

# Satellite CT Scanning for Urban Infrastructural Health Diagnosis

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Institute of Space and Earth Information Science, The Chinese University of Hong Kong

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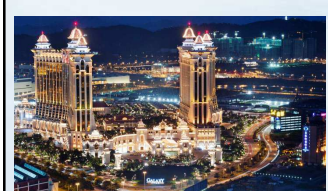
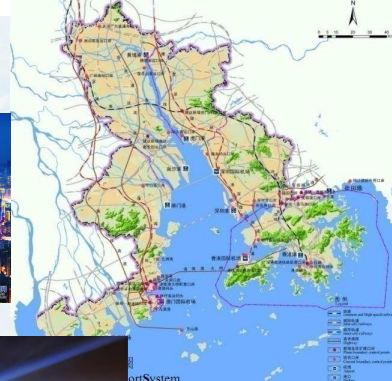


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- Case Works
- Future Research

# Introduction-rapid urbanization



## Rapid Urbanization in PRD Region to be one of the largest bay areas






## Mapping Impervious Surfaces with Satellite

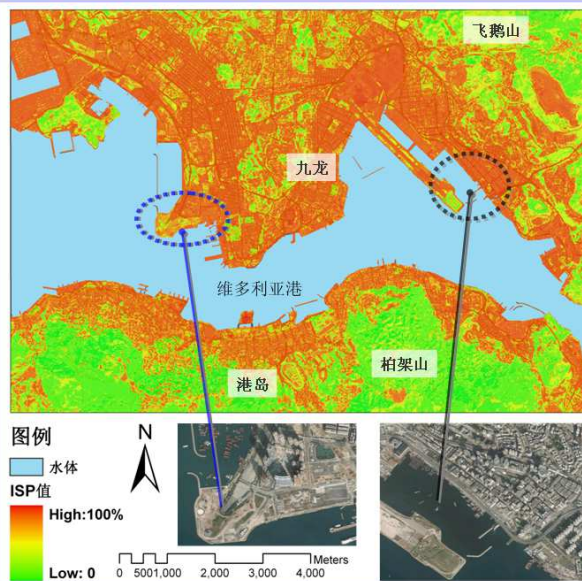
Taylor & Francis Series in Remote Sensing Applications  
Qihao Weng, Series Editor

### Remote Sensing of Impervious Surfaces in Tropical and Subtropical Areas



Hongsheng Zhang • Hui Lin  
Yuanzhi Zhang • Qihao Weng

CRC Press  
Taylor & Francis Group



## Building Height Retrieval for Urban Climate Research

IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 12, NO. 8, AUGUST 2015 1795

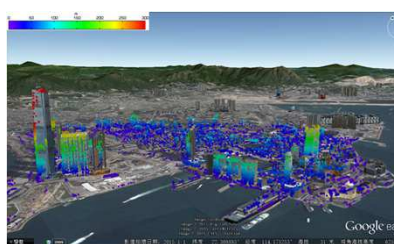
### Fusion of WorldView-2 Stereo and Multitemporal TerraSAR-X Images for Building Height Extraction in Urban Areas

Yong Xu, Peifeng Ma, Edward Ng, and Hui Lin, *Senior Member, IEEE*

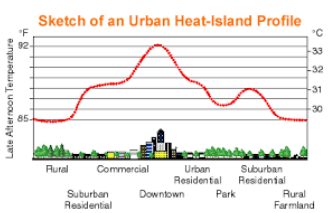
**Abstract**—We investigated the joint use of the high-resolution WorldView-2 optical satellite images and the multitemporal TerraSAR-X synthetic aperture radar (SAR) satellite images to extract building height information in high-density urban areas. The main idea of the proposed fusion approach is to take full advantage of both data sets in building height retrieval. The proposed approach includes two main stages. First, initial building height estimates are extracted from WorldView-2 stereo images and multitemporal SAR images. These initial results are then combined using a novel object-based fusion approach, in which the heights of points for the same building footprint are retrieved and integrated. Experiments on the Mong Kok area of Hong Kong showed that the proposed approach using both data sets outperforms the use of either stereo images or SAR images alone. According to the results of the proposed approach, the average absolute height retrieval error is 6.623 m, which is much lower than using stereo and SAR images (9.08 and 12.24 m, respectively). The proposed fusion approach is suitable for building height retrieval in urban areas where single satellite data have limitations.

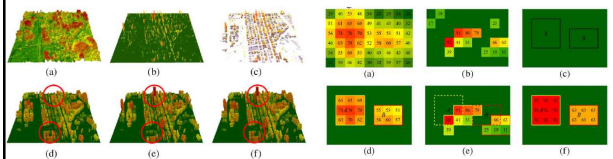
ground building height extraction. Studies using stereo images for building height extraction have mainly focused on parts of the aforementioned stages. Some studies have emphasized on the development of advanced stereoscopic matching methods to improve the building height retrieval accuracy [2], whereas others have investigated the use of multiple stereo images to identify common targets for height retrieval [3], [4]. In addition, some studies have made use of ancillary data, such as approximate digital elevation modeling or prior building footprints [5]. In addition to stereo images, monocular satellite image can be used to retrieve the height of buildings in areas where the shadows of the buildings can be measured [6]. However, the accuracy of this method is affected by the quality of the measured shadows and the surrounding environments, which limits its practical use.

In addition to stereo images, SAR images have been widely used for building height retrieval in recent decades, and var-

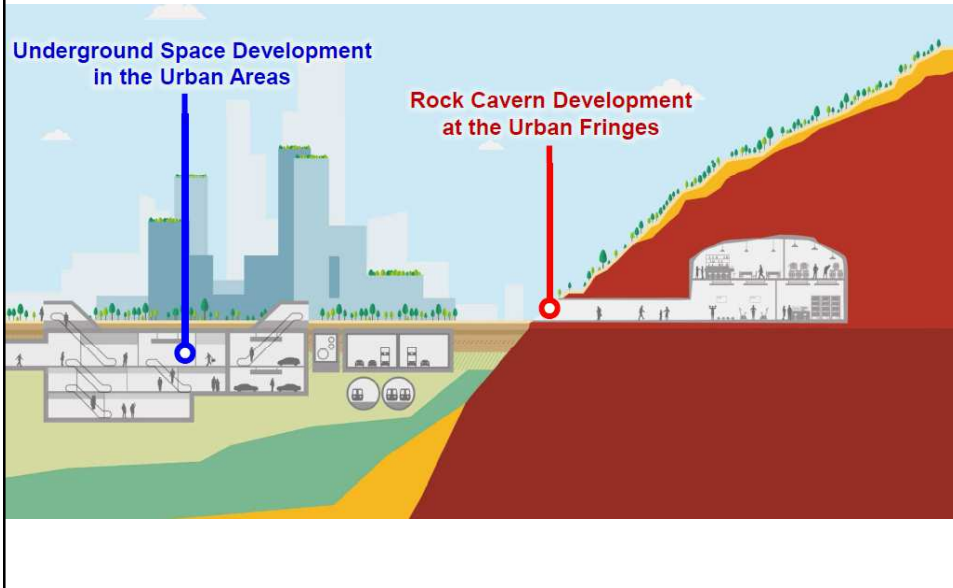


#### Sketch of an Urban Heat-Island Profile





## Introduction-rapid urbanization



## A Trend: Urban Underground Use



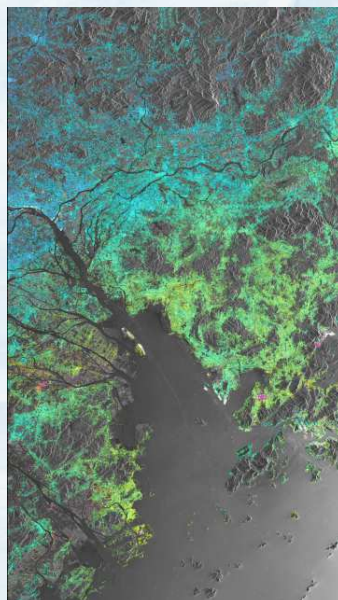
## Asia's largest underground railway station opens in Shenzhen

(Xinhua/chinadailyasia.com) Updated: 2015-12-31 09:49 Comments 



A passenger buys ticket at the Futian underground railway station in Shenzhen, South China's Guangdong province, Dec 30, 2015. Asia's largest underground railway station opened on Wednesday in the southern Chinese city of Shenzhen, launching high-speed rail service between Guangzhou and Hong Kong. The new line slashes travel time between Guangzhou and Hong Kong to half an hour. [Photo/Xinhua]

## Ground Surface Subsidence and Landslide



cm/yr  
-3

ation Science  
f Hong Kong  
息科學研究所



# Introduction-urban geo-hazards



2016年11月8日，日本福岡市出現大面积道路塌陷



## Conventional Engineering Methods



Leveling

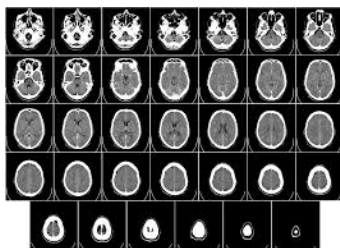


GPS

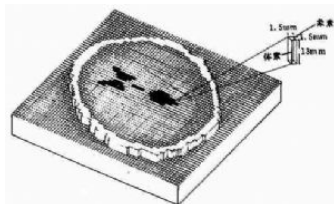
## Computed Tomography (CT)



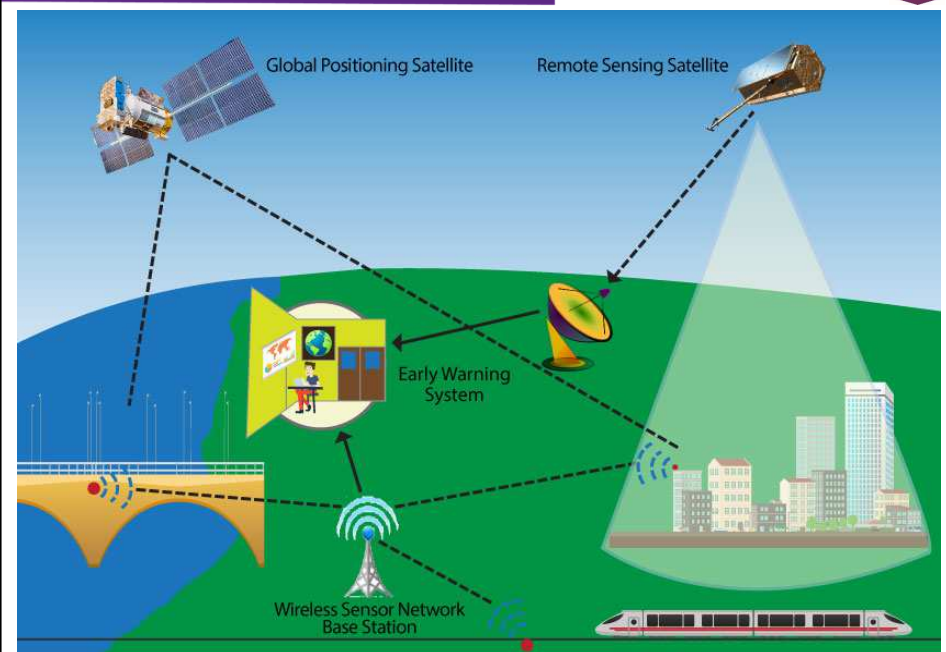
X-Ray Computed Tomography, X-CT can help to generate the 3D images of our body or part of our body



Regular CT Scanning for Health Checking



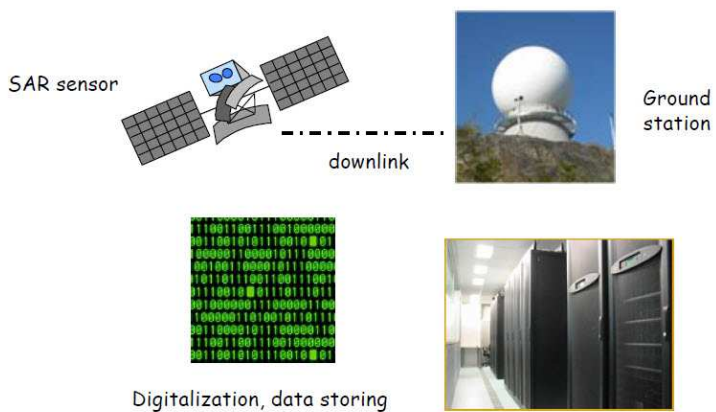
# Principles



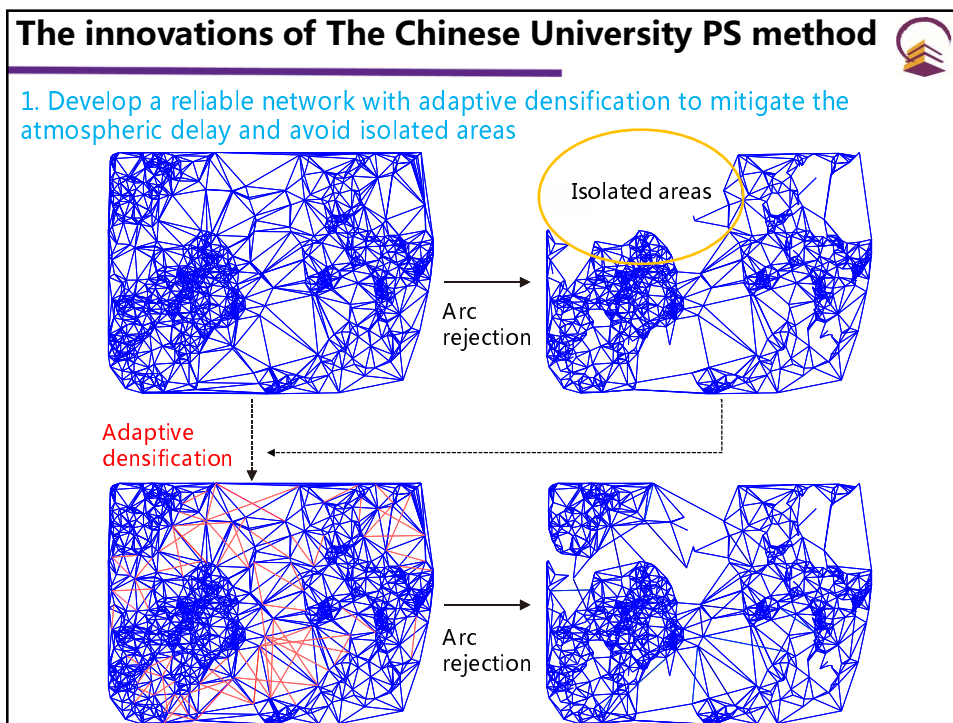
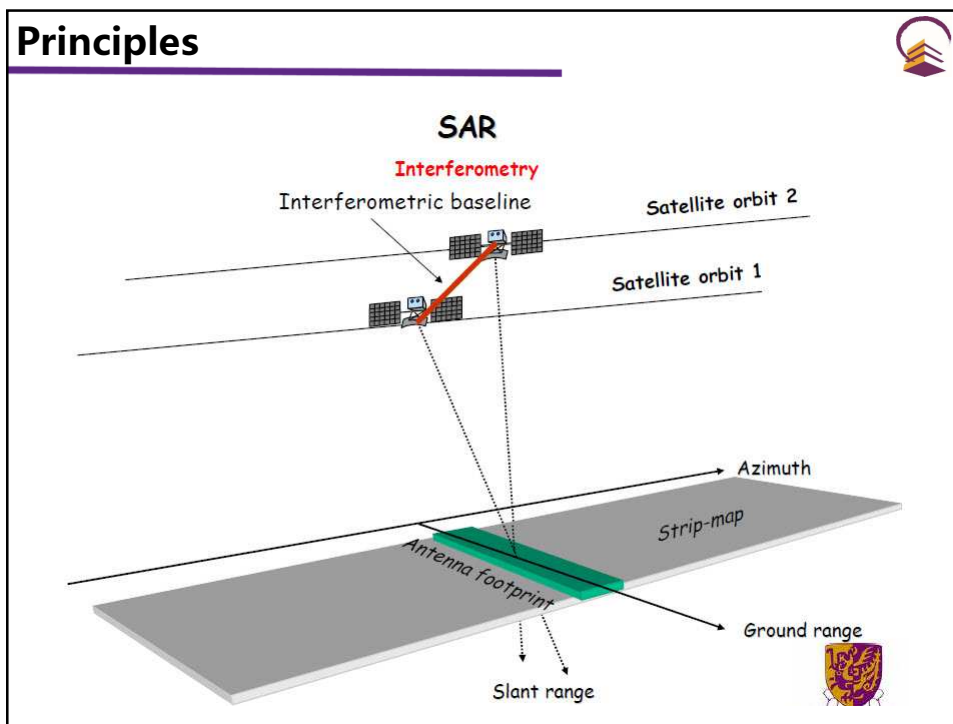
# Principles

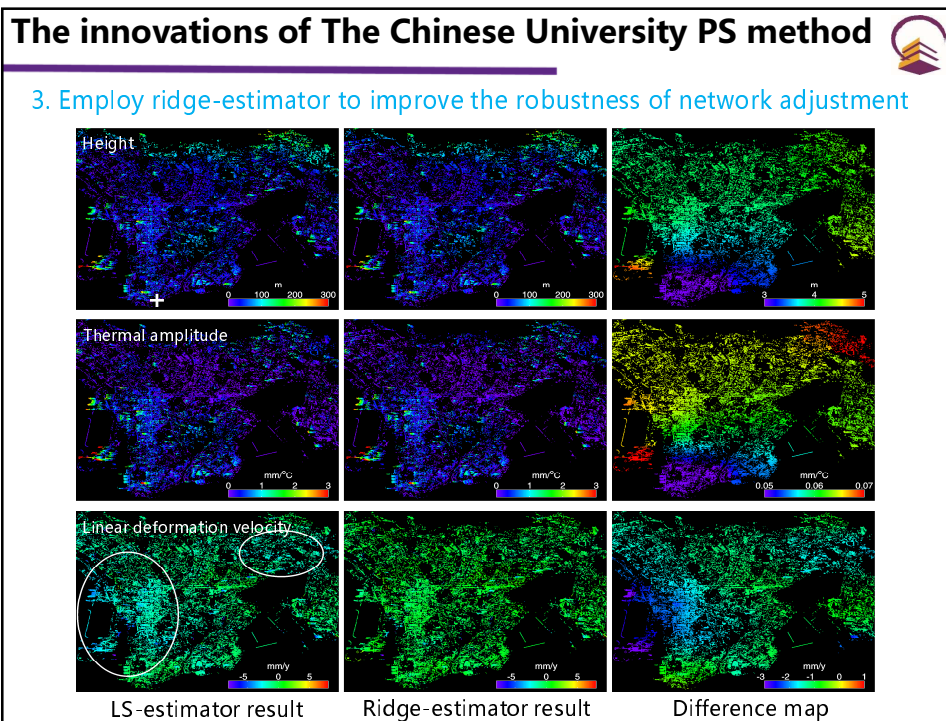
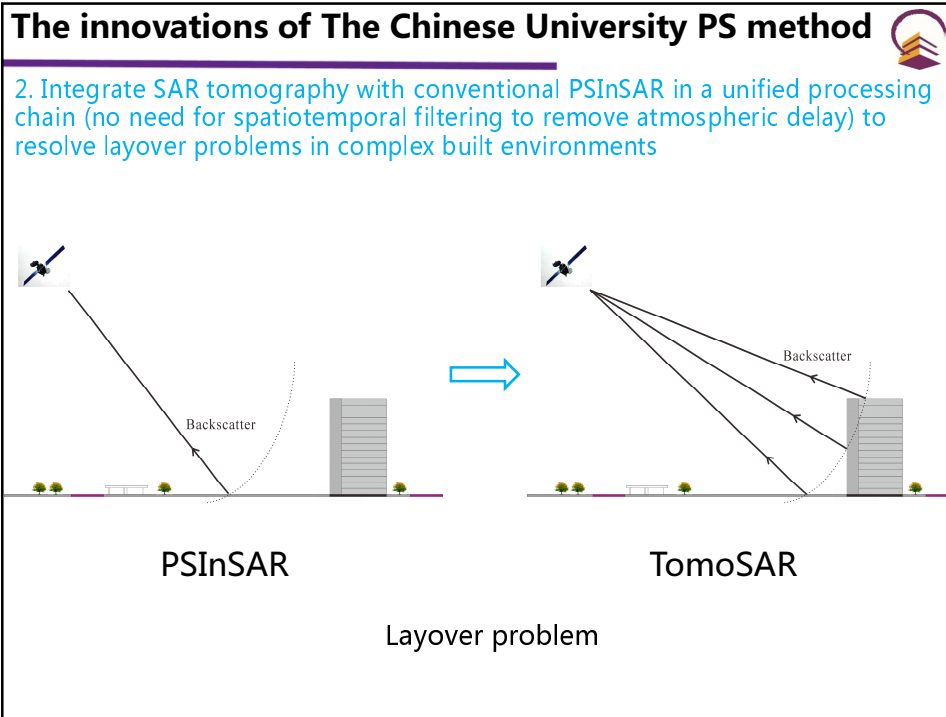


## Data transmission and processing



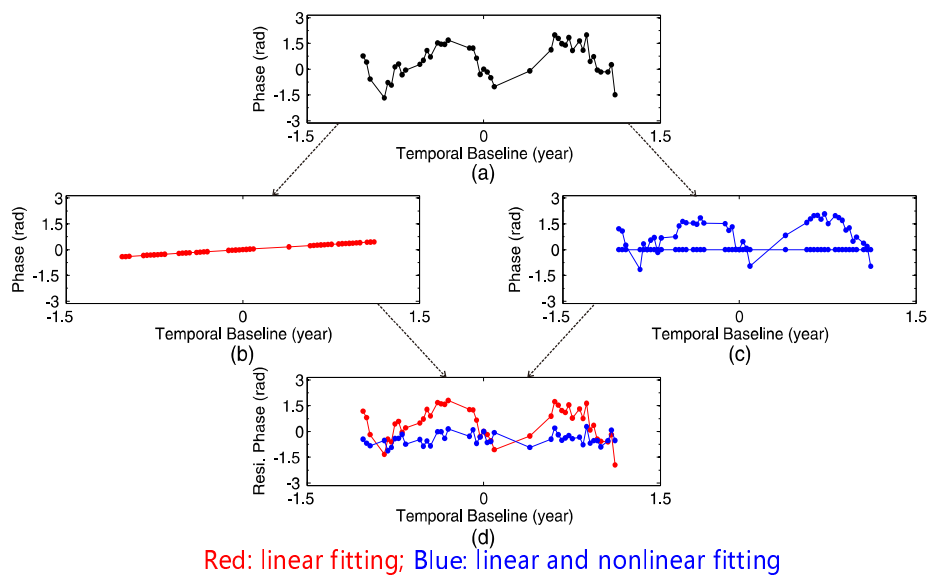




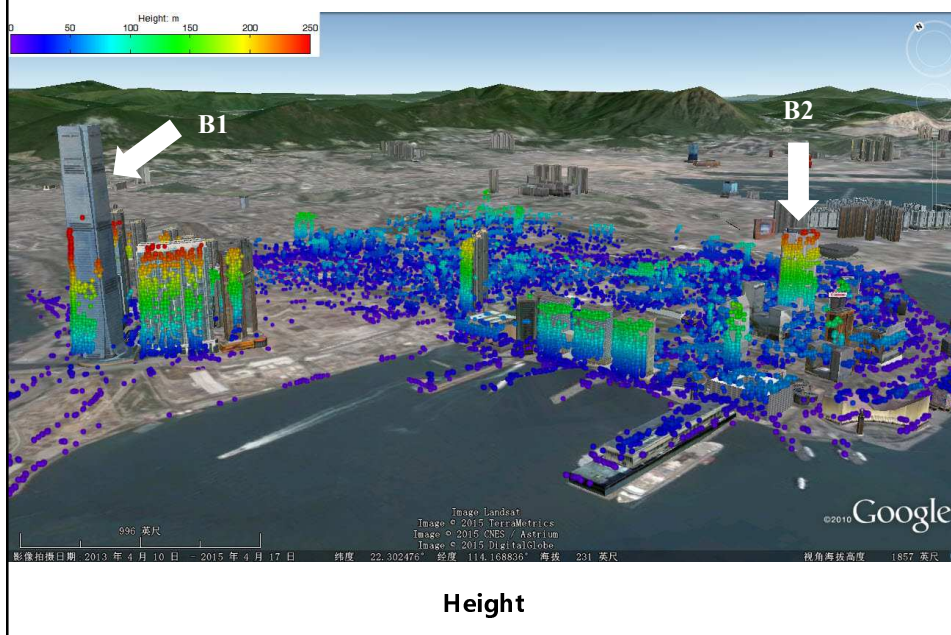


## The innovations of The Chinese University PS method

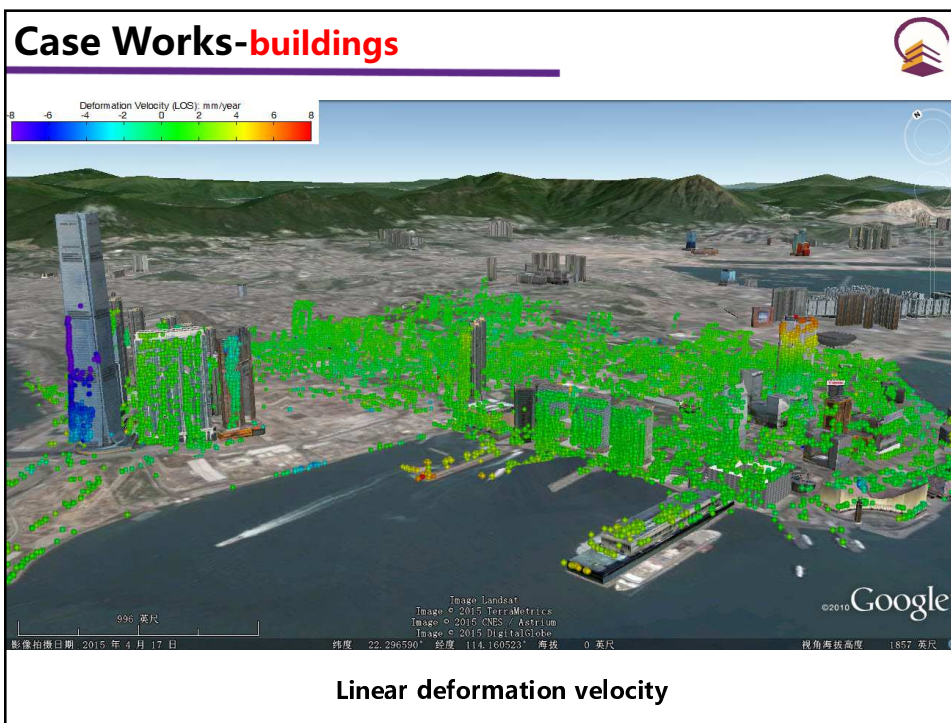
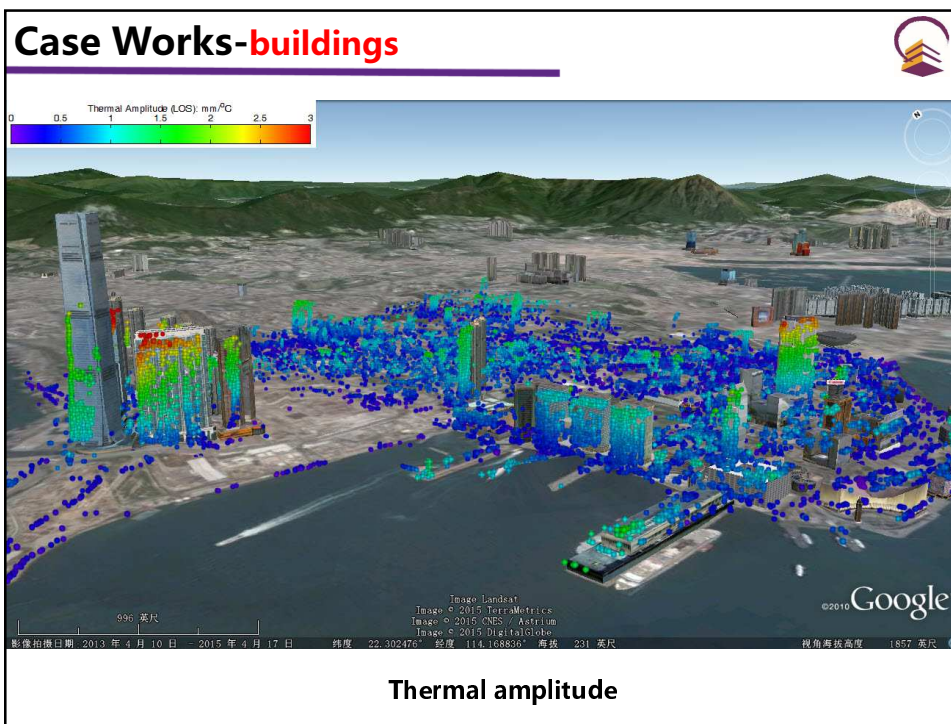
4. Introduce seasonal temperature function to approximate thermal expansion and improve the monitoring capability for skyscrapers, bridges, railways and etc.



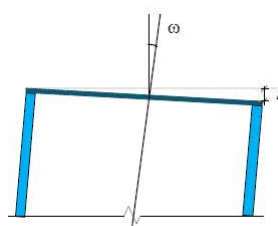
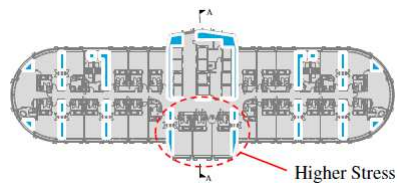
## Case Works-buildings







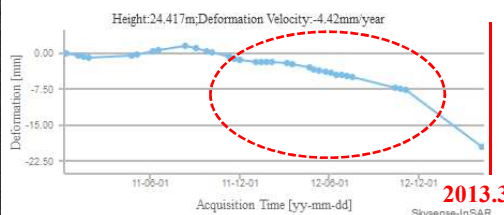
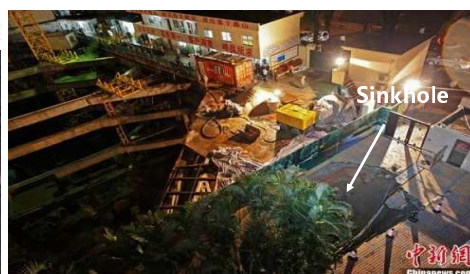
### Case Works-buildings



Deformed Shape  
(Due to asymmetrical loading on floor)

Linear deformation velocity

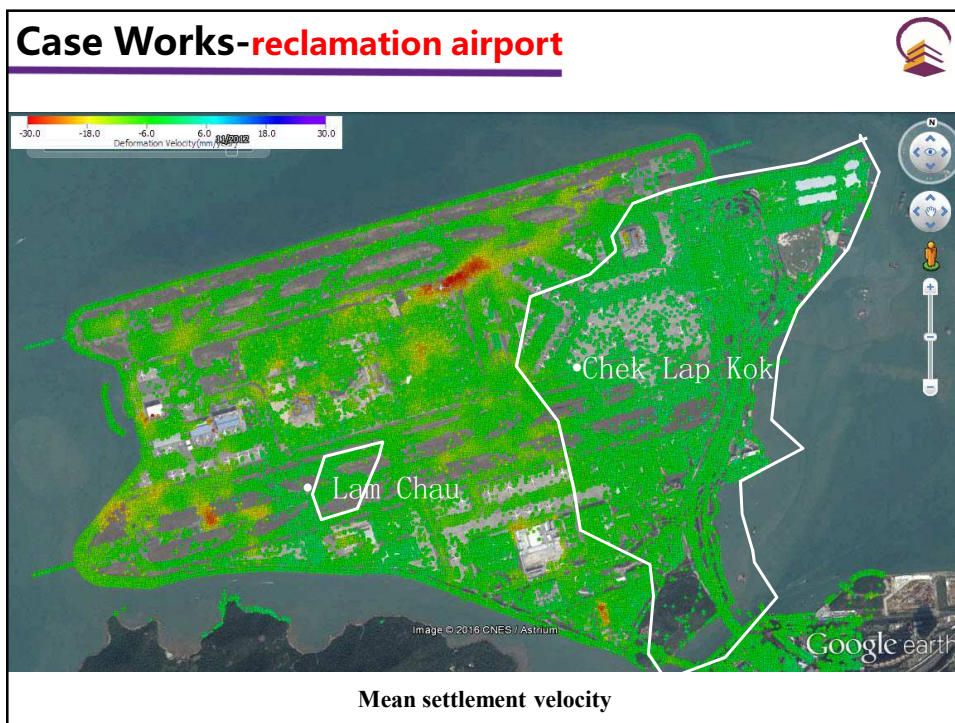
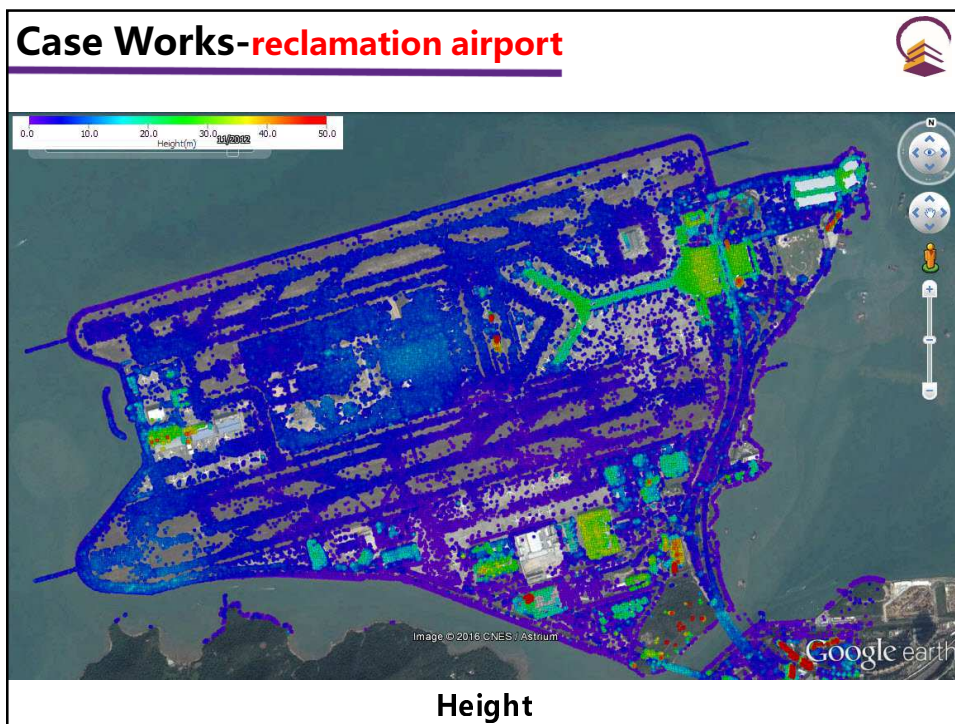
### Case Works-sinkhole



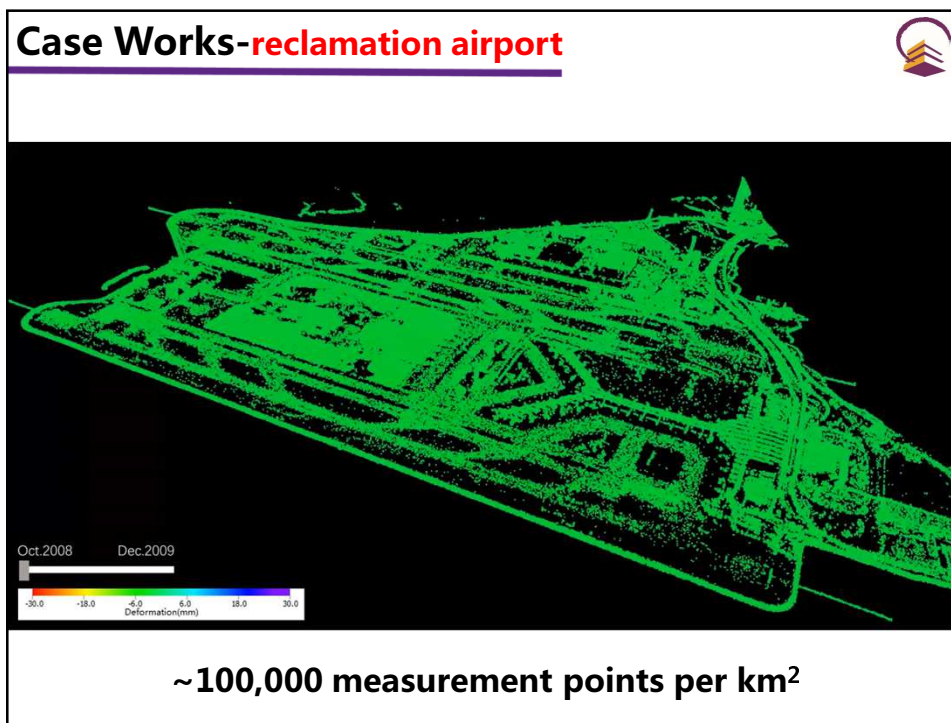
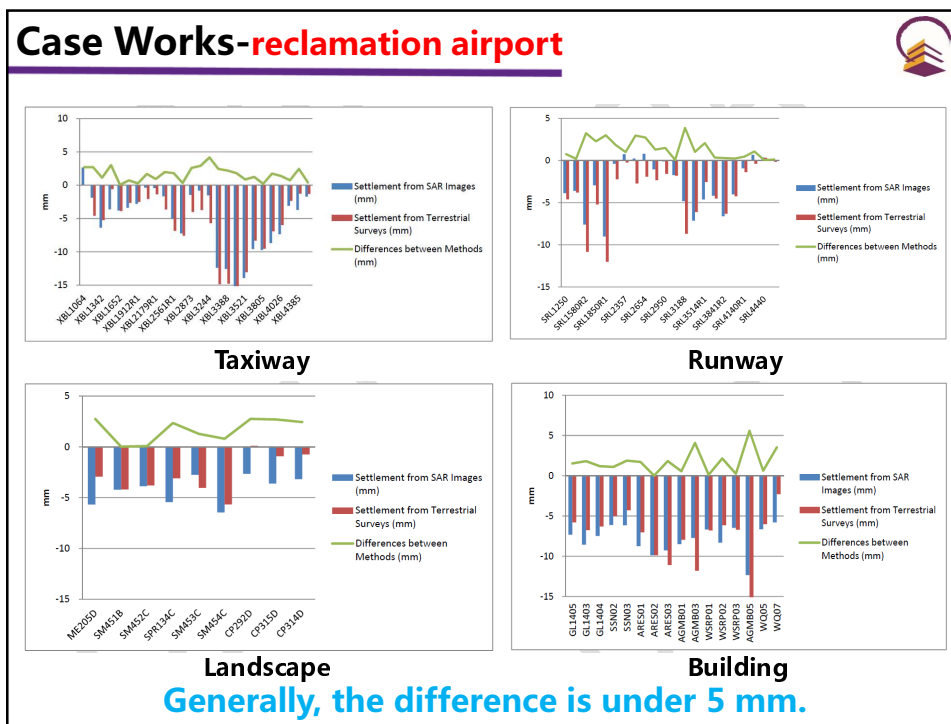
Time series

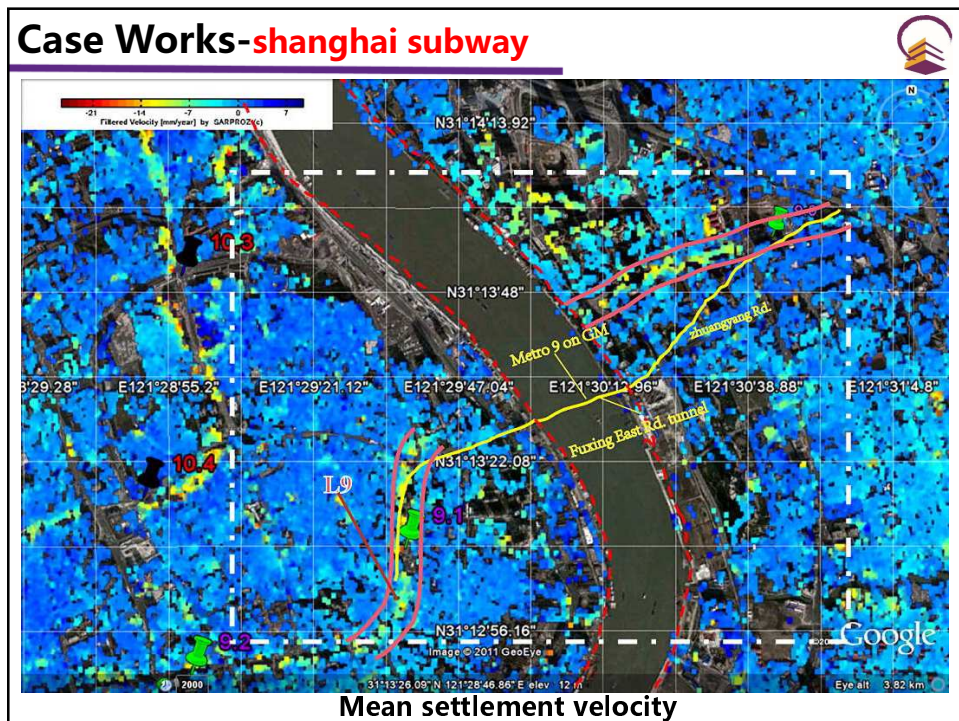
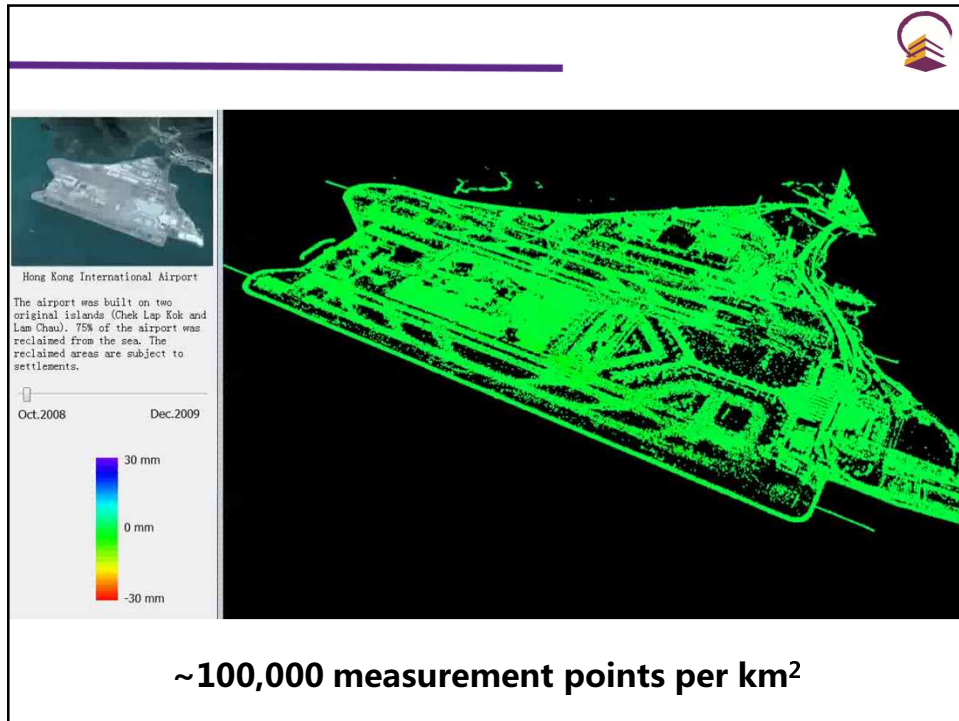
Linear deformation velocity

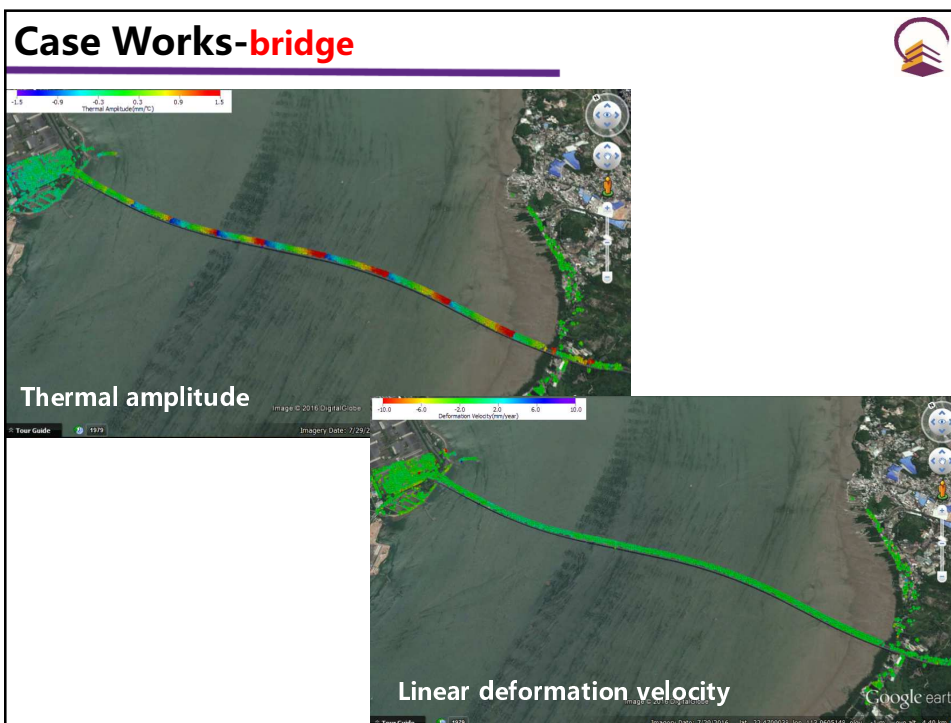
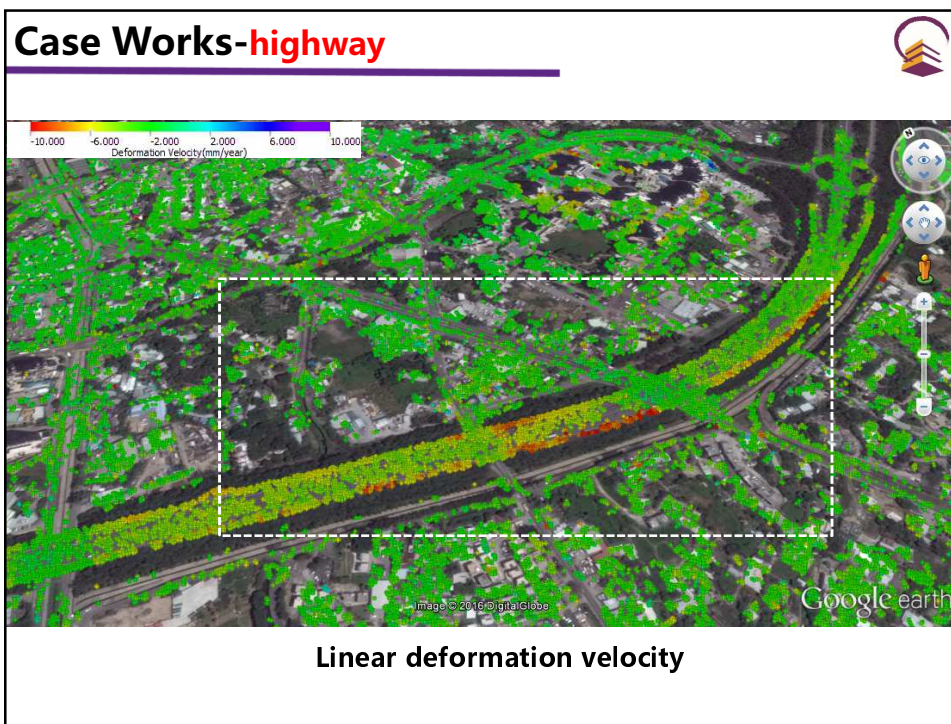




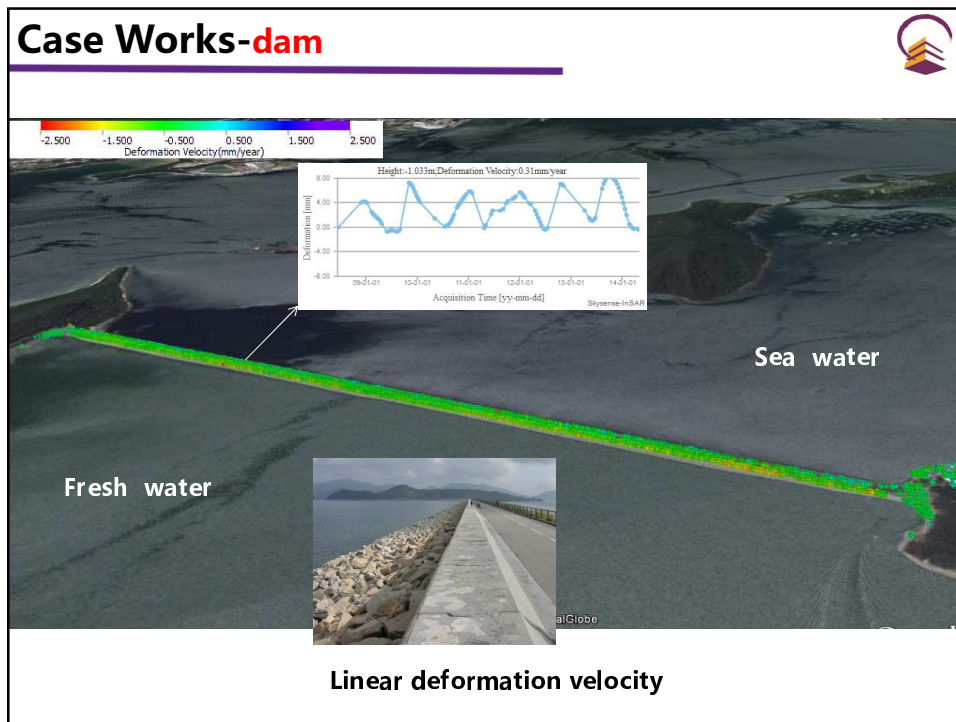












## Summary

- We need to pay more attention to those hidden risks as the results of rapid urbanization
- The health of urban infrastructure should be regularly checked with efficient ways
- InSAR technology can help for building up the urban "CT" platform
- A Space/ground based integrated platform could provide a solution for monitoring the urban infrastructure health

## Future Research



### Key issues :

- How to standardize methodologies for engineering and scientific use
- How to construct multi-level (individual-, district-, city-, regional-, national-level) monitoring system
- How to establish an early-warning system for urban infrastructure diagnosis

