Research Forum 2018

Urban Weather Monitoring for Smart Cities

18 October 2018
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Weather and Radiation Observation Networks

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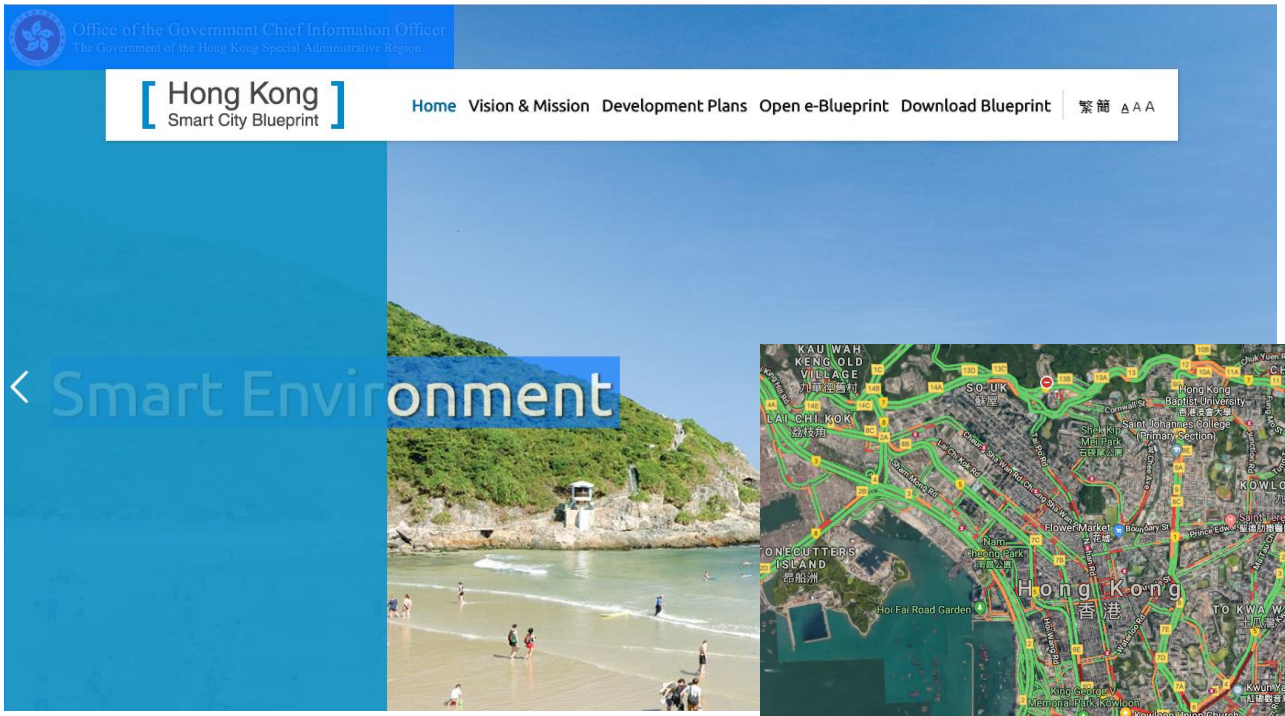
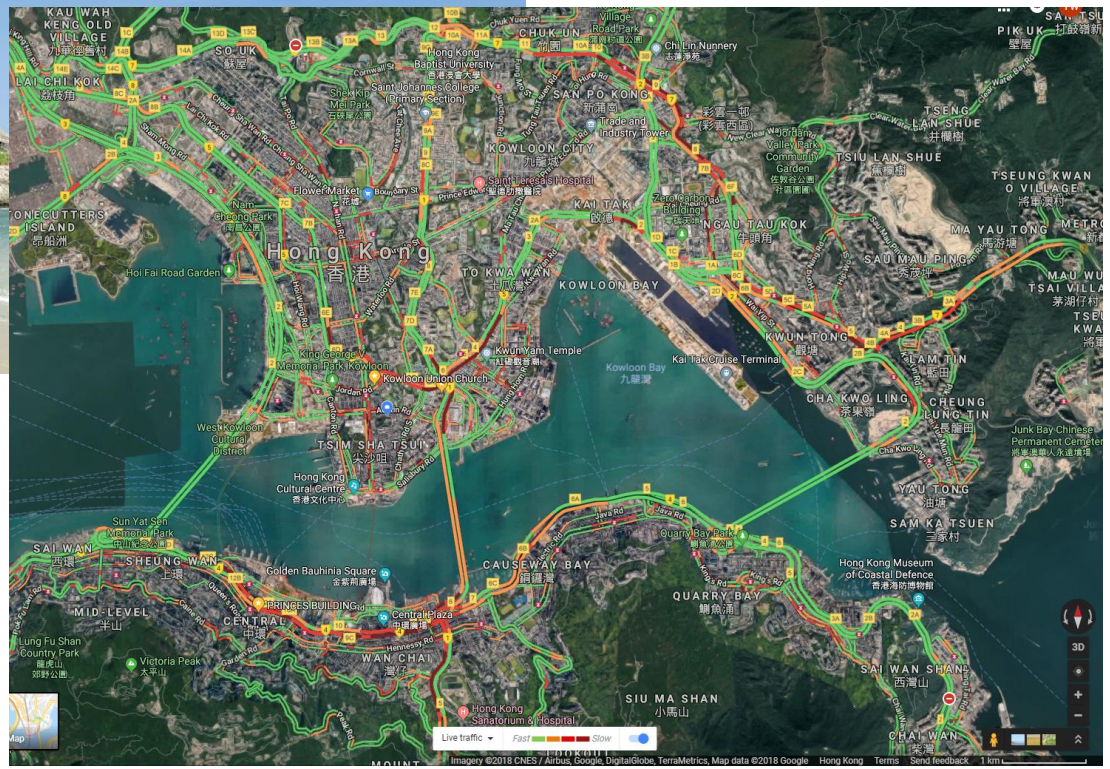
Urban Weather Monitoring for Smart Cities

1. Smart Cities Initiatives
2. Microclimate study by HKO in 2017-2018
3. Ways forward

Smart Cities Initiatives





To be a smart city, observation data are required to support decision makers.

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Microclimate study by HKO in 2017-2018

ICAWS 2017 : Application of button-size temperature sensors for micro-climate study of the urban environment of Hong Kong (YW Chan et. al.)

CIMO TECO 2018 : Application of miniature sensors in the development of micro-climate stations for urban climate studies in Hong Kong (John KW Chan et. al.)

Study the heat distribution/variations over the Kowloon Peninsula in different weather scenarios for a better understanding of the urban climate.

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Microclimate study by HKO in 2017-2018

Temperature Sensor (i-Button)

Accuracy: better than ± 0.5°C

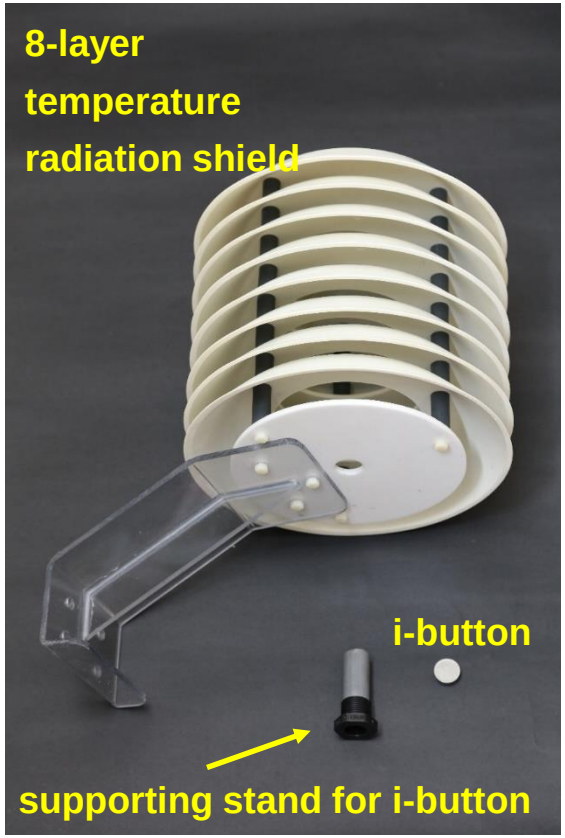
Range: -10°C to +65°C

Sampling time: 5 minute

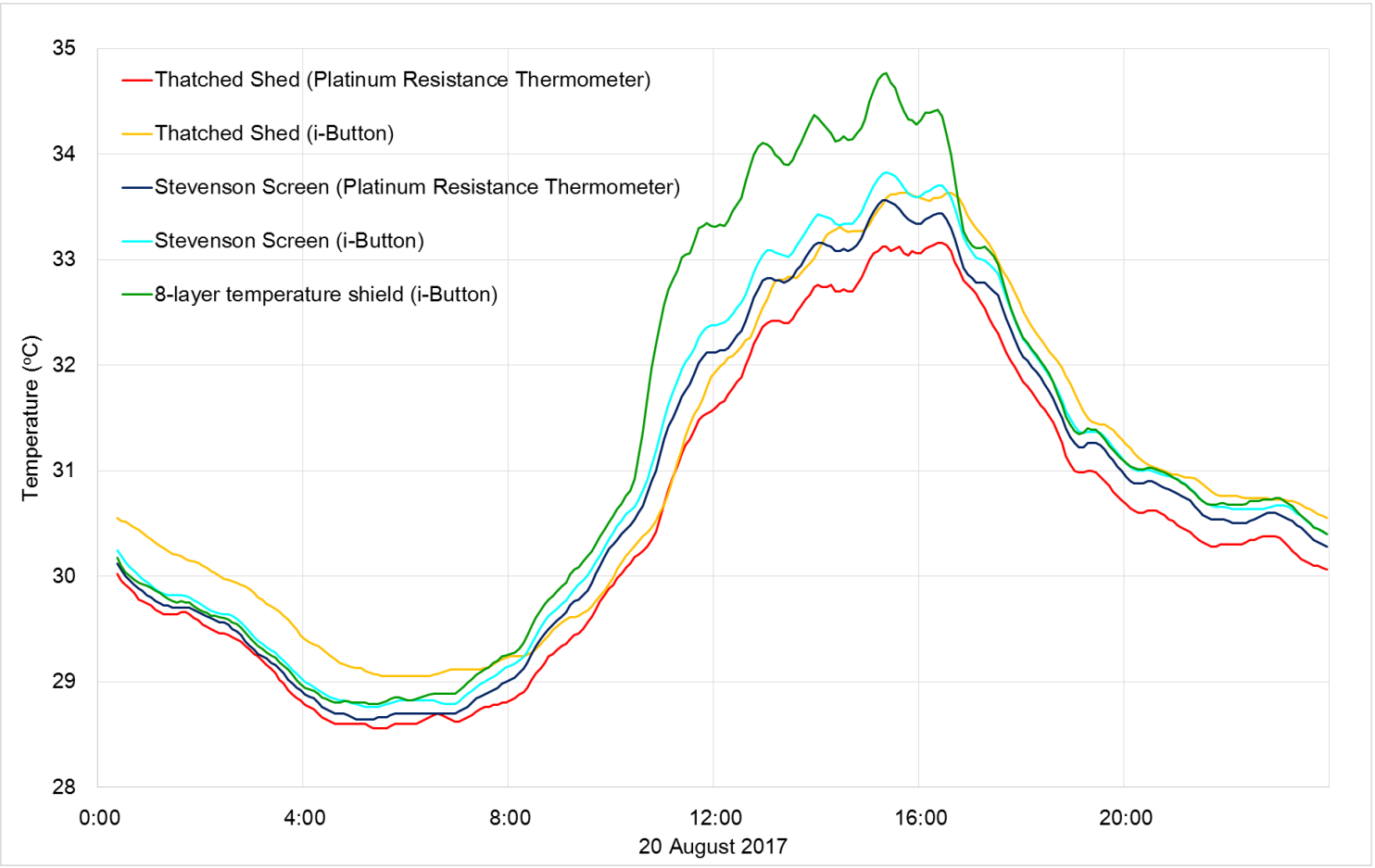
Individually calibrated in a NIST-traceable chamber

No external electric supply needed

Microclimate study by HKO in 2017-2018



Microclimate study by HKO in 2017-2018



20 August 2017

Mean Cloud amount: 29%

Mean RH: 75%

Total Bright Sunshine: 10.2 hours

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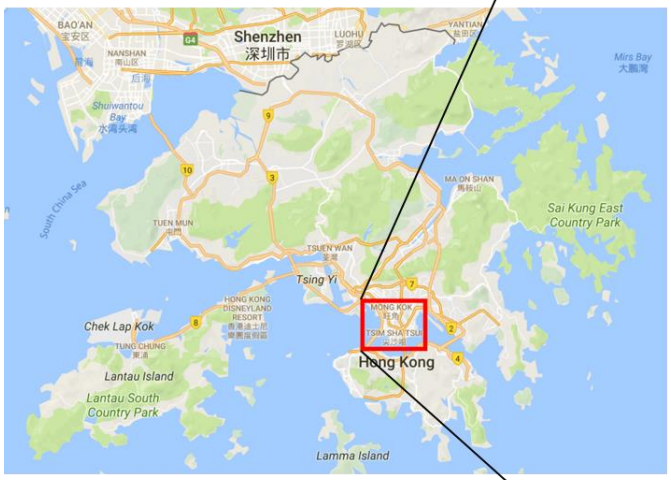
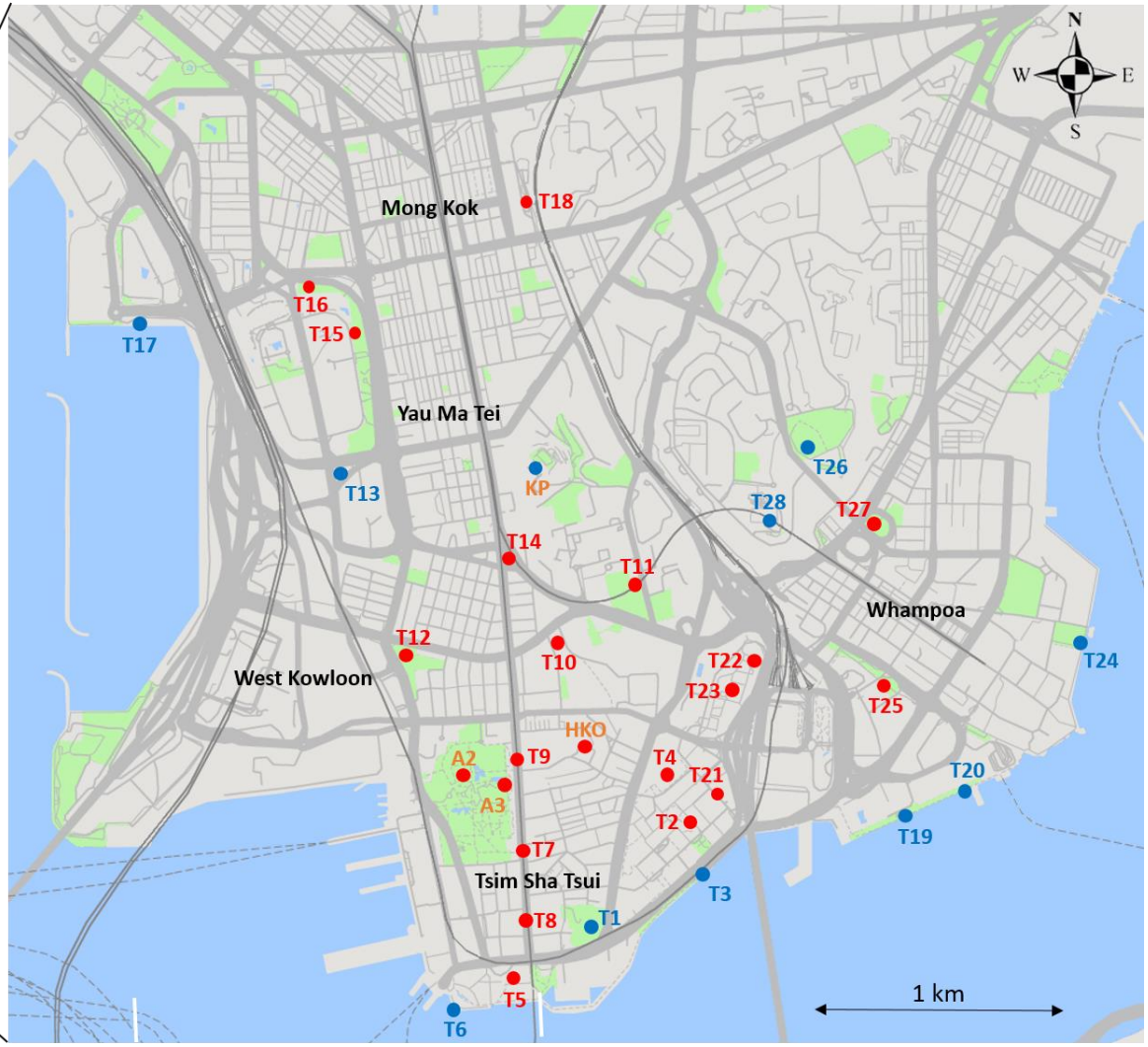
Microclimate study by HKO in 2017-2018

Observation Network





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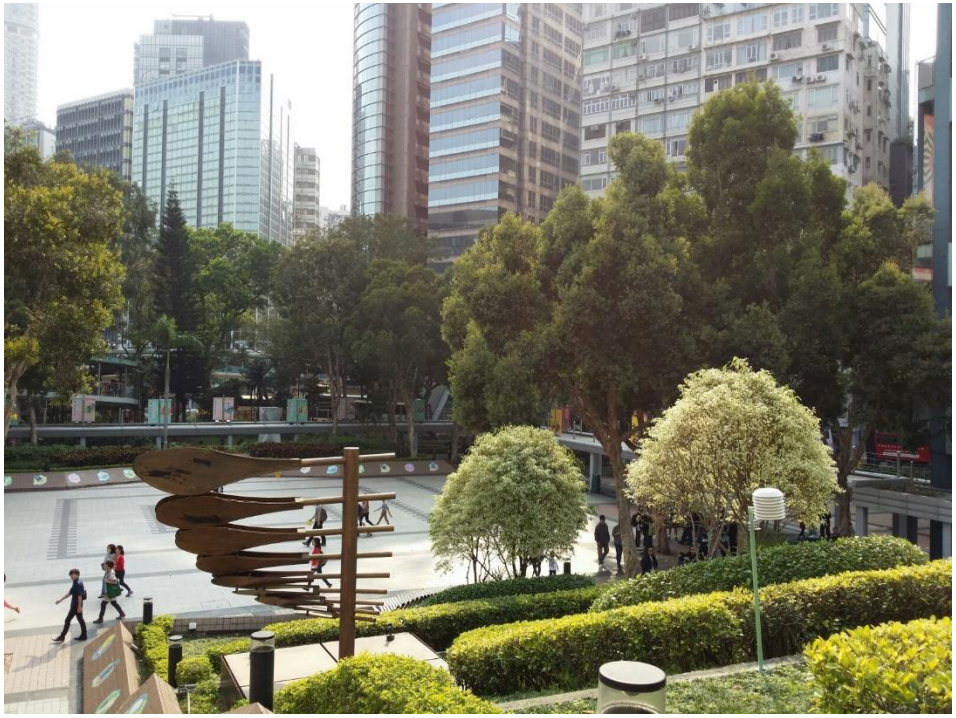
Microclimate study by HKO in 2017-2018

Measuring Sites (Green Park, East of HKO)



Science Museum (T4)

Microclimate study by HKO in 2017-2018

Measuring Sites (Green Park, West of HKO)

Kowloon Park, Park Lane (A3)

Microclimate study by HKO in 2017-2018

Site Characterization

Station Code	Site Name (latitude and longitude of temperature station)	Altitude	WMO Site Classification		Sky View Factor (SVF)
			Heat Source	Projected Shade	
HKO	HKO Headquarters *(22°18'07" 114°10'27")*	33.0m	3	5	0.31
KP	King's Park Meteorological Station *(22°18'43" 114°10'22")*	67.0m	1	1	**0.61**
A2	Kowloon Park Central *(22°18'03" 114°10'11")*	26.9m	2	4	0.46
A3	Park Lane, Kowloon Park *(22°18'02" 114°10'17")*	18.7m	4	5	0.46
T1	Signal Hill Garden *(22°17'45" 114°10'29")*	36.6m	2	5	**0.50**
T2	East Tsim Sha Tsui Centenary Garden *(22°17'58" 114°10'41")*	5.8m	4	5	0.27
T3	East Tsim Sha Tsui Promenade *(22°17'49" 114°10'41")*	6.1m	3	4	**0.58**
T4	Science Museum *(22°18'03" 114°10'37")*	11.0m	4	4	0.45
T5	Space Museum *(22°17'38" 114°10'17")*	5.6m	5	5	0.34
T6	Viewing Deck of Cultural Centre *(22°17'35" 114°10'10")*	10.1m	2	4	**0.73**
T7	Nathan Road near Kowloon Mosque *(22°17'53" 114°10'19")*	8.7m	5	5	0.27
T8	Nathan Road near Chungking Mansions *(22°17'46" 114°10'20")*	6.3m	5	5	0.12
T9	Nathan Road near Park Lane *(22°18'05" 114°10'18")*	11.1m	5	5	0.38
T10	Kowloon Cricket Club *(22°18'20" 114°10'24")*	9.9m	2	4	0.38
T11	Club de Recreio *(22°18'27" 114°10'35")*	10.8m	3	4	**0.49**
T12	Koon Chung King George V Memorial Park				

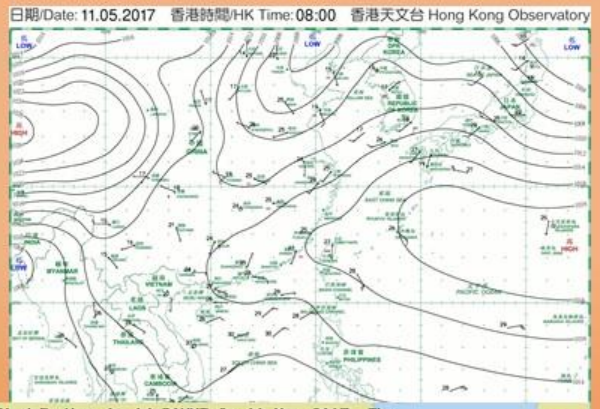
Microclimate study by HKO in 2017-2018

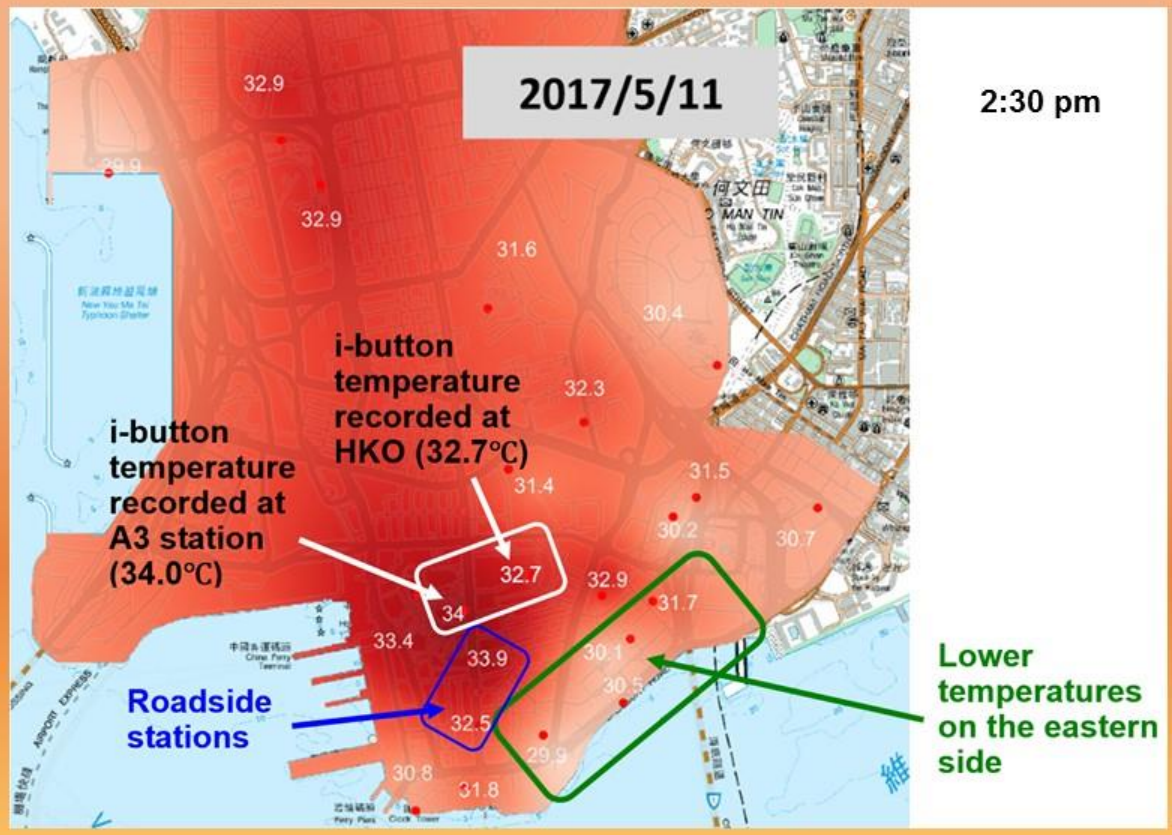
Site Characterization

Station Code	Site Name (latitude and longitude of temperature station)	Altitude	WMO Site Classification		Sky View Factor (SVF)
			Heat Source	Projected Shade	
T13	Junction Road *(22°18'41" 114°09' 54")*	5.7m	3	2	**0.58**
T14	Gascoigne Road *(22°18'31" 114°10'17")*	8.6m	4	5	0.32
T15	Cherry Street Park *(22°18'58" 114°09'57")*	7.2m	3	4	0.48
T16	Cherry Street Park North *(22°19'05" 114°09'50")*	6.1m	3	4	0.39
T17	Olympic Hoi Fai Road Promenade *(22°19'00" 114°09'26")*	5.9m	2	2	**0.56**
T18	Mong Kok East Station *(22°19'16" 114°10'19")*	14.2m	5	5	0.39
T19	Hung Hom Promenade *(22°17'59" 114°11'11")*	5.9m	2	4	**0.63**
T20	Hung Hom Pier Promenade *(22°18'02" 114°11'19")*	5.7m	3	4	**0.51**
T21	Hong Tat Path Garden *(22°18'03" 114°10'45")*	7.3m	4	5	0.23
T22	Podium of Polytechnic University*(22°18'17" 114°10'51")*	14.6m	5	5	0.47
T23	Lawn Polytechnic University *(22°18'14" 114°10'48")*	6.0m	4	5	0.17
T24	Tai Wan Shan *(22°18'20" 114°11'35")*	5.3m	4	4	**0.56**
T25	Hung Lai Road *(22°18'15" 114°11'09")*	5.2m	5	5	0.27
T26	Ho Man Tin East Service Reservoir *(22°18'44" 114°10'57")*	70.9m	2	4	**0.60**
T27	Fat Kwong Street Garden No.1*(22°18'35" 114°11'07")*	20.1m	2	3	0.35
T28	Ho Man Tin High Level Service Reservoir Playground *(22°18'35"*	75.9m	1	2	**0.77**

Microclimate study by HKO in 2017-2018

Scenario 1 – Easterly and westerly wind regimes





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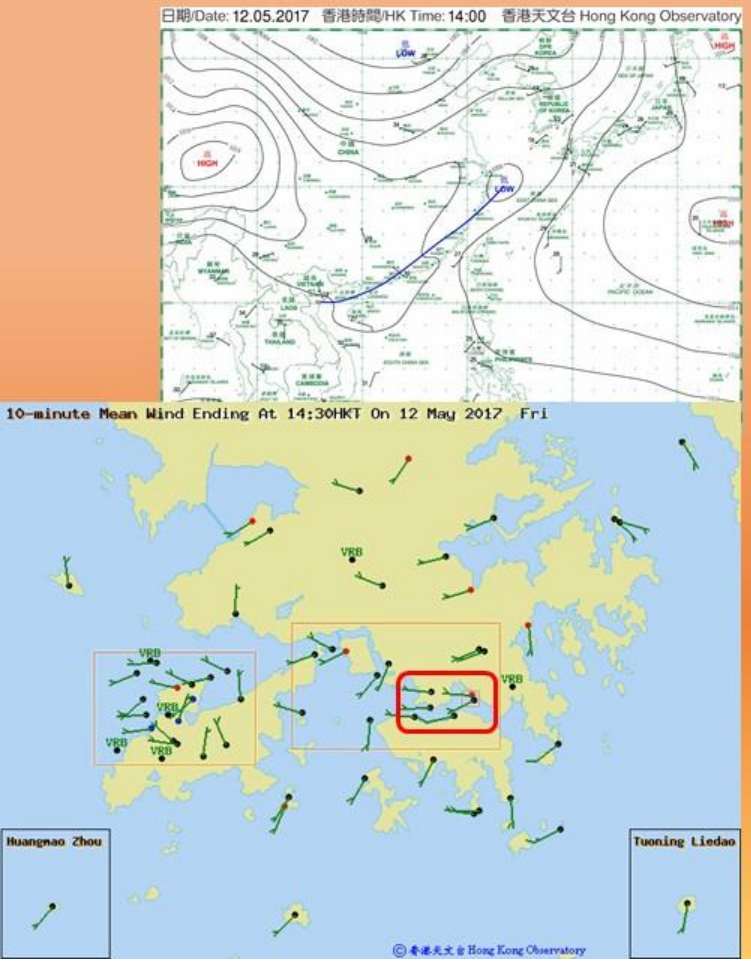
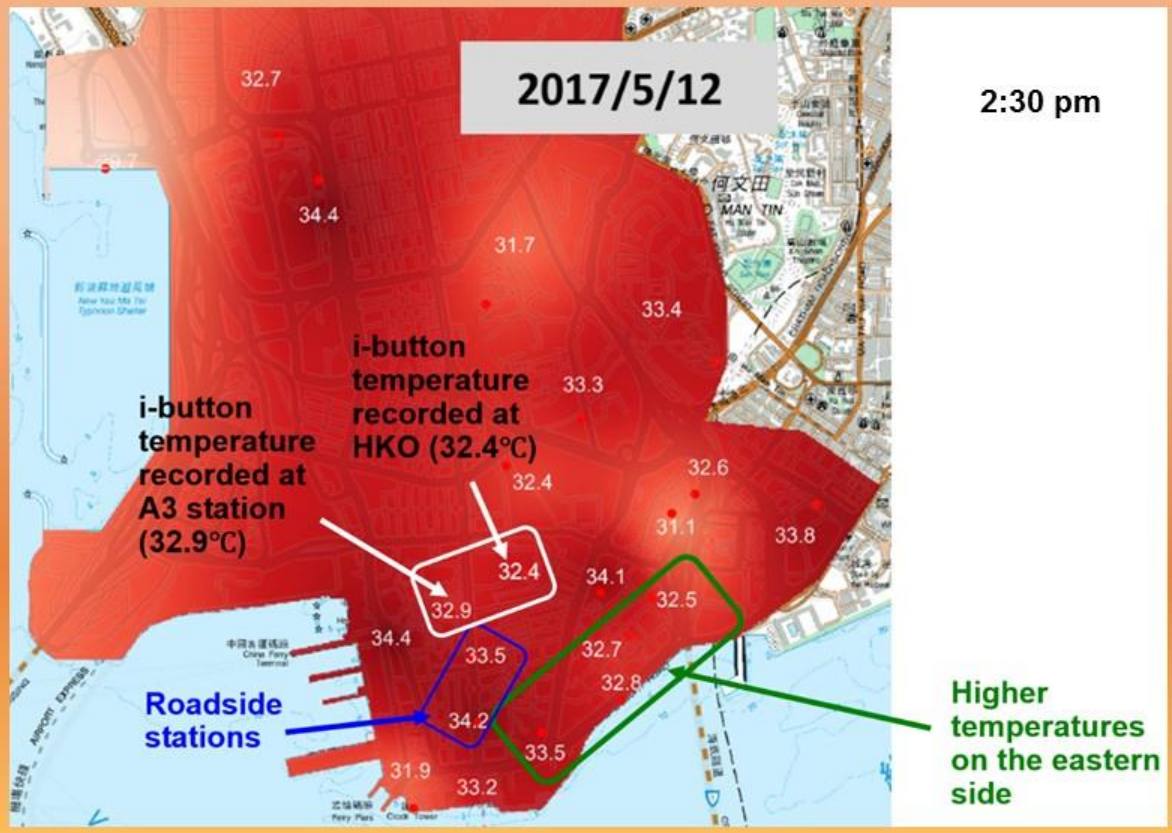
Microclimate study by HKO in 2017-2018

Scenario 1 – Easterly and westerly wind regimes





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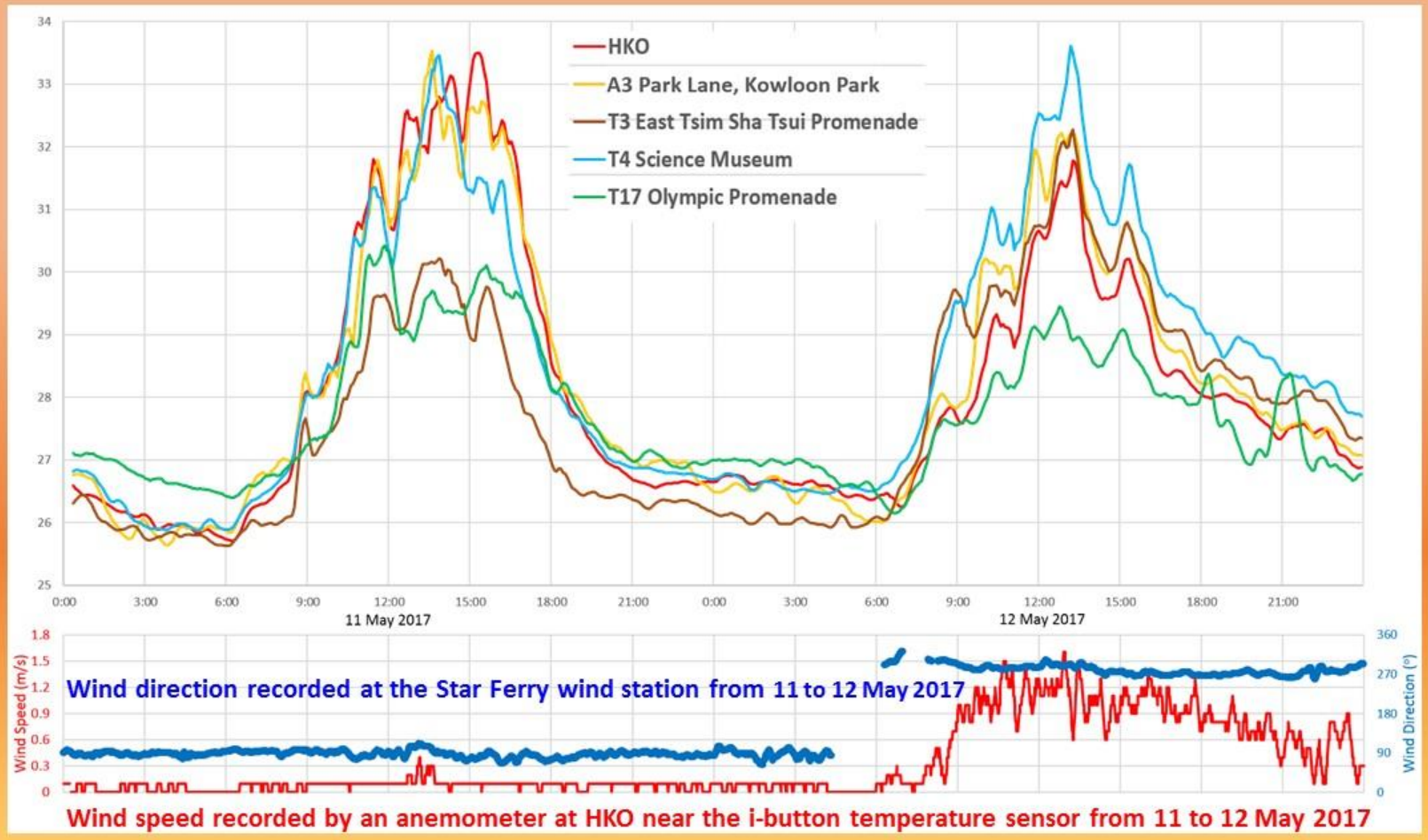
Microclimate study by HKO in 2017-2018

Scenario 1 – Easterly and westerly wind regimes



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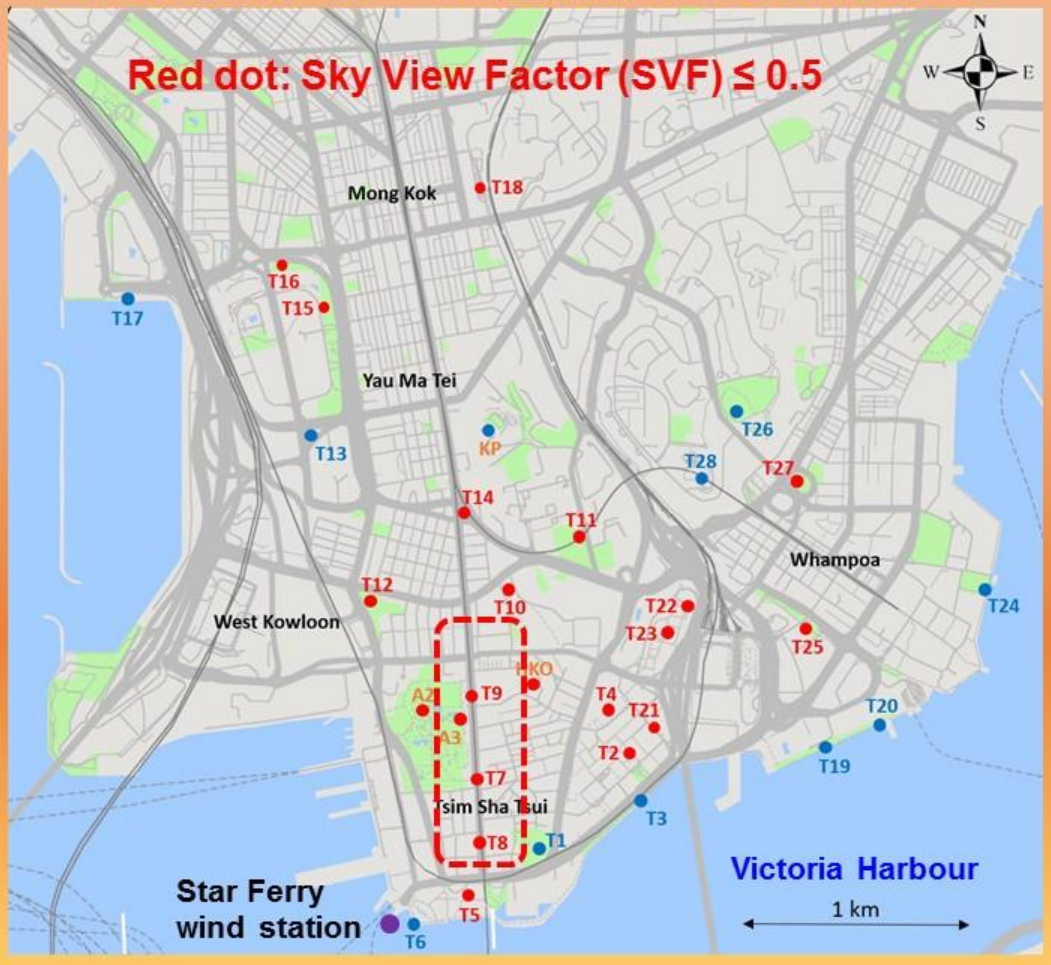
Microclimate study by HKO in 2017-2018

Scenario 1 – Easterly and westerly wind regimes

Microclimate study by HKO in 2017-2018

Scenario 2 – Roadside stations



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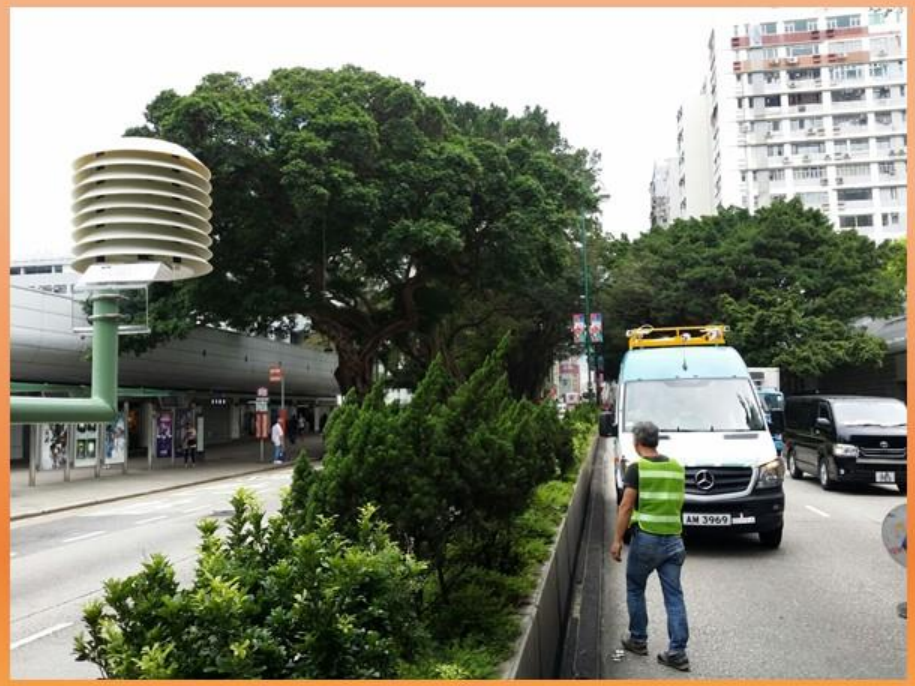
Microclimate study by HKO in 2017-2018

Measuring Sites (Roadside)



Nathan Road near Park Lane (T9)

Microclimate study by HKO in 2017-2018

Measuring Sites (Roadside)

Nathan Road near Kowloon Mosque (T7)

Microclimate study by HKO in 2017-2018

Measuring Sites (Roadside)

Nathan Road near Chungking Mansions (T8)

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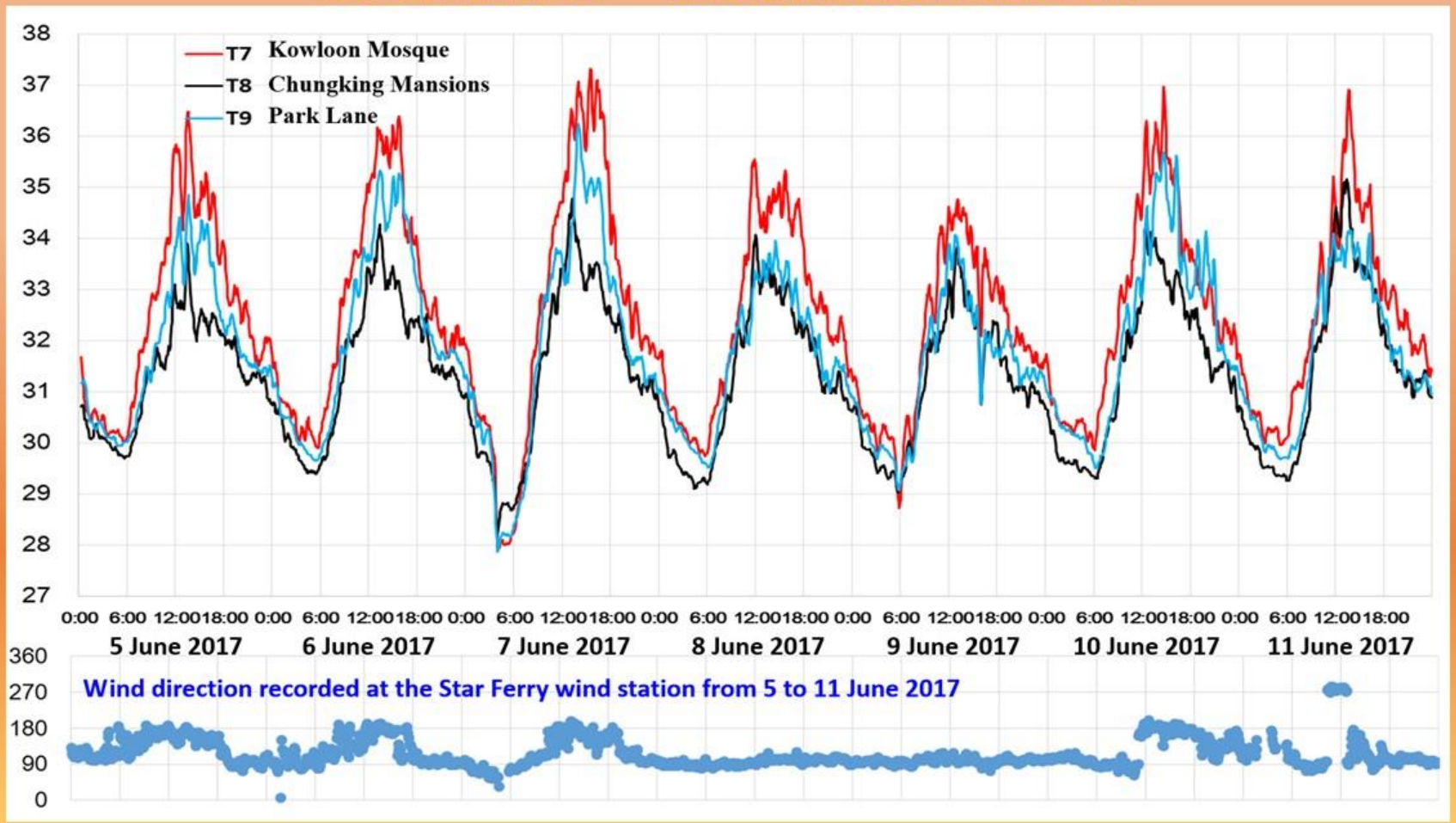
Microclimate study by HKO in 2017-2018

Scenario 2 – Roadside stations

Microclimate study by HKO in 2017-2018

Scenario 2 – Roadside stations



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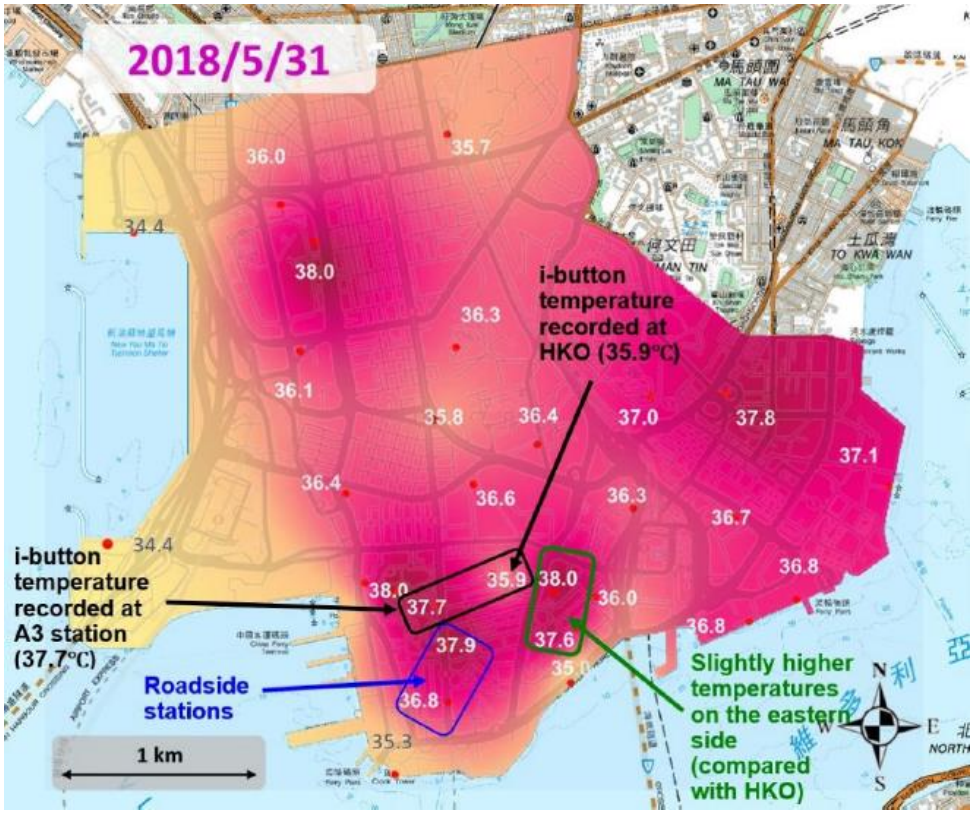

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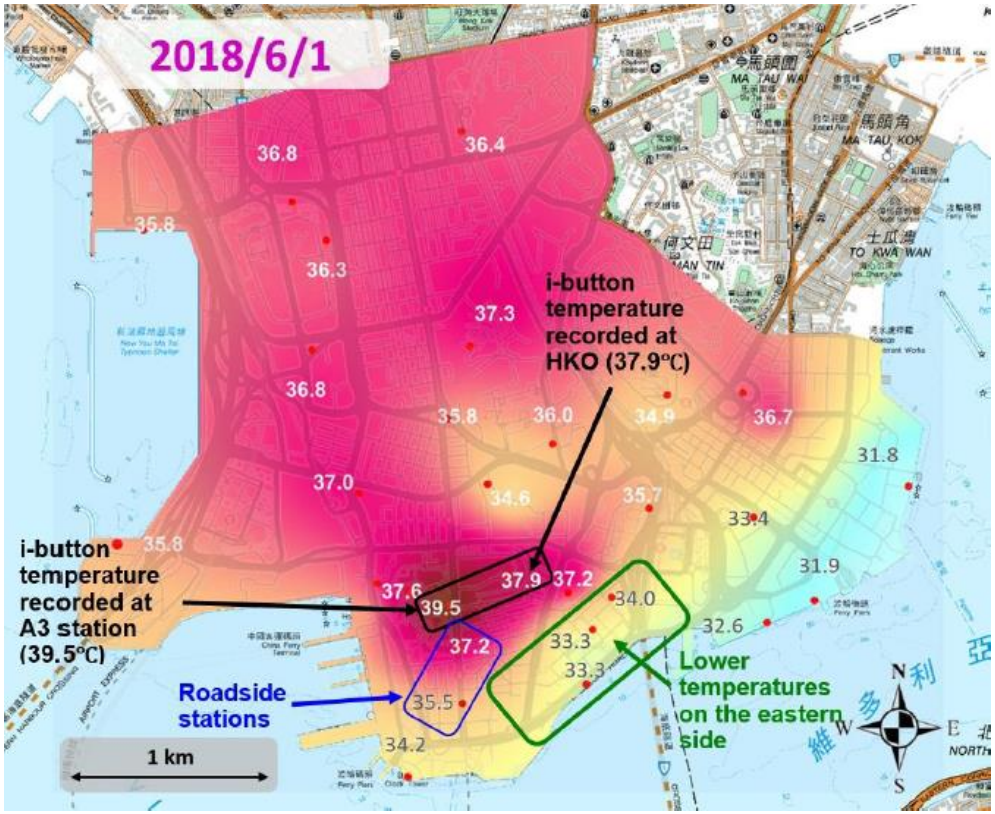

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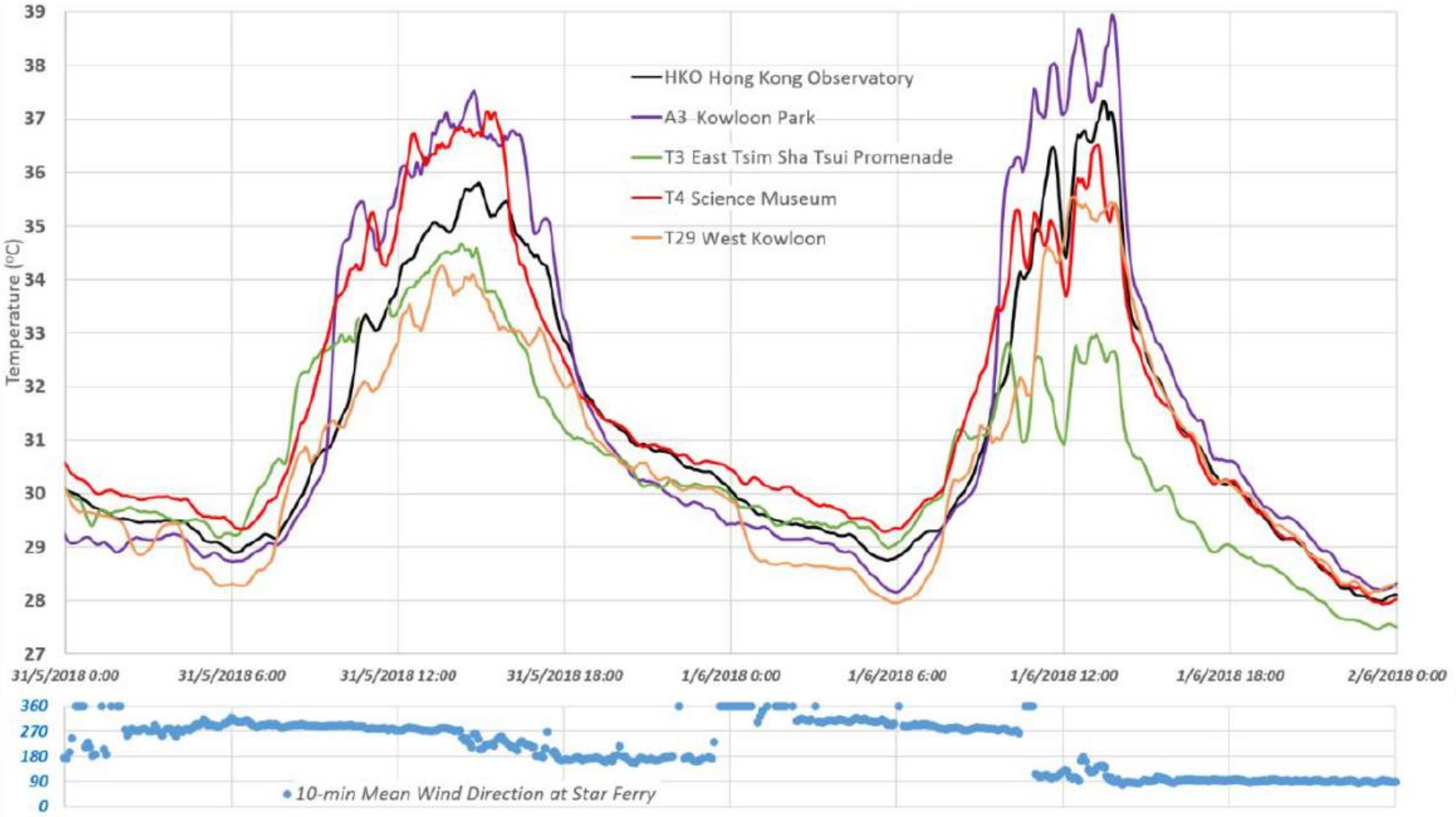

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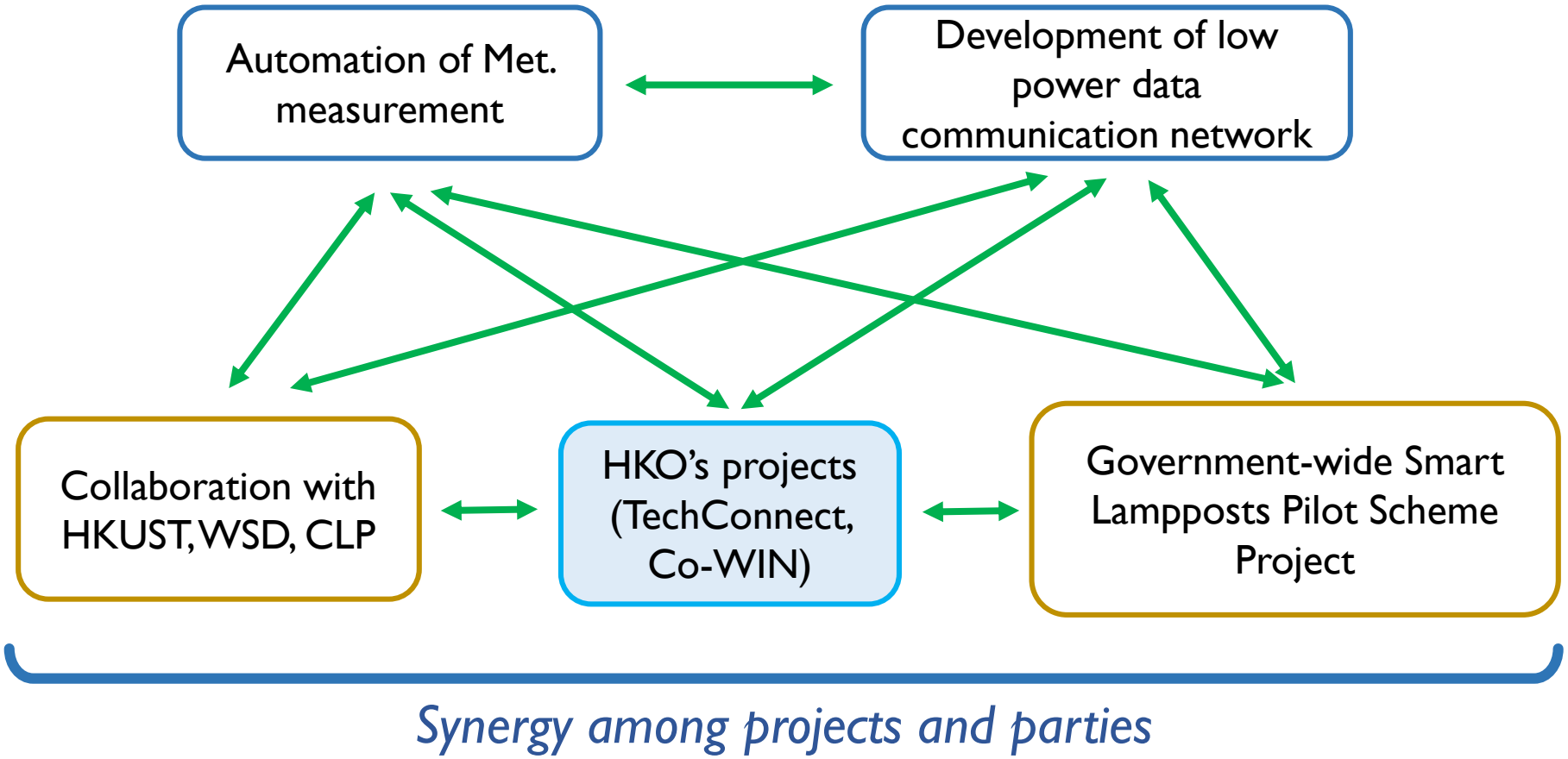
Ways forward



TechConnect Project
Integrated urban weather monitoring and data-sharing platform for smart cities
(智慧城市綜合天氣監測及數據分享平台)

A pilot project to develop a real-time urban weather monitoring system and data sharing platform suitable for the climate and high density urban environment of Hong Kong, leveraging on the emerging IoT technologies and stakeholder partnership.

Project period : April 2018 - Mar 2021

Innovation and Technology Bureau approved funding support
(including hardware, software and manpower)

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TechConnect Project
Integrated urban weather monitoring and data-sharing platform for smart cities
(智慧城市綜合天氣監測及數據分享平台)

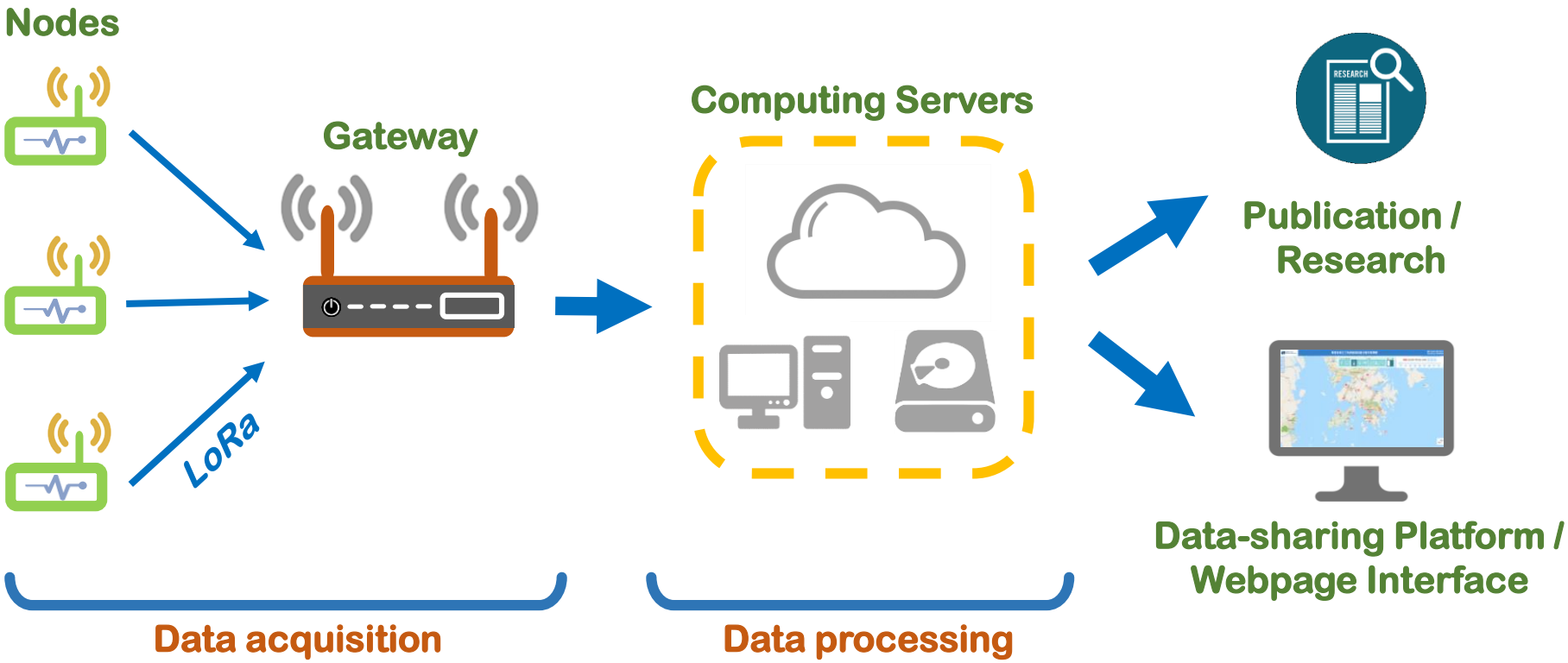
Targets:

1. A network of more than 20 Automatic Weather Monitoring Stations (AWMS) in target areas and venues providing reliable street level weather and related observations on a real time basis.

2. A user-friendly data-sharing platform facilitating reliable processing, archival, retrieval and sharing of data in popular open data format from the AWMS network as well as consolidated forecast data from computer models.

3. Development of urban scale forecasts and impact-based warnings.

TechConnect Project Framework



LoRa – Long Range, Low Power, wireless telecommunications system

Brief Description of the Pilot Project

Development of new compact sensors and network :

- Develop miniature and low power sensors for urban weather monitoring
- Enhance existing Co-WIN stations with new types of sensors to support the project
- Establish a network of new compact and mobile sensors in target test areas (e.g. Yau Tsim Mong District) and venues offered by collaborators for this project.

Development and implementation of data-sharing and research platform :

- Develop a data-sharing platform in support of Big Data analytics and smart city as well as research and development for other weather/climate-sensitive operations, applications and services
- Integrate the collected data with forecast data from computer weather models and other related forecasting systems to facilitate the development of urban scale personalized automatic weather forecast and multi-hazard impact-based forecasts and warnings for the city.

Planned Equipment for AWMS

AWMS Equipment

Full suite

All-in-one weather sensor

Measure: Temperature (T)
Relative humidity (RH)
Pressure (P)
Wind speed and direction (v_s, v_d)
Solar radiation (W/m^2)
Rainfall (mm/h)

Basic suite

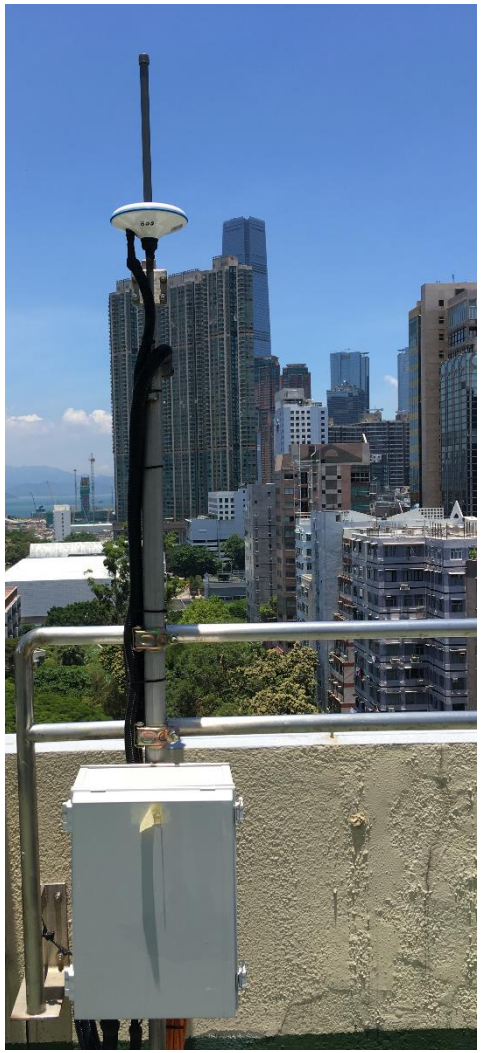
Self-developed weather sensor

Measure: Temperature (T)
Relative humidity (RH)
Pressure (P)

Selected location

UV sensor

Measure: Ultra-violet index (UV)



LoRa gateway station

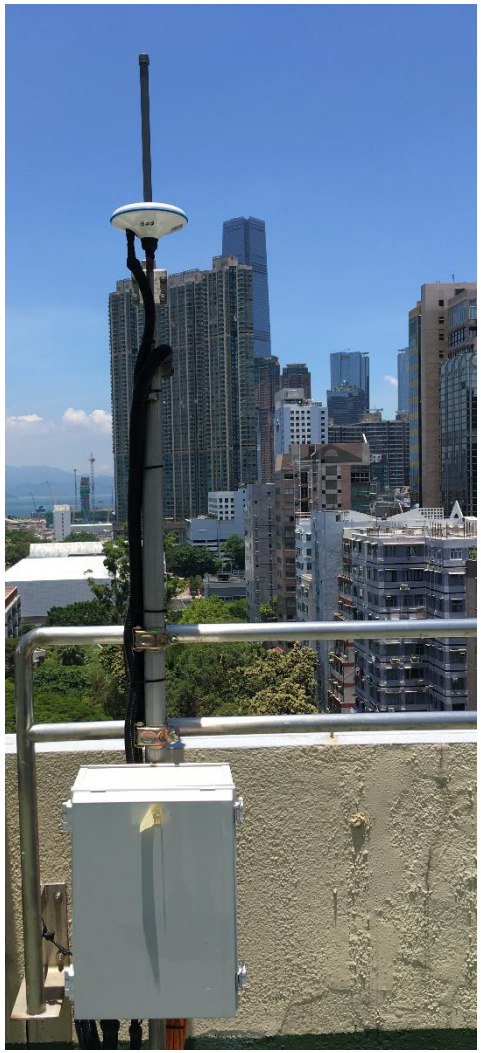
Planned Equipment for AWMS

Basic suite

Self-developed weather sensor

Measure: Temperature (T)
Relative humidity (RH)
Pressure (P)

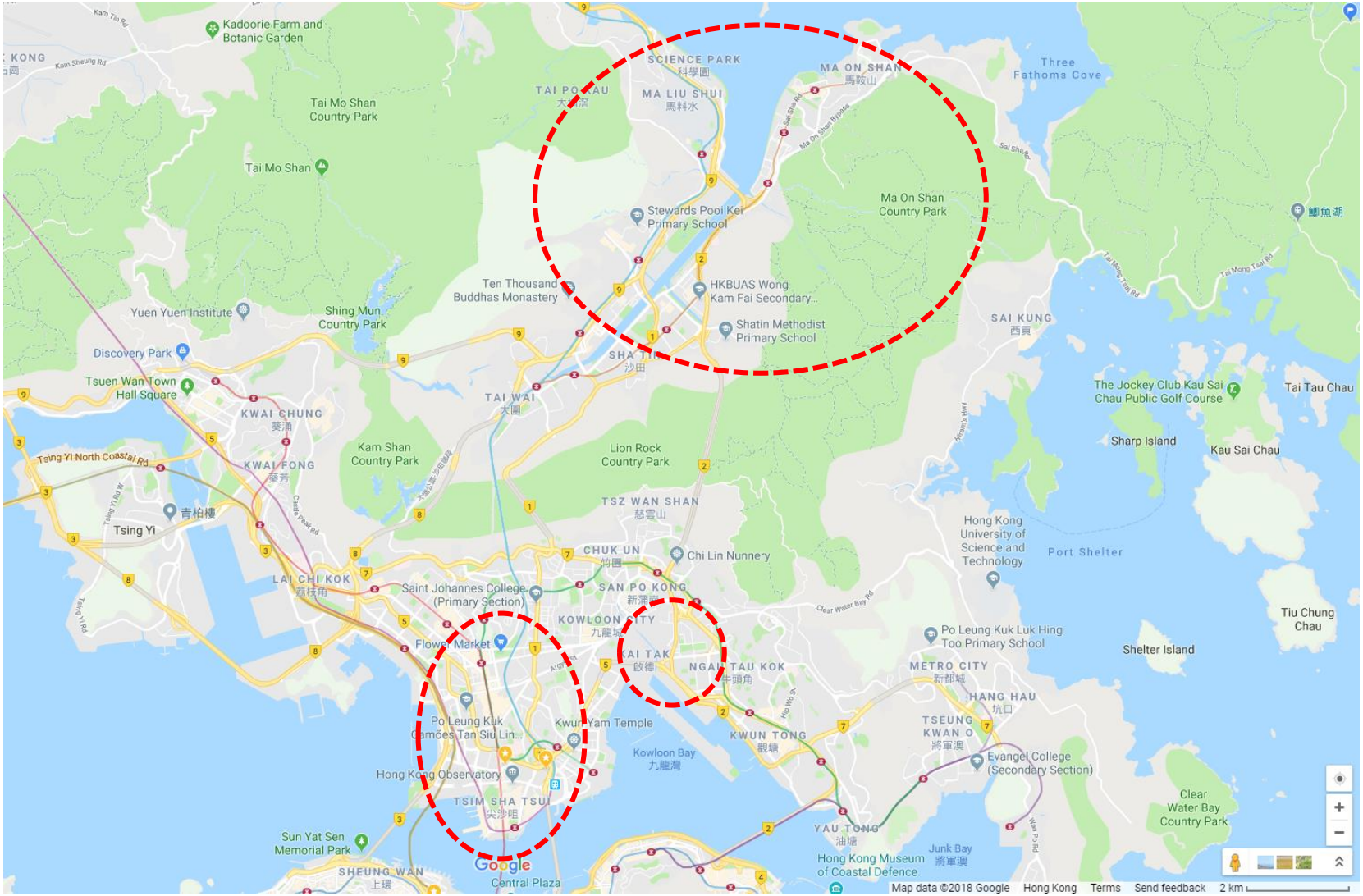
Planned to equip with UV sensor and solar PV



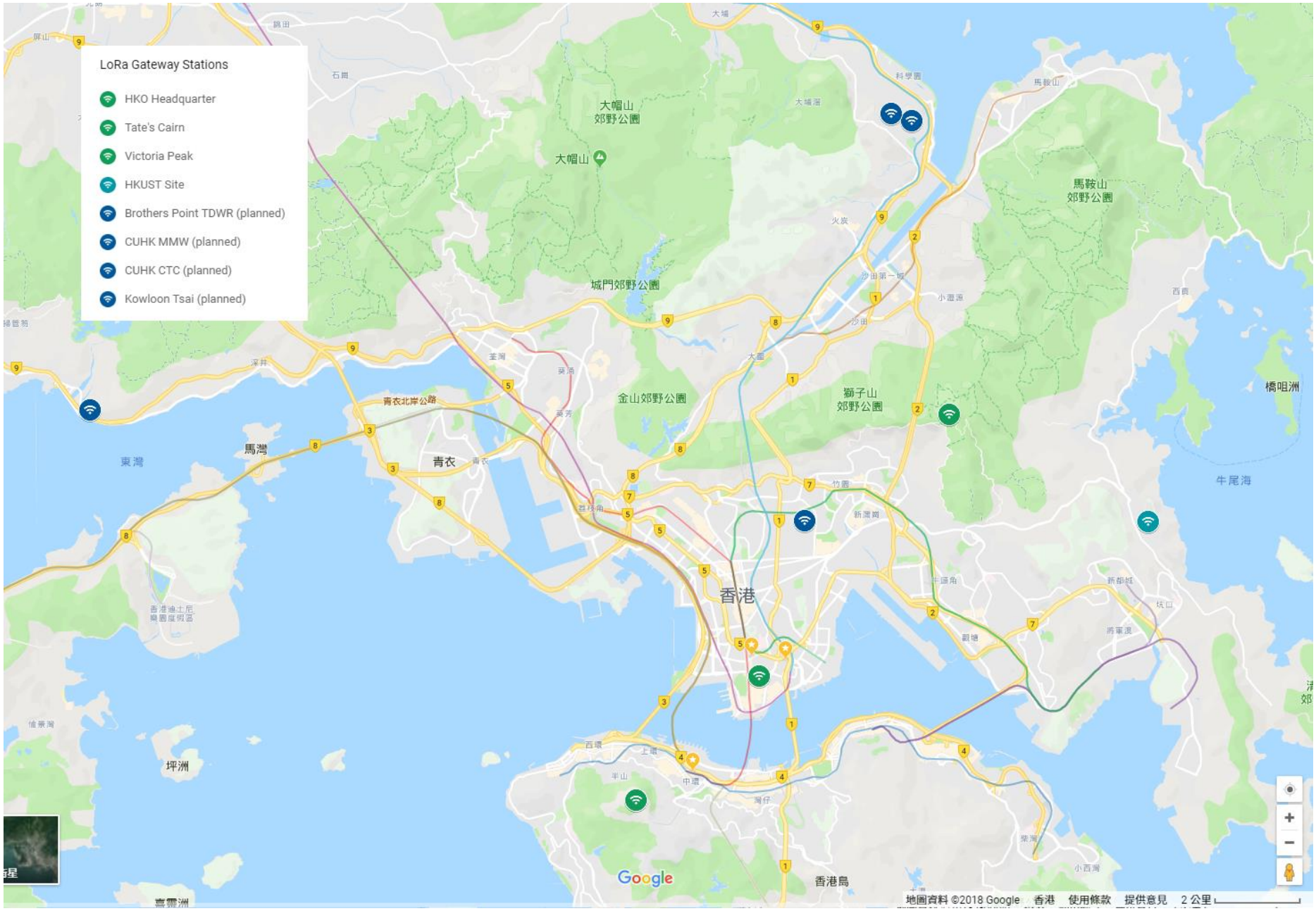
LoRa gateway station

Planned sites for Automatic Weather Monitoring Stations (AWMS)

Area	Kowloon Peninsula	Kowloon East	Shatin
No. of sites	10 +	4 +	6 +



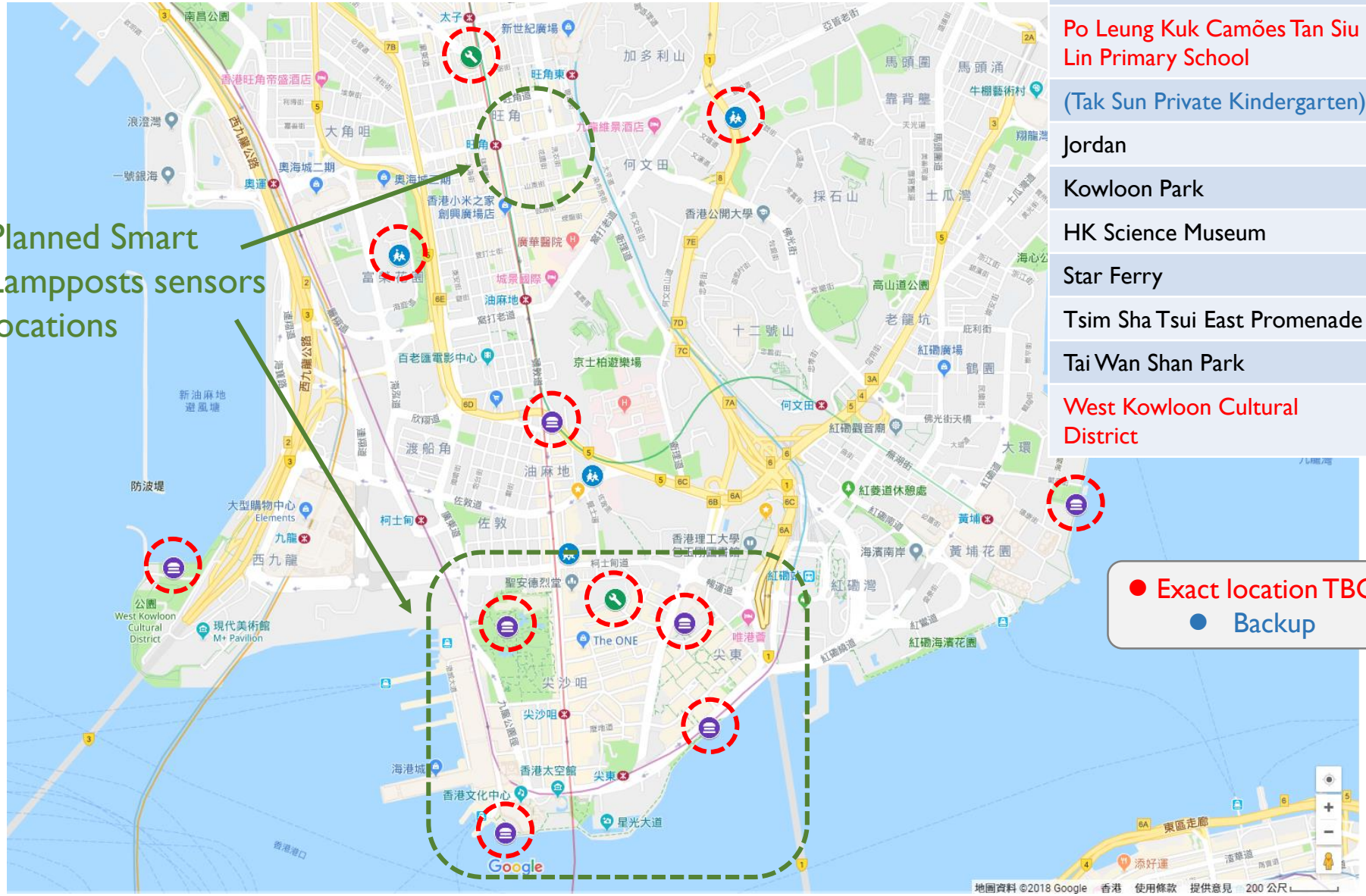
Planned LoRa gateway stations



Planned sites for AWMS

Area 1: Kowloon Peninsula

Planned Smart Lampposts sensors locations



HKO Headquarter
Mong Kok
Hop Yat Church School
Po Leung Kuk Camões Tan Siu Lin Primary School
(Tak Sun Private Kindergarten)
Jordan
Kowloon Park
HK Science Museum
Star Ferry
Tsim Sha Tsui East Promenade
Tai Wan Shan Park
West Kowloon Cultural District

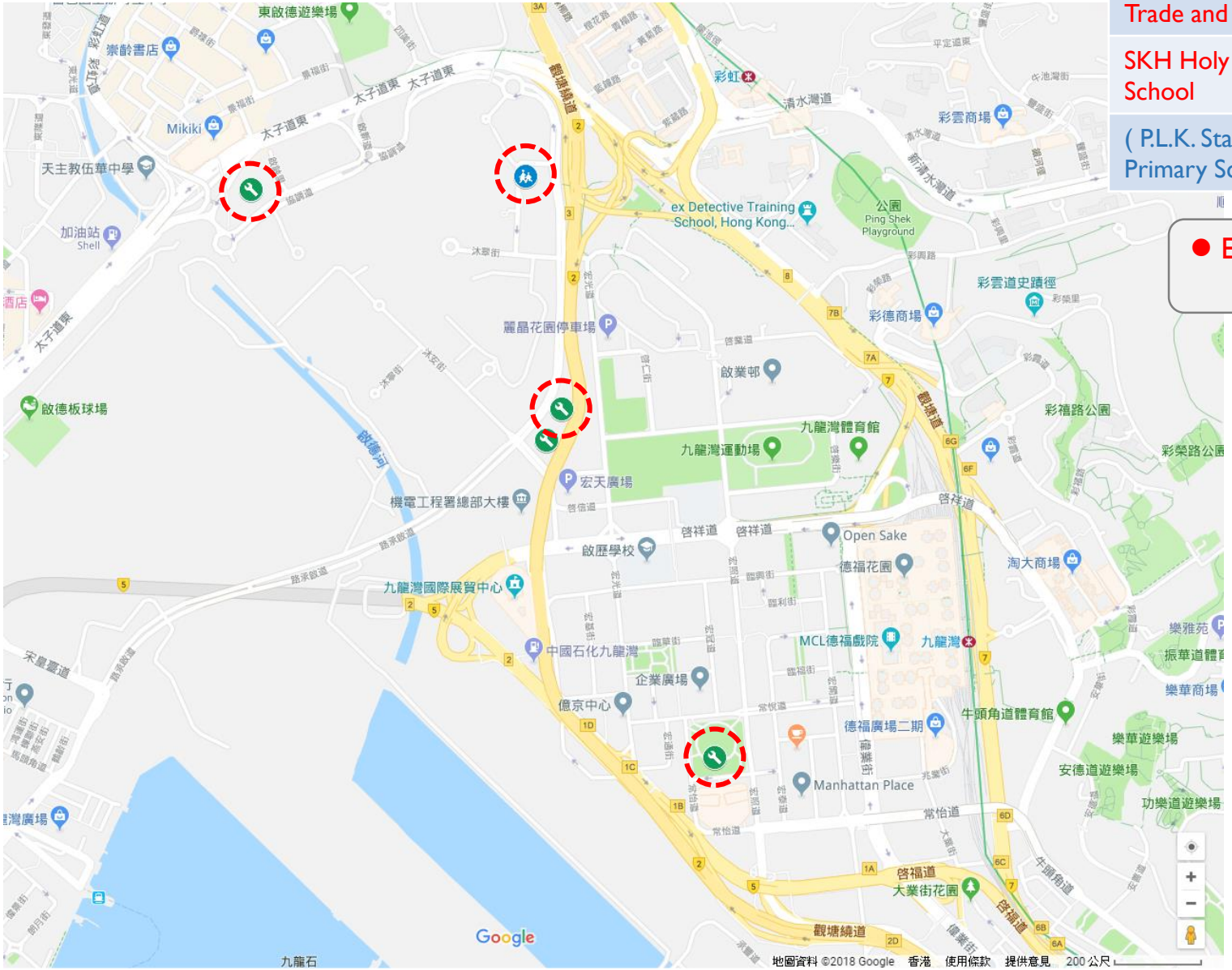
● Exact location TBC
● Backup

Planned sites for AWMS

Area 2: Kowloon East

- Zero Carbon Building
- Kai Tak District Cooling System
- Trade and Industry Tower
- SKH Holy Cross Primary School
- (P.L.K. Stanley Ho Sau Nan Primary School)

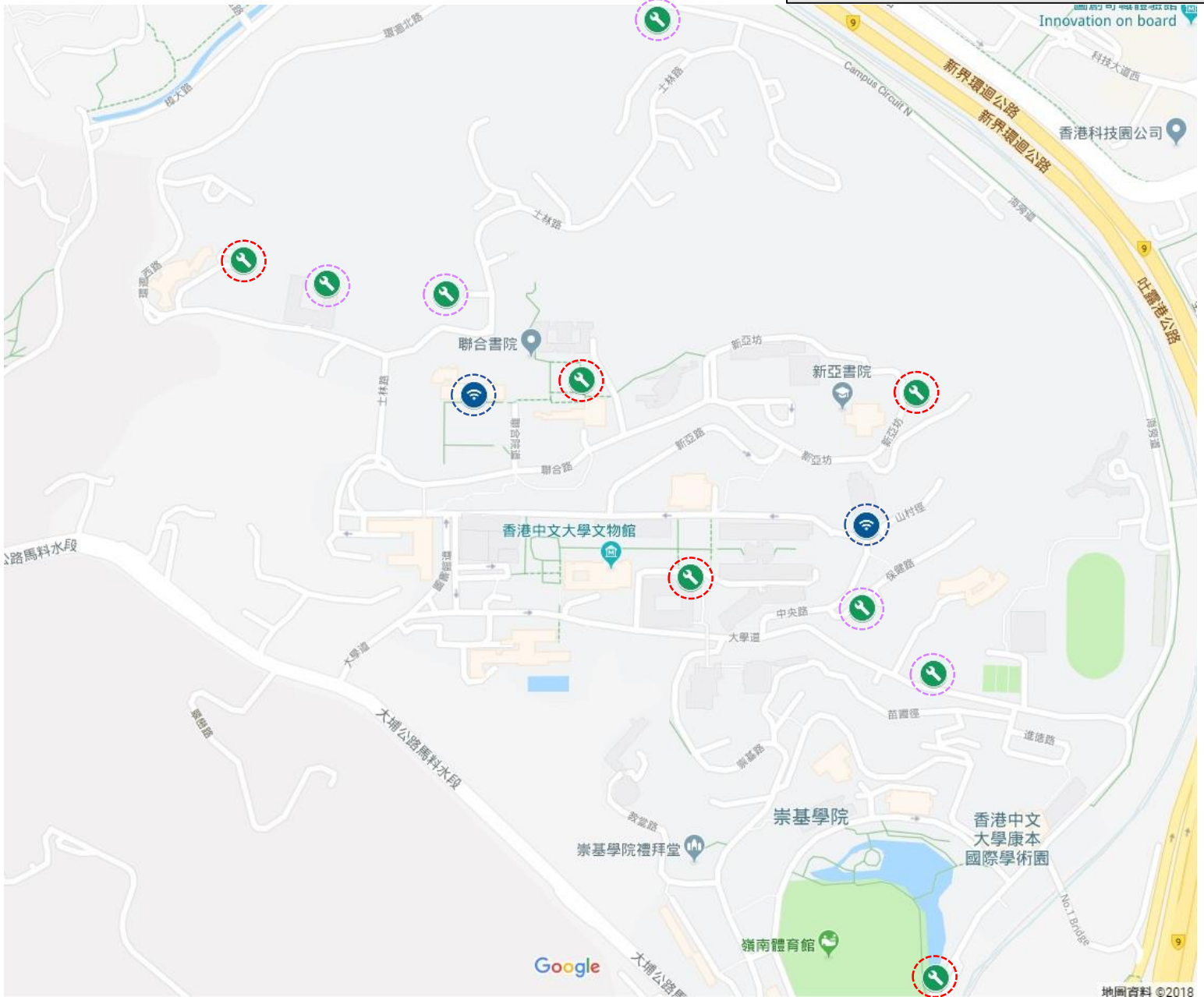
● Exact location TBC
● Backup



Planned Sites for AWMS and gateway stations

The Chinese University of Hong Kong

● Phase 1 ● Phase 2
● Gateway Station



Planned sites for AWMS

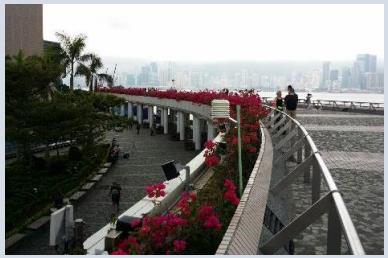
Area 3: Shatin (cont.)

P.L.K. Wu Chung College	Full
(TBC)	Basic

- Exact location TBC
- Backup

Integrated Urban-scale Weather Observation and Forecasting System

Collaborators



iButton

Co-WIN

AWMS sites

- Full suite
- Basic suite

LoRaWAN

LoRa
encrypted data stream

AWMS 1

AWMS 2

AWMS *n*

Gateway station 1

Gateway station 2

Gateway station *n*

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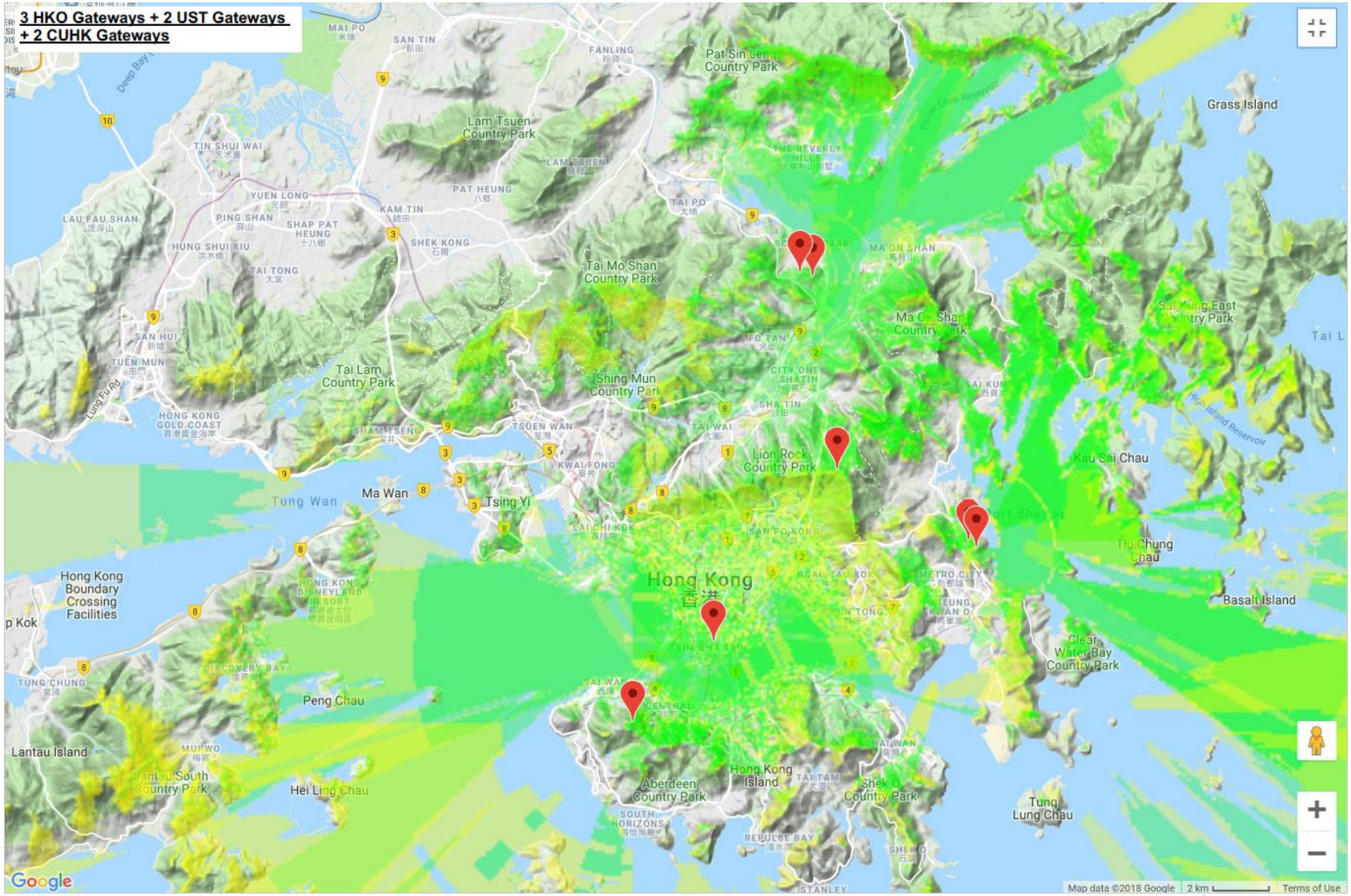
Extending the LoRaWAN



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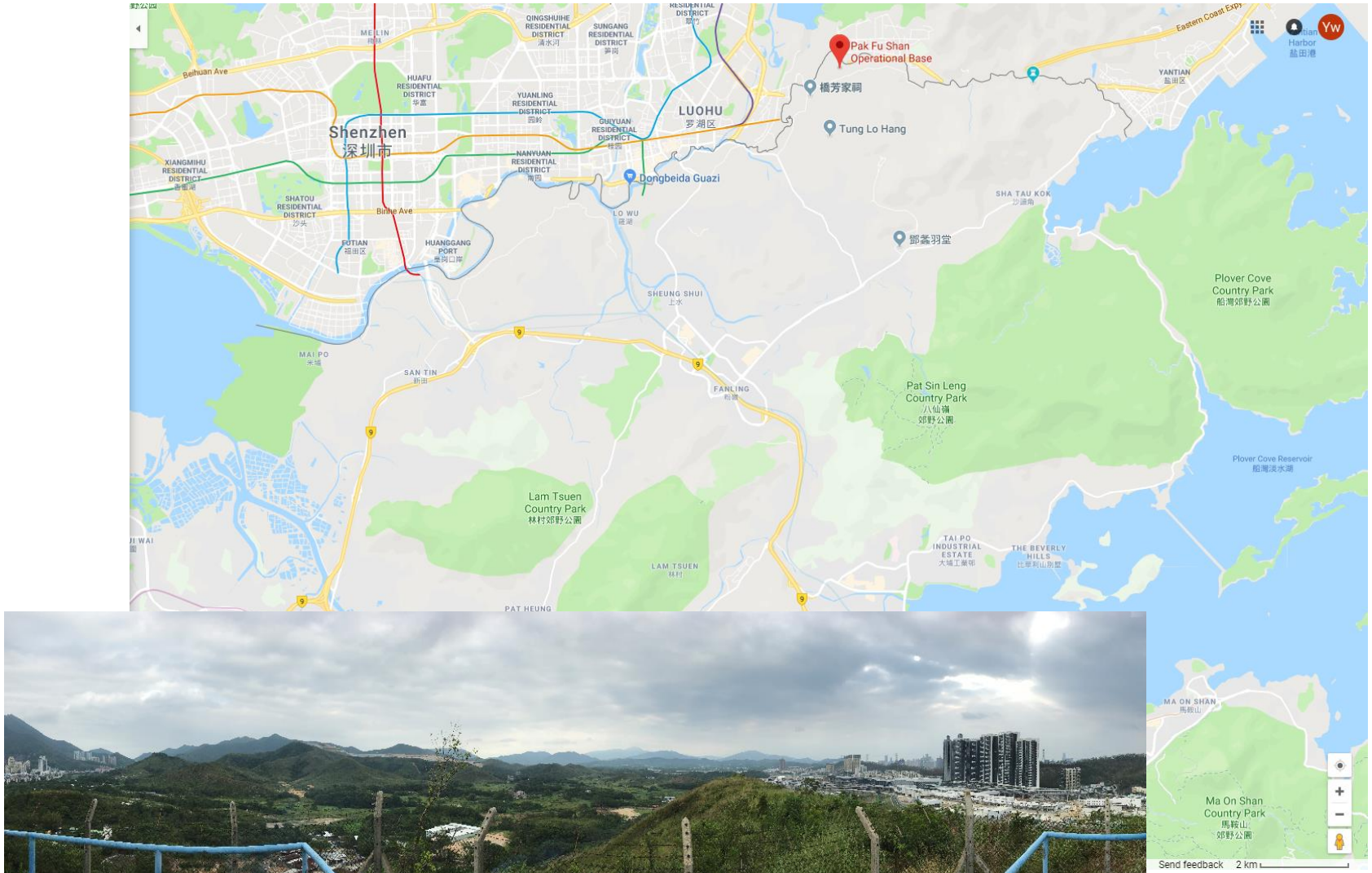
Extending the LoRaWAN

Collaboration with Water Supplies Department (WSD) and China Light and Power (CLP)



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Thank you