber optics. A total of ten tendons were tested under tension until failure on the testing frame. The GFRP tendon was inserted into the metal grips at two ends to facilitate the gripping of the clamps on the testing frame. Monotonic tensile loading was applied to the tendons until the failure of the tendons.

6) Knowledge sharing and technology transfer, policy recommendation, and community engagement through public seminars of the advanced technology have been continuously carried out. The team had been actively engaged in various academic events to introduce our project and the geospatial technology in the last reporting period. These events have been undertaken respectively, for academic and community sharing to the Government officials, oversea academia, students as well as the general public to transfer the knowledge on new technologies for tree management.