Application of GIS and Big Data to Assess Typhoon Impacts

TECO

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HONG KONG OBSERVATORY

Introduction

- Weather forecasts told us how the weather might change and prompt us to prepare for potential problems associated with weather changes.
- However, there were still cases where the weather forecasts, particularly for significant weather changes, were accurate but the general public might not fully prepare for the impacts brought by weather changes.
- We needed to confirm the relationship between weather and its impacts.

Figure was quoted from the apple daily.

- Weather related impacts include:

Fallen tree

Flooding

Vessels stranded due to severe weather

Figures were quoted from HKO.

Non-meteorological data that HKO received

Transport Department:
Transportation data

Information Services Department:
Flooding, fallen trees, etc…

HKO

Figures were quoted from HKO and Community Weather Information Network.

Current challenges

- How to mine the useful information hidden under the massive heap of data?
- How to analysis these materials with meteorological data in order to better understand the information?

Automatic process

Reports were received in textual format

Data

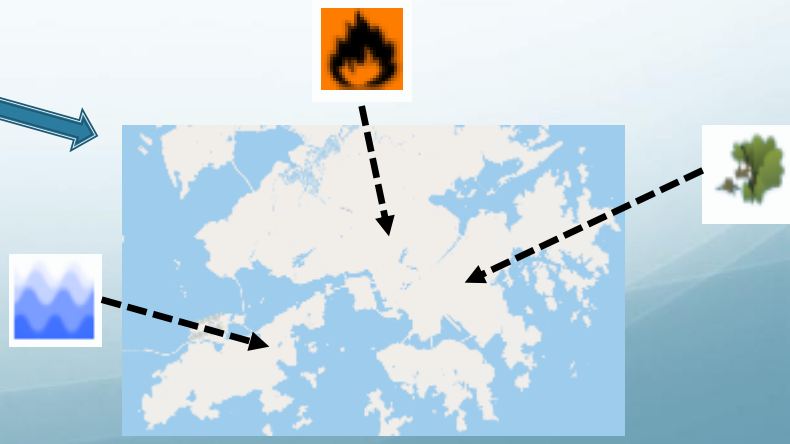
1. Filtering

Weather related reports

2. Geo-coding the location of reports

Oracle database

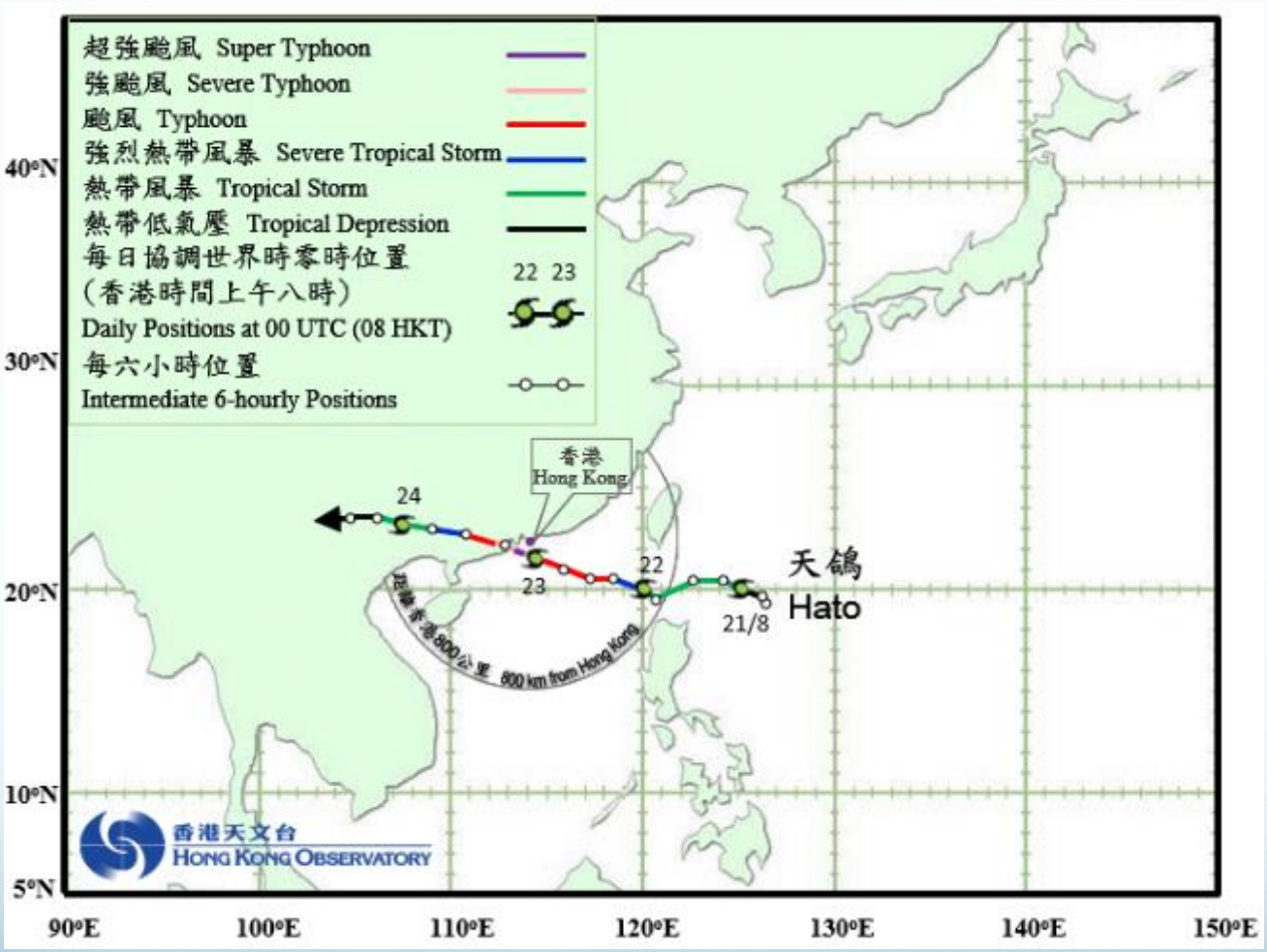
3. Projected on the GIS platform



Cases studies：

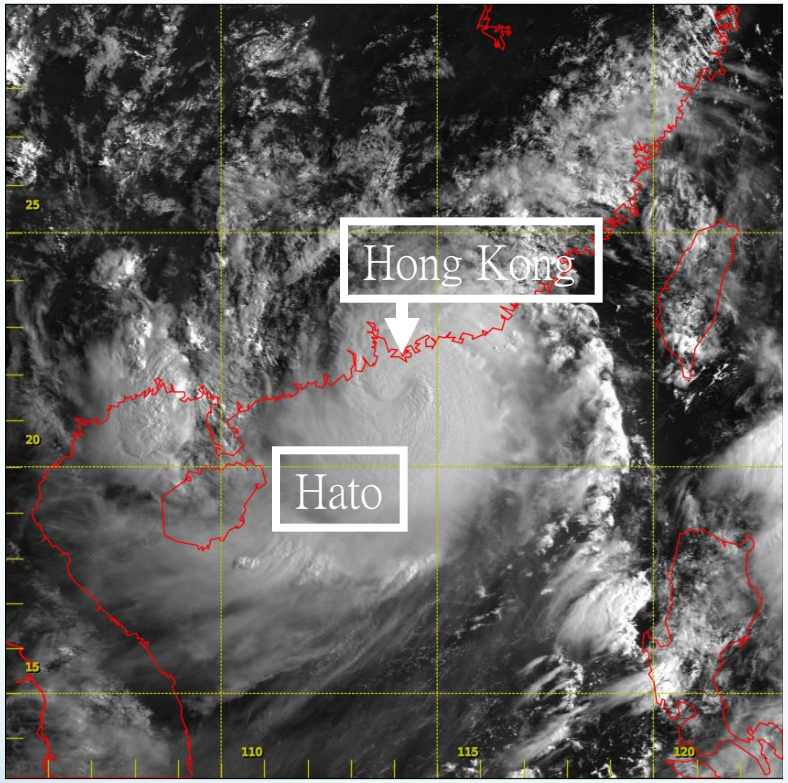
- Fallen trees relating to tropical cyclone
- Flooding due to storm surge

Case study 1: Impact due to tropical cyclone Fallen trees on 23 August 2017

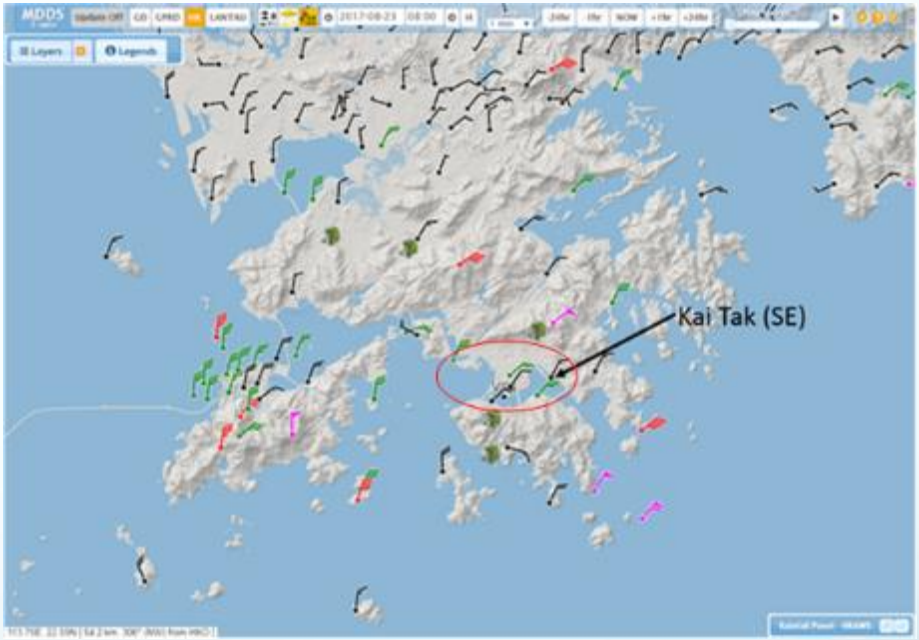


Provisional track of Hato: 20-24 August 2017

Wind data overlapping with fallen tree reports

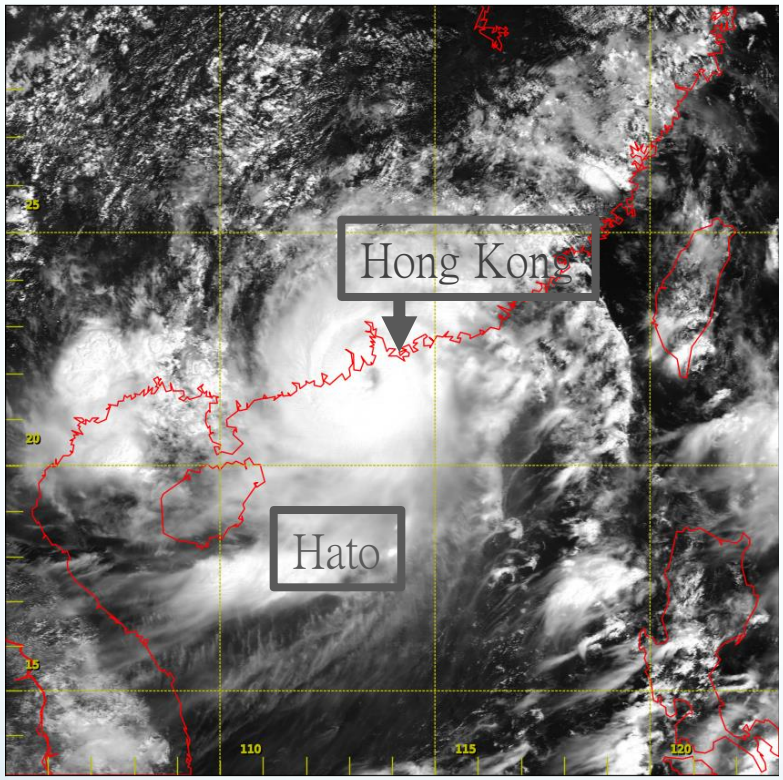


Visible satellite imagery at 8 HKT on 23 August 2017

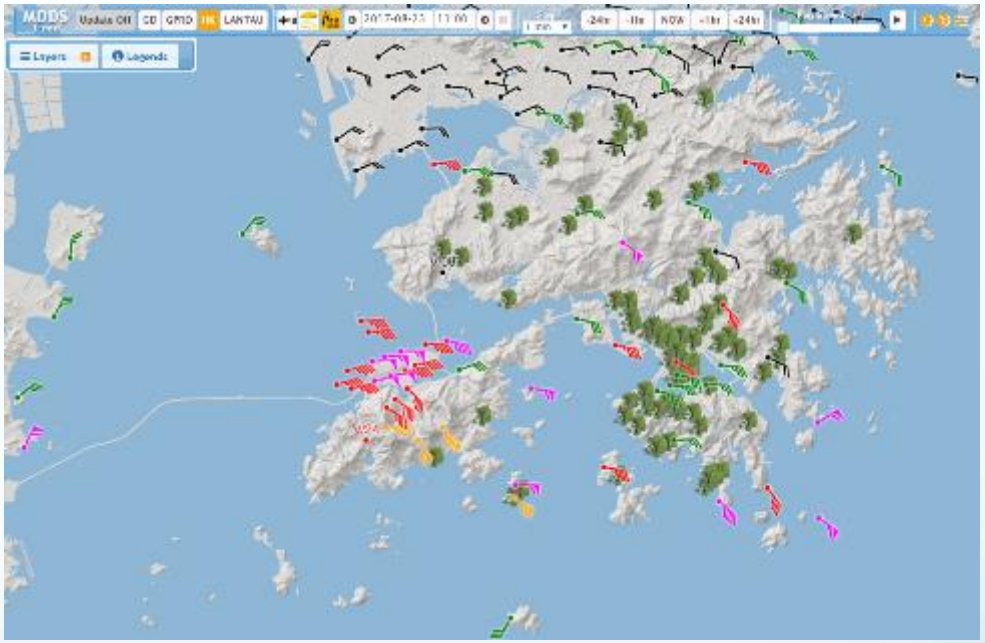


There were only 5 fallen tree reports until 8 HKT on 23 August 2017.

Wind data overlapping with fallen tree reports

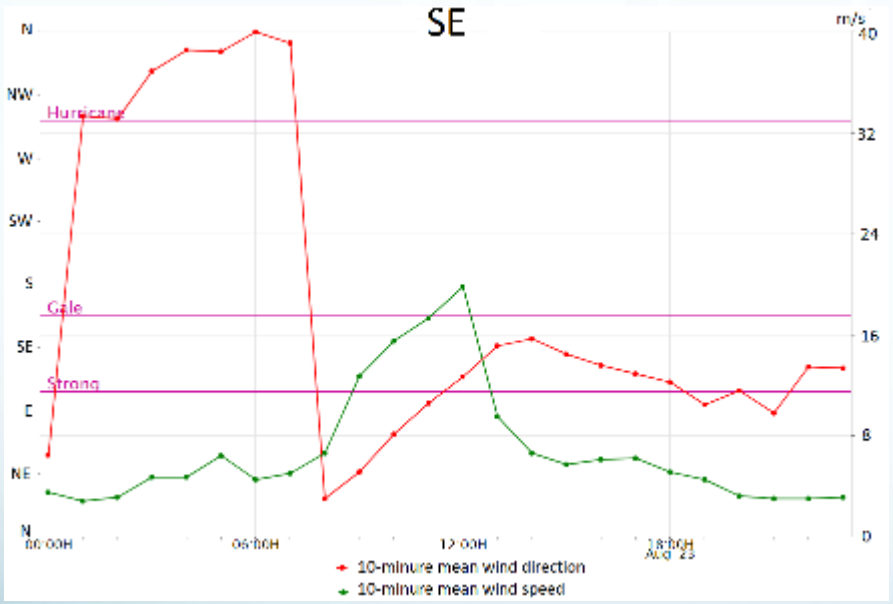


Visible satellite imagery at 11 HKT on 23 August 2017



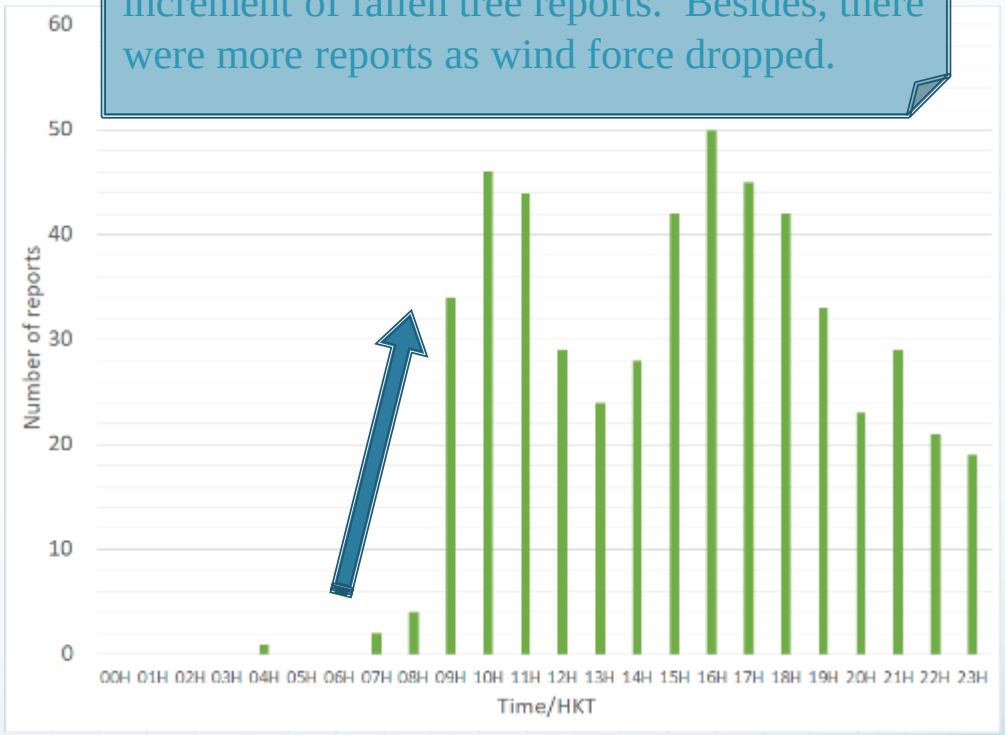
There were 131 fallen tree reports until 11 HKT on 23 August 2017.

Time-series of wind at Kai Tak and fallen tree reports



Time series of wind at Kai Tak on 23 August 2017

When prevailing wind direction changed from northeast to southeast, there was a significant increment of fallen tree reports. Besides, there were more reports as wind force dropped.



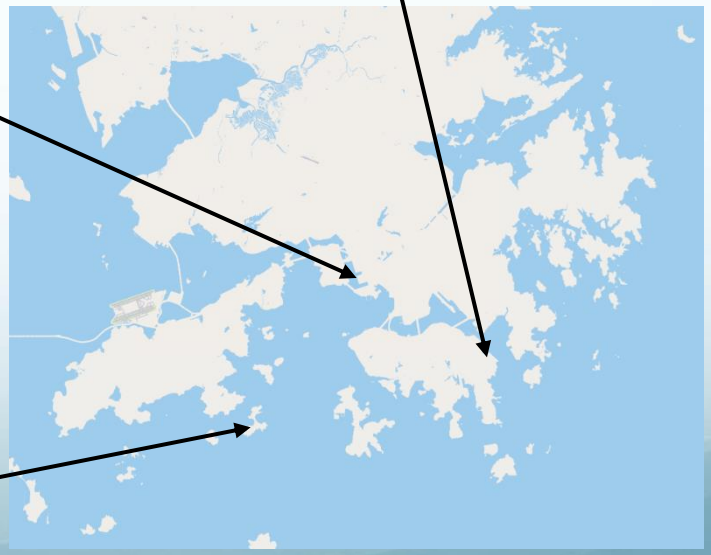
Time series of fallen tree reports on the same day

The passage of Hato resulted in fallen trees in many parts of Hong Kong

Mei Foo

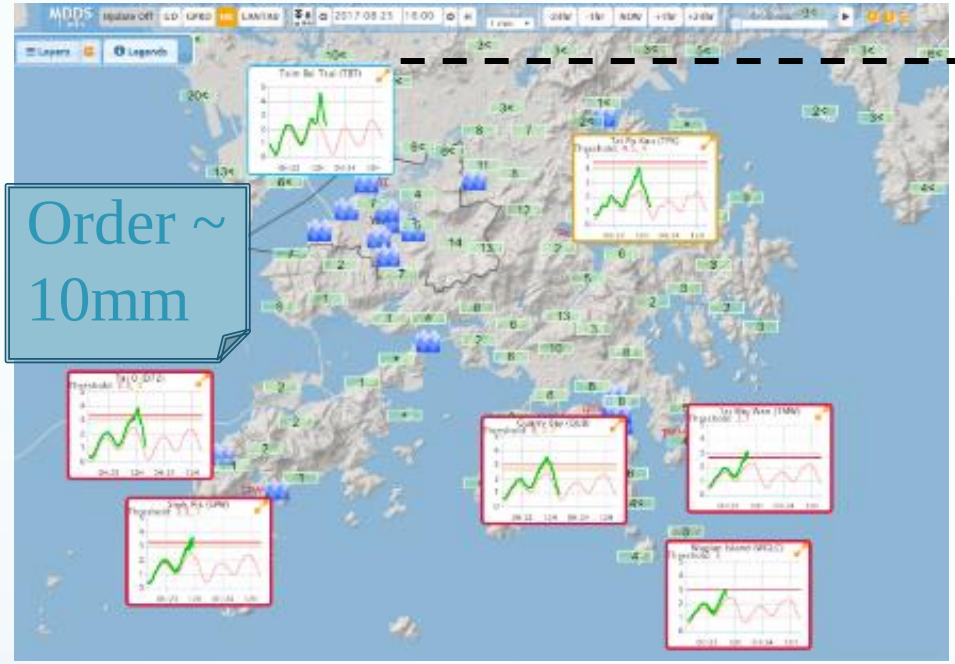
Siu Sai Wan

Cheung Chau



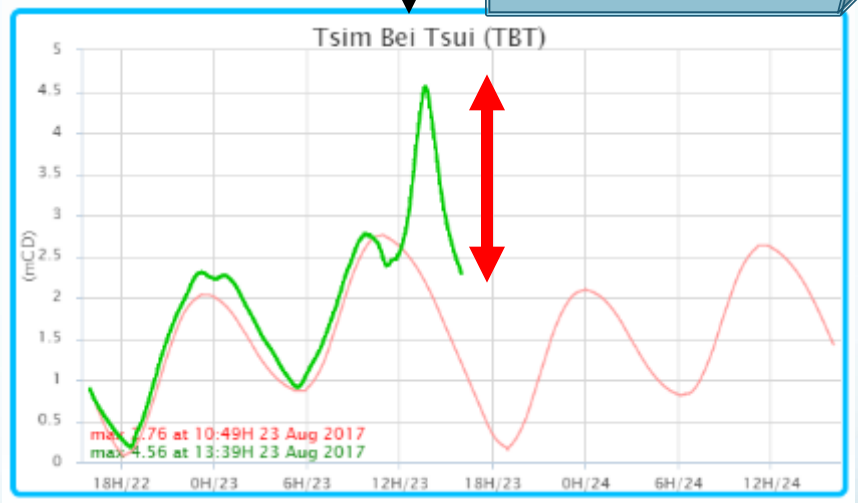
Figures were quoted from HKO and Community Weather Information Network.

Case study 2: Impact of storm surge Flooding on 23 August 2017



Display of 3-hour total rainfall data (integers highlighted in pale green), water-level time series charts and cumulative flooding reports (blue wavy icons) at 16 HKT, 23 August 2017. 8 flooding reports were found in Yuen Long (black enclosed line).

2 meter (Order~1000 mm)



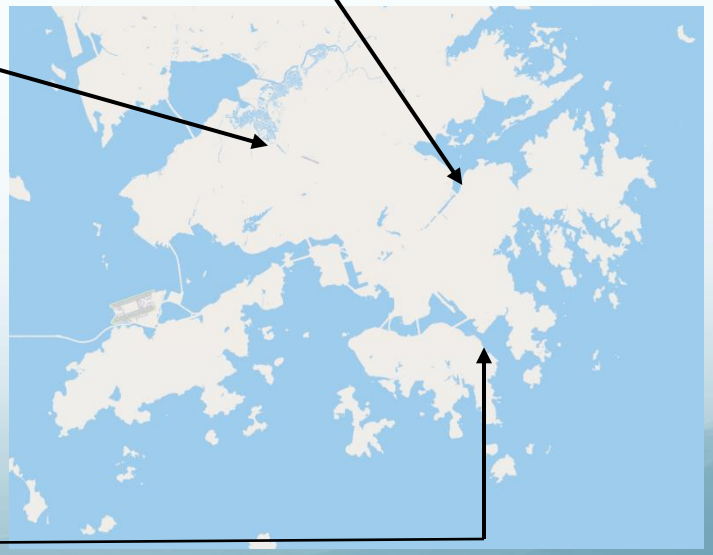
Predicted and measured water level time-series of Tim Bei Tsui. Water level raised by 2 meter.

The passage of Hato resulted in flooding in different parts of Hong Kong

Yuen Long

Coastal area of Tolo Harbour

Heng Fa Chuen



Figures were quoted from HKO and Community Weather Information Network.

Brief summary

- The impacts of weather were important for decision-making and emergency services.
- Cases studies of tropical cyclone, storm surge, monsoon and dry continent airstream were carried. The impacts associating with the corresponding weather were briefly understood. It could be found that the extent of the impacts not only correlated with the weather, but also depended on non-meteorological factors like orography, land use and human activities.
- More studies were needed to build up the relationship among different factors.

Follow up

- Increasing the sources of reports：

The studies employed the reports from Hong Kong Police Force and Fire Services Department. It was possible to overlook reports at rural area.

- We could carry analysis by referring to reports provided from other government departments. Besides, we could make reference to non-official reports such as social media.

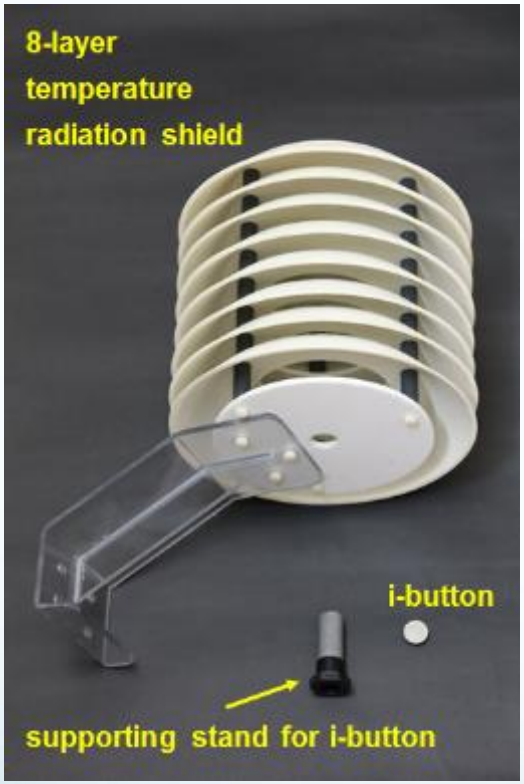
Follow up

- Improving the weather observation network:

Increasing the density of weather observation network.

- HKO and the Department of Applied Physics of the Hong Kong Polytechnic University have established the Community Weather Information Network (Co-WIN) in 2007.
- The Chinese University of Hong Kong joined forces in 2016 to help implement Co-WIN.
- HKO has established in 2017 a dense semi-automatic temperature measurement network of miniature temperature sensors, namely the i-button sensors.

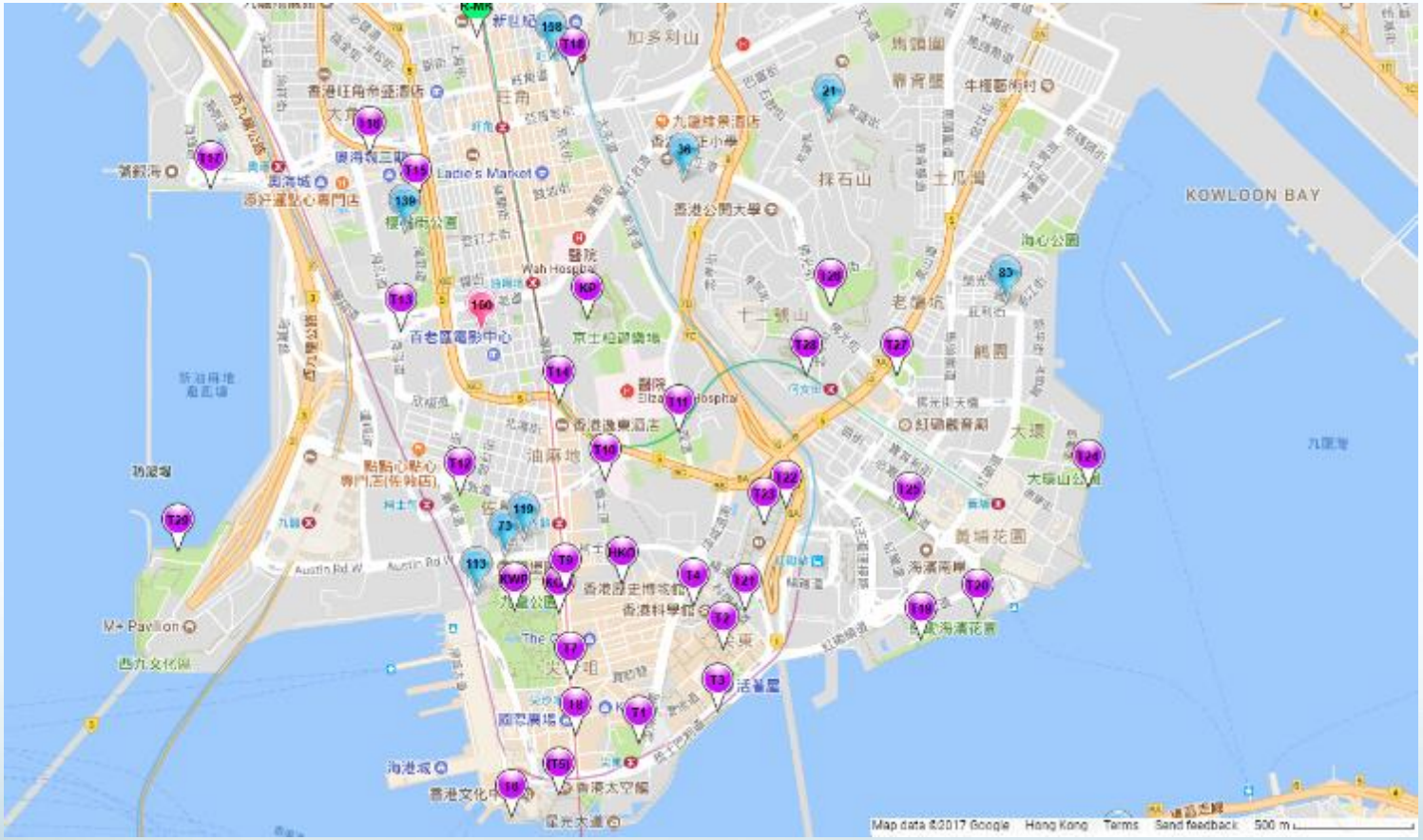
Illustration of miniature temperature sensors



The i-button temperature sensor installed inside a radiation shield

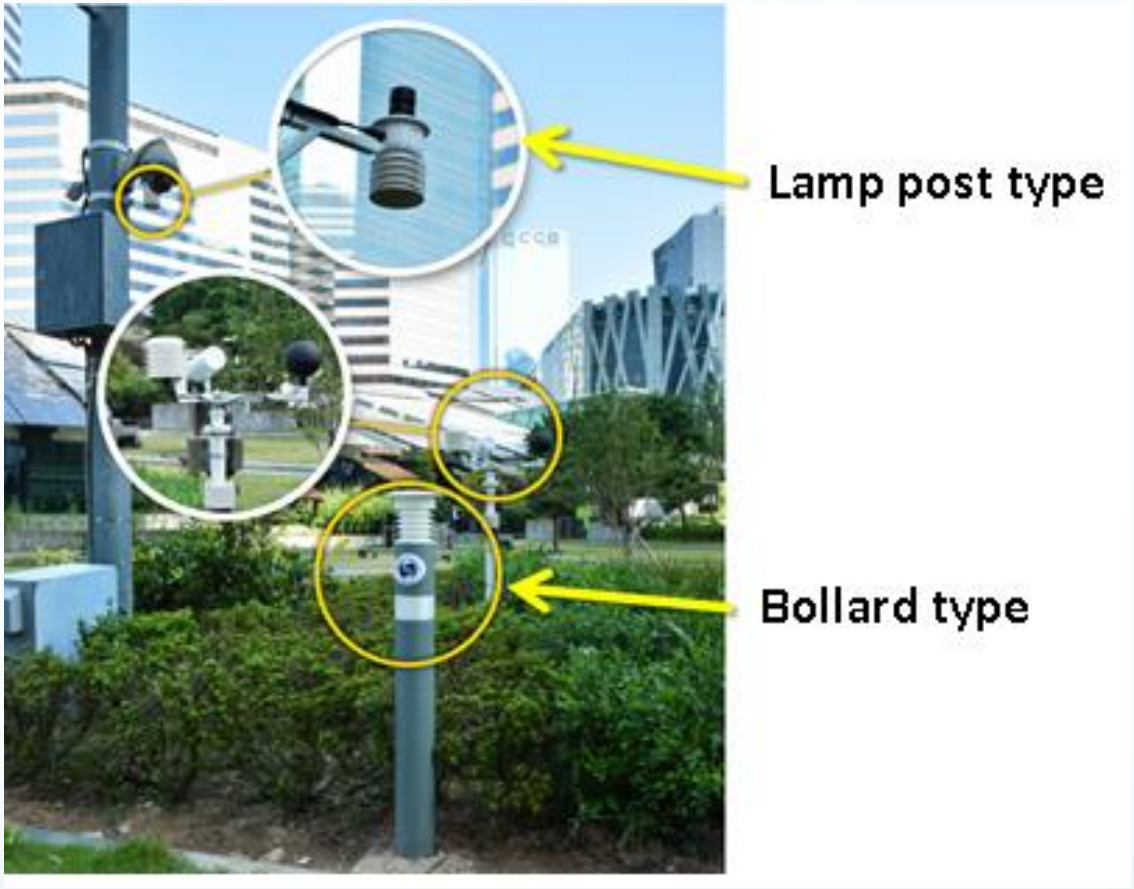
The i-button sensor installed at the viewing deck of Cultural Centre at Tsim Sha Tsui, Hong Kong.

The network of i-button temperature sensors and Co-WIN members in Yau Tsim Mong District



Purple balloons illustrated the location of i-button. The blue balloons showed the position of Co-WIN members.

The prototype of Co-WIN 2.0 AWS



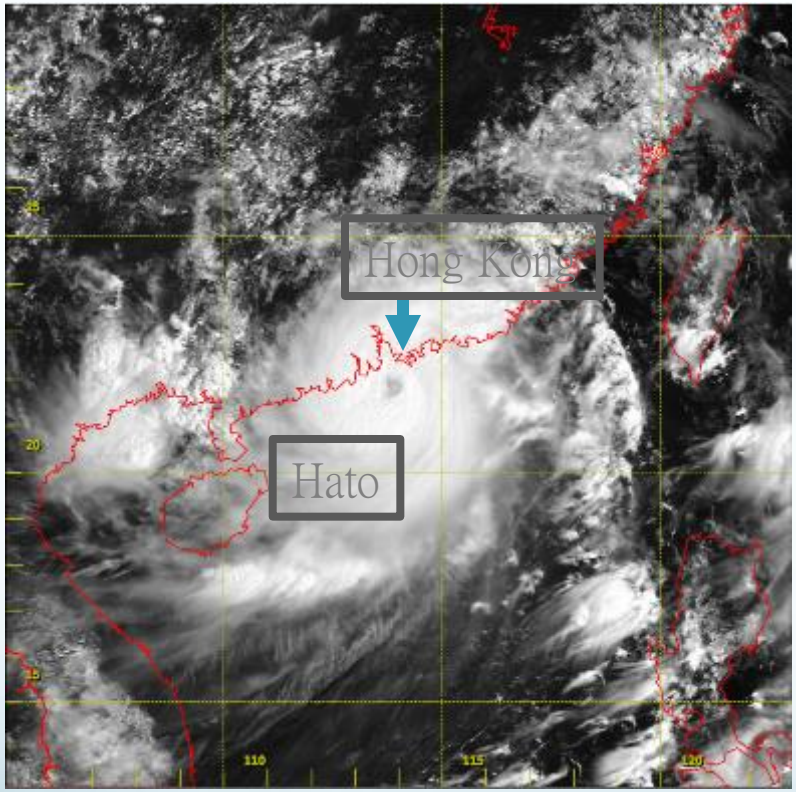
It measured temperature, pressure, UV, wind speed and direction. Other sensors such as those for measuring solar and gamma radiation sensors would also be tested.

Outlook

- With more cases available in the future, we hoped that the precise weather regimes, among other non-meteorological factors, could be better discriminated and the corresponding impact level better quantified.
- Together with the development of probabilistic forecasting techniques, impact-based forecasting could be more effective.
- The Observatory would continue to reinforce its weather monitoring capabilities so as to help Hong Kong become a smart city.

Thank you.

Visible satellite imagery and image of radar echoes



Visible satellite imagery at 10 HKT on 23 August 2017

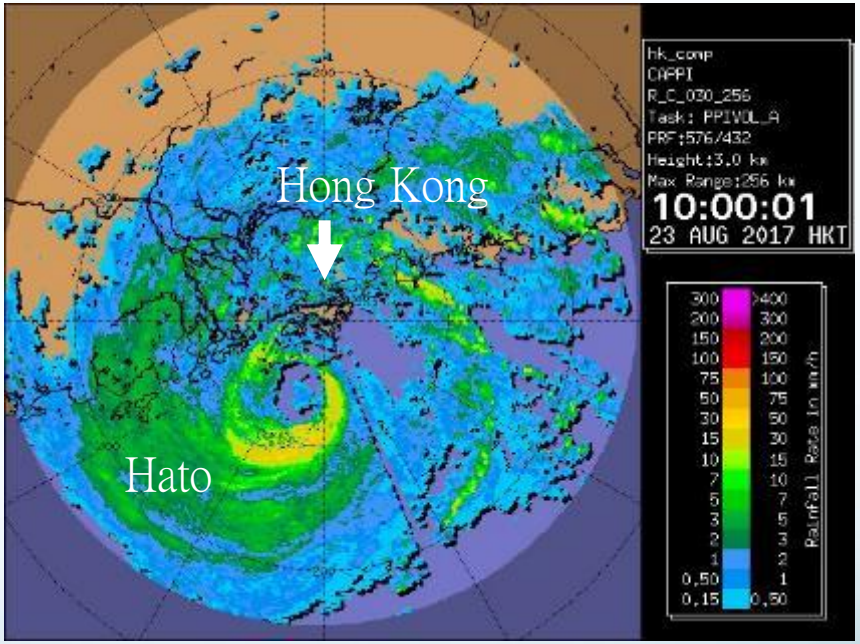
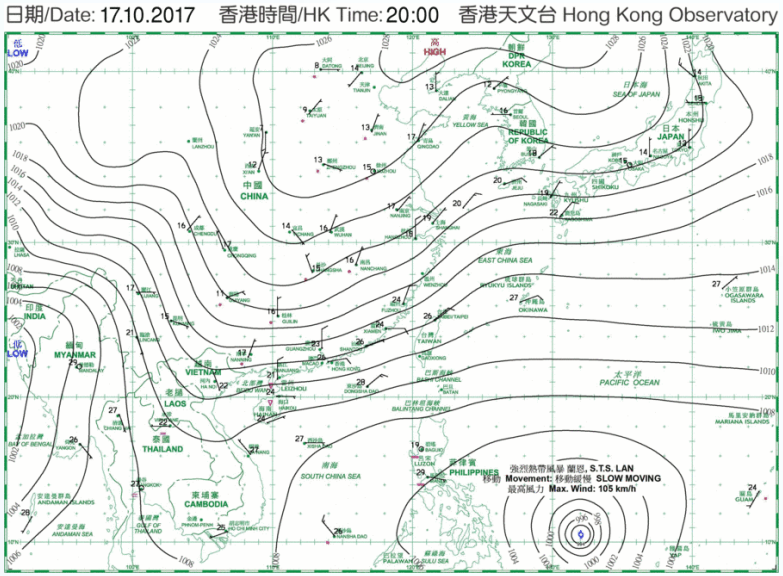


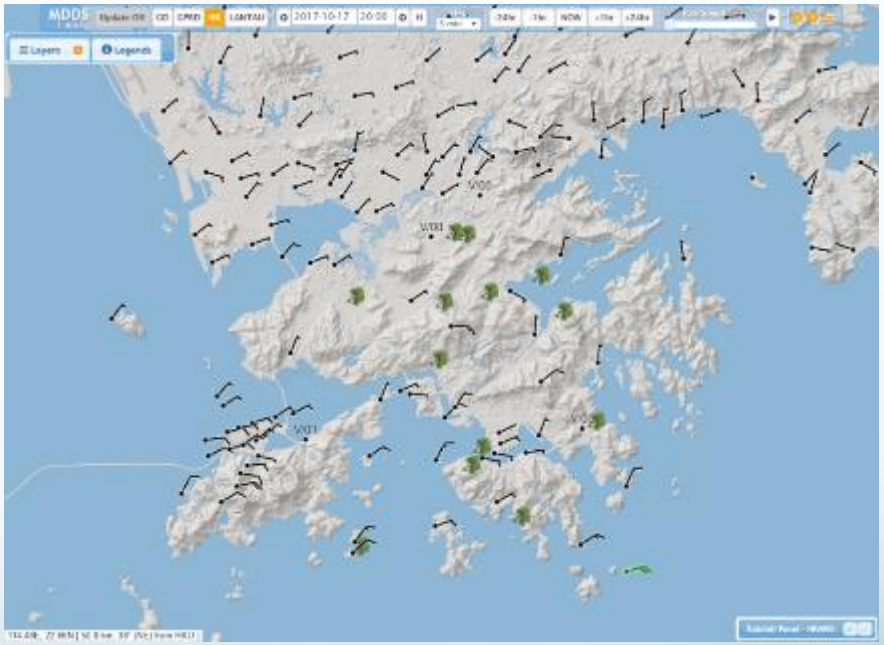
Image of radar echoes at 10 HKT on 23 August 2017

Case study 3: Impact of monsoon
Fallen trees on 17 October 2017



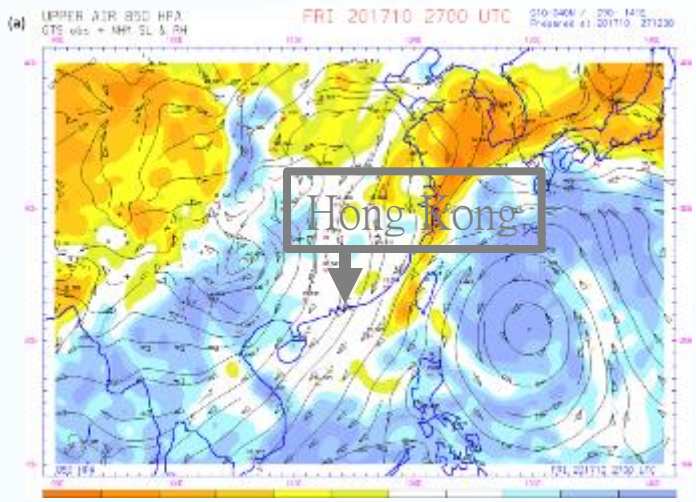
Weather chart analyzed at 20 HKT on 17 October 2017. Tight isobars over southern China indicates the prevalence of strong northeast monsoon.

Over 10 fallen tree reports were received under strong northeast monsoon.

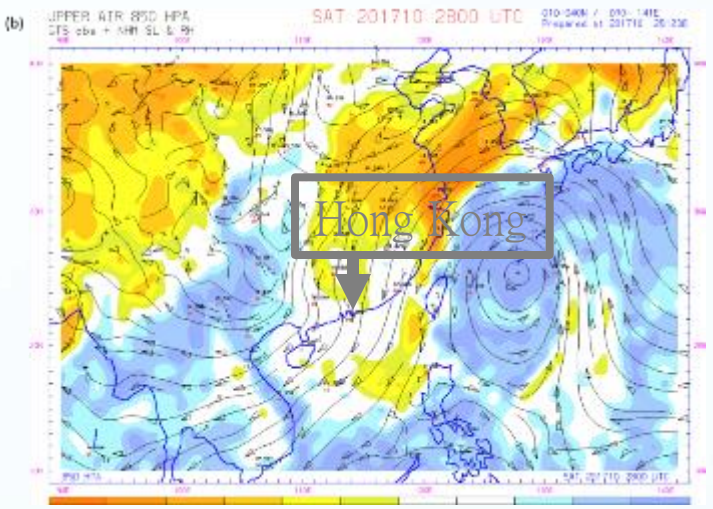


Display of winds and fallen trees at 20 HKT on 17 October 2017

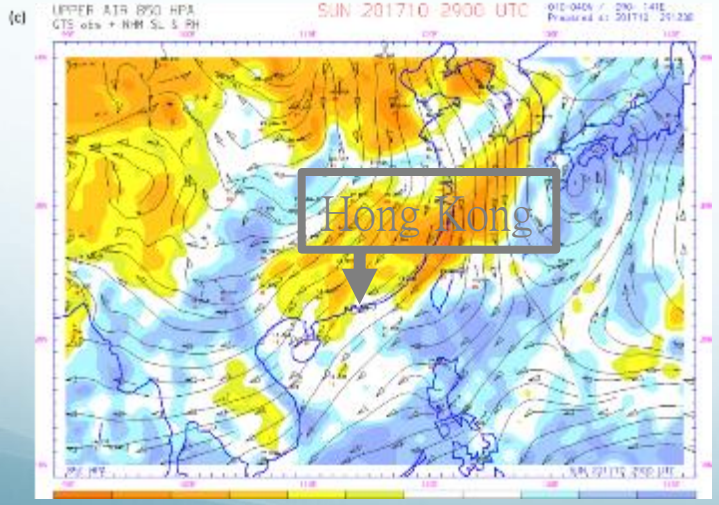
Case study 4: Impact due to dry continent airstream Hill fires on 28 October 2017



08 HKT on 27 October 2017



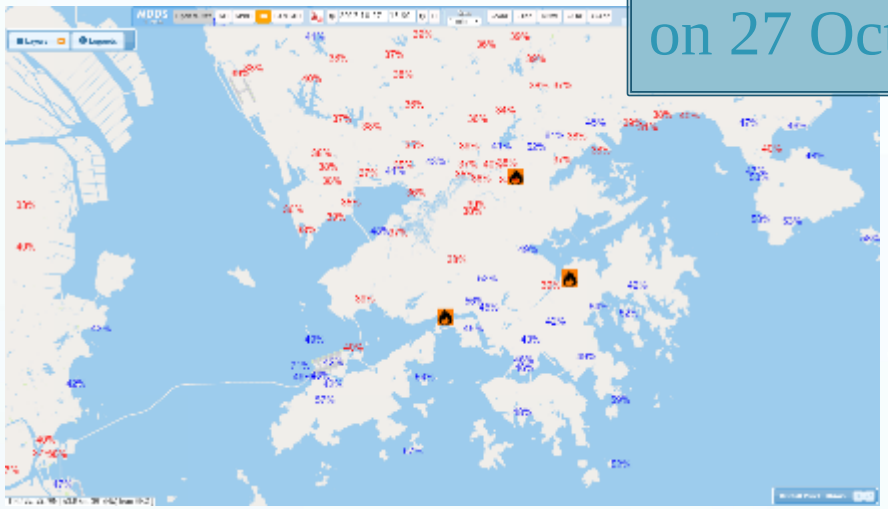
08 HKT on 28 October 2017



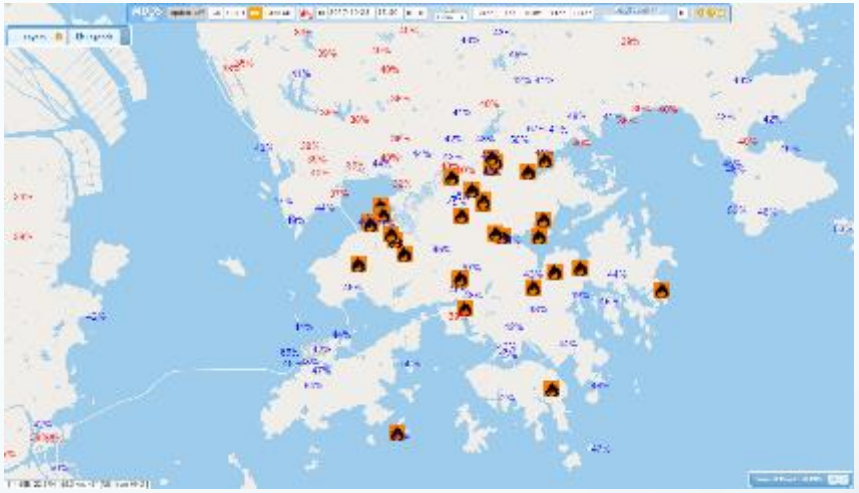
08 HKT on 29 October 2017

Integrated display of R.H. and hill fires

Drier condition was observed on 27 October 2017 (left).



There were only 3 hill fire reports until 15:30HKT on 27 October 2017.

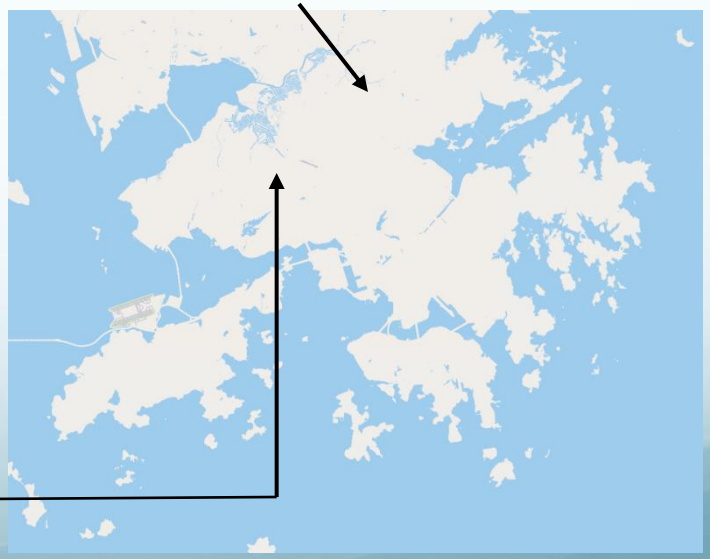


There were 32 hill fire reports until 15:30HKT on 28 October 2017.

Hill fires in different parts of the territory during Chung Yeung Festival

Sheung Shui

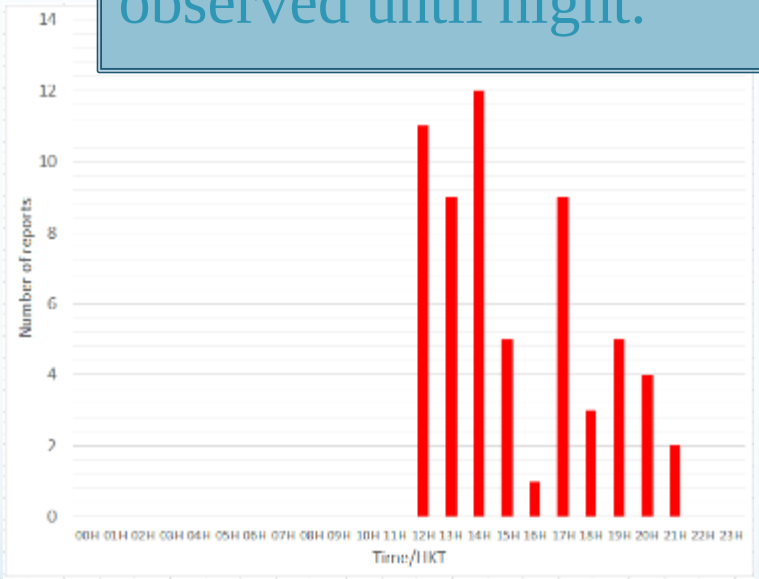
Yuen Long



Figures were quoted from Headline daily and Sing Tao daily.

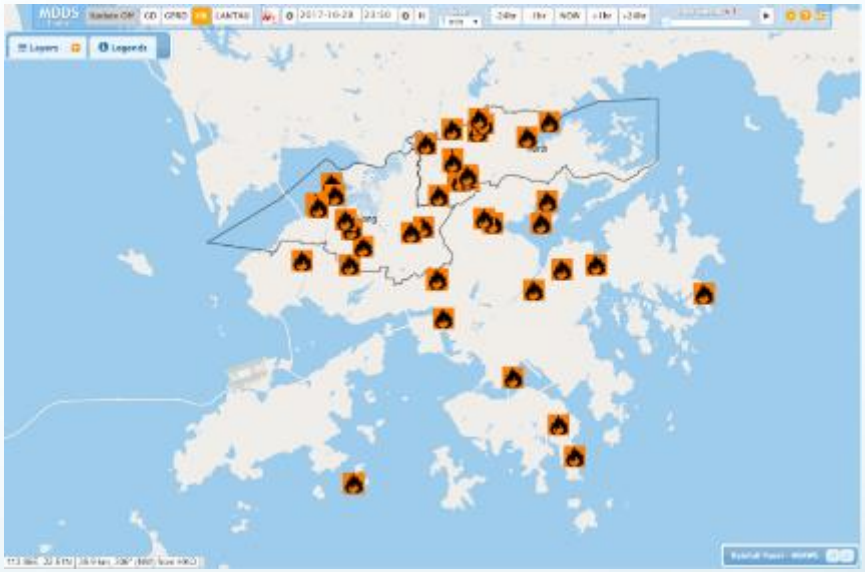
Time series of hourly hill fire reports and the spatial distribution of reports

Hill fires were found after 12 HKT. They could be observed until night.



Hourly hill fire reports received on 28 October 2017

Hill fires were mostly observed in the New Territories.



Spatial distribution of hill fires on the same day