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Ground Subsidence Monitoring and Causal Analysis in Wuhan City Based on Fusion of Multi-Source InSAR Data

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1. Introduction

Due to the limitation of data, most of the existing studies in Wuhan area are in a short period(1-2 years), so the overall process of subsidence cannot be clearly understood. Only qualitative analysis can be made on the cause of deformation.

Our study focus on the COSMO-SkyMed data obtained from 2012-2019 are used for the long time series InSAR analysis in Wuhan area. The whole deformation process of the settling area can be seen.
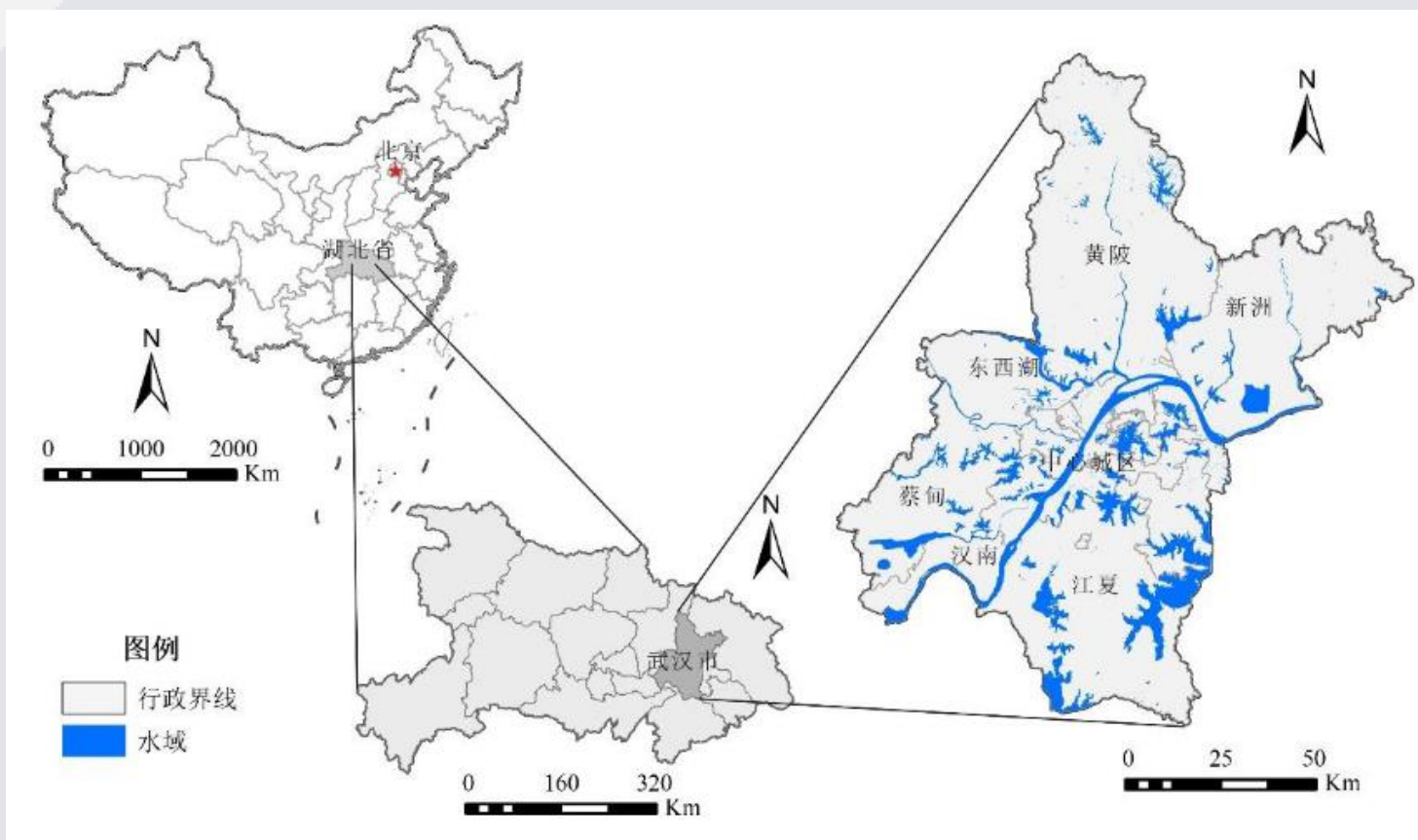
2. Methods

➤ Preprocessing
- Coregistration: Coherence coefficient method
- Reflectivity Map Generation & Amplitude Stability Index Generation

➤ Geocoding
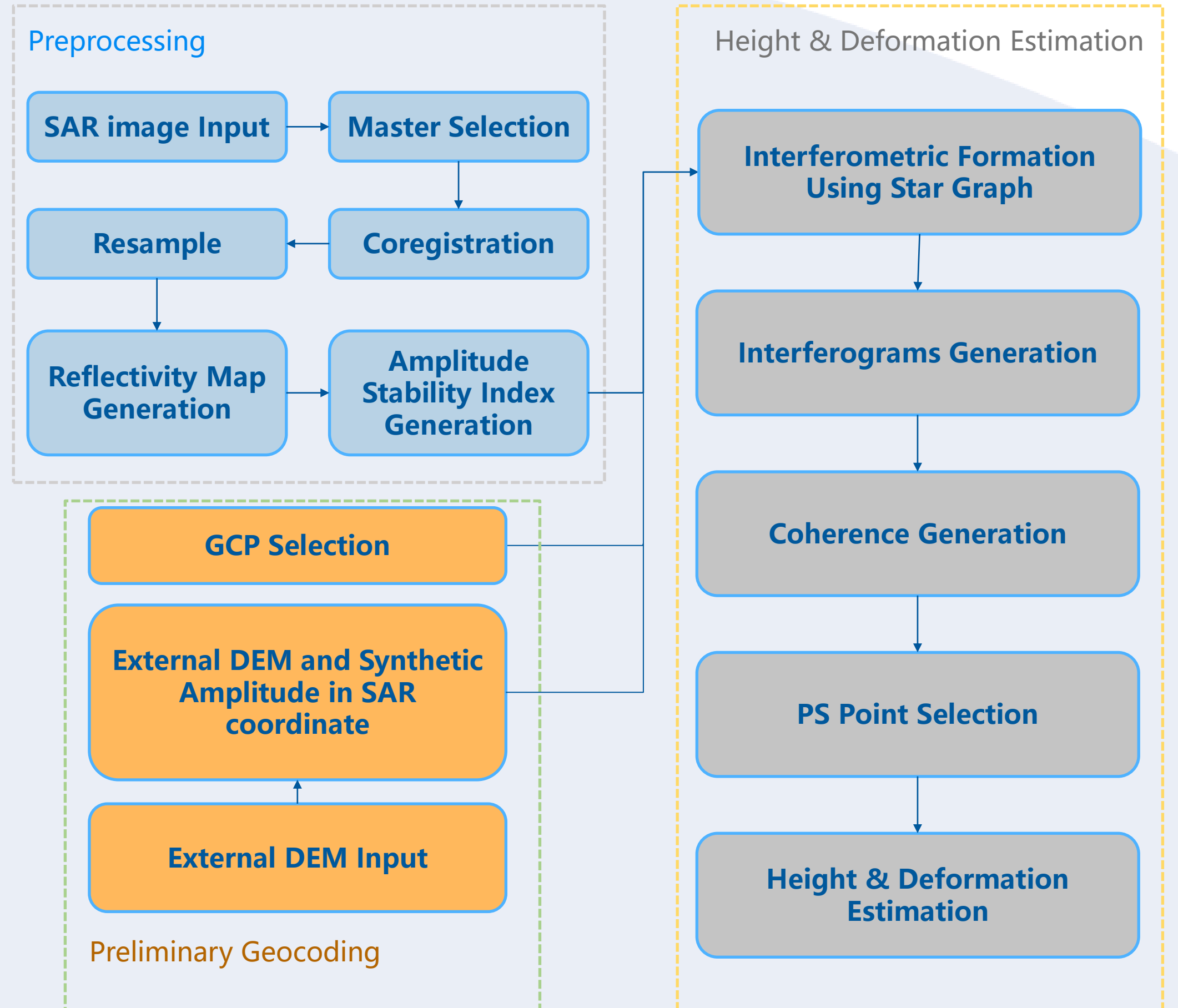- GCP Selection: Defined through image orbit data

➤ APS Estimation
- PSC Point Select: Amplitude stability/ Temporal coherence
- Triangulation of sparse PSC network(Delaunay) and generation of differential phase
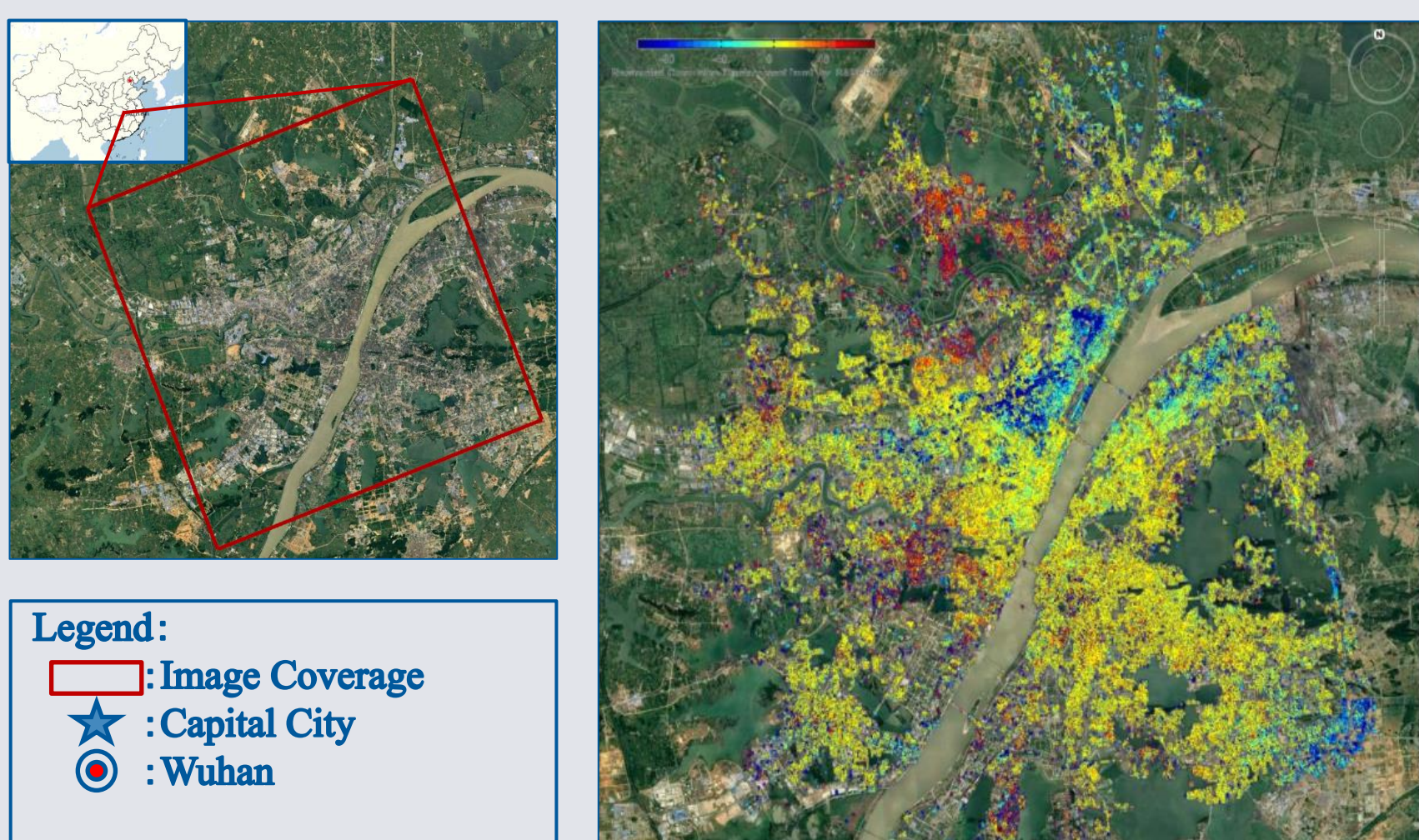
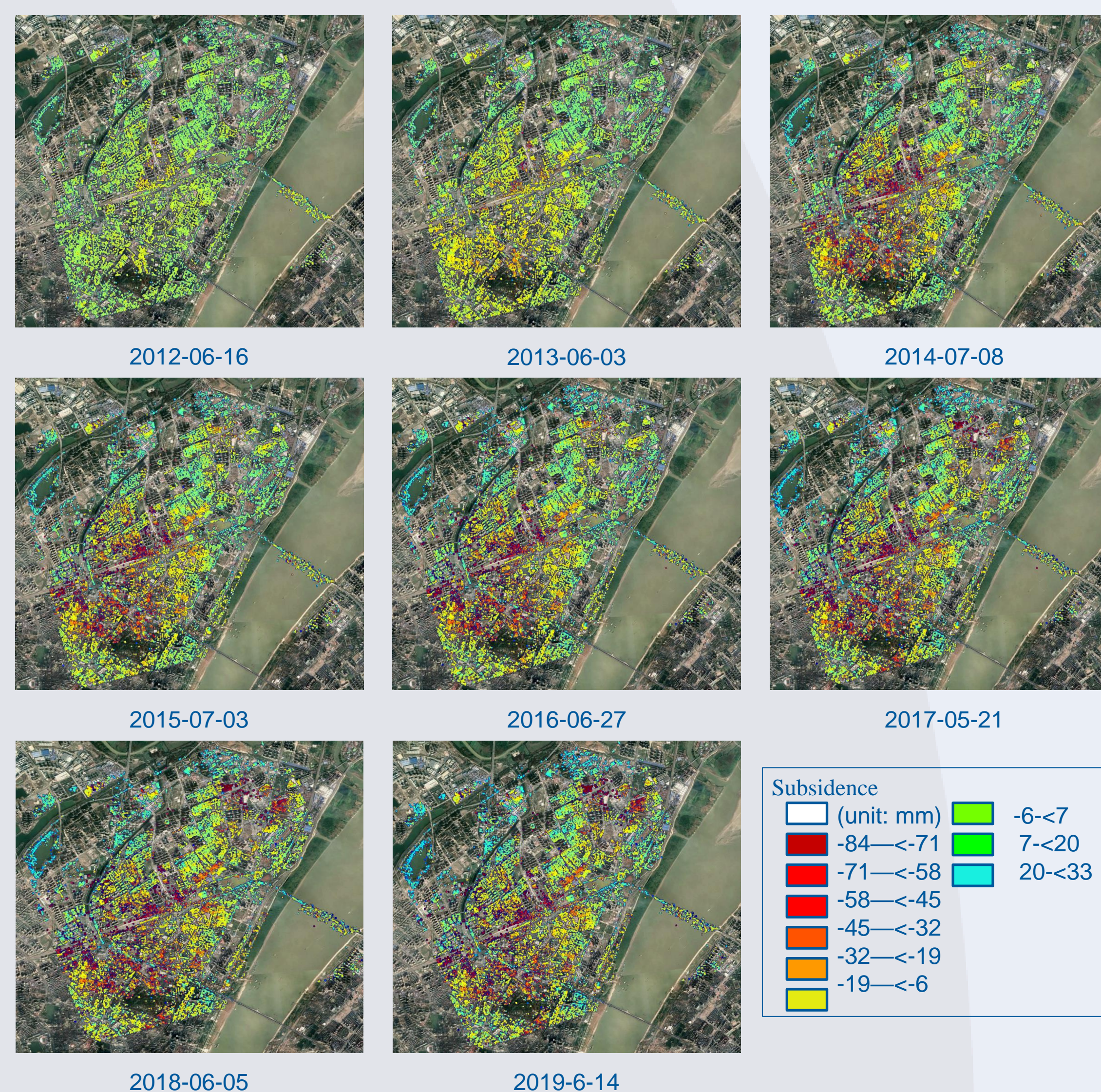### ➤ Sparse Estimation
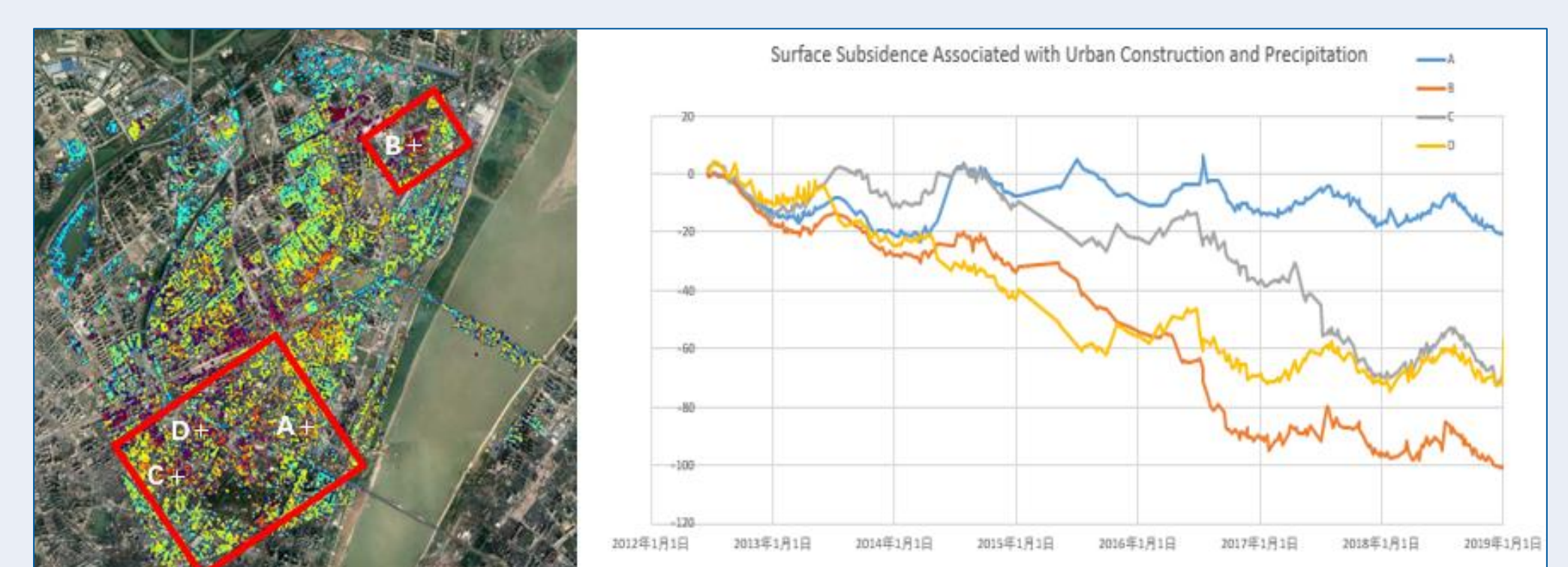- Deformation and Topographic Estimation

➤ Workflow

Preprocessing
SAR image Input → Master Selection
Resample → Coregistration
Reflectivity Map Generation → Amplitude Stability Index Generation

Preliminary Geocoding
GCP Selection
External DEM and Synthetic Amplitude in SAR coordinate
External DEM Input

Height & Deformation Estimation
Interferometric Formation Using Star Graph
Interferograms Generation
Coherence Generation
PS Point Selection
Height & Deformation Estimation

3. Results

➤ Study Area and Data

Legend:
: Image Coverage
: Capital City
: Wuhan

286 COSMO-SkyMed HH-polarization SAR images of Wuhan, Hubei province, were used for subsidence detection. The research area is the urban area of Wuhan(Hankou, Hanyang, Wuchang).

2012-06-16   2013-06-03   2014-07-08
2015-07-03   2016-06-27   2017-05-21
2018-06-05   2019-6-14

Subsidence
(unit: mm)   -6-<7
-84-<-71   7-<20
-71-<-58   20-<33
-58-<-45
-45-<-32
-32-<-19
-19-<-6

The two main deformation area has been observed are Jianghan District, Qingshan District. Jianghan District has the largest deformation scale, so according to the different causes, the deformation of Jianghan District is divided into three sub-regions, Houhu area(soft soil), Xinrong area(subway), and Hankou CBD(buildings and groundwater). According to the surface cumulative subsidence time series, the subsidence of Hankou CBD and Houhu area began in 2014 and gradually expanded. The subsidence of Xinrong area began in 2017. The subsidence along the Yangtze River is small, but the range is wide, and the trend of gradual expansion appears.

Cumulative Deformation Curve of Houhu Area

Surface Subsidence Associated with Urban Construction and Precipitation

Qingshan District is an important industrial town in Wuhan. Wuhan Iron and Steel (Group) Company, China First Metallurgical Construction Corporation, and Wuhan Petrochemical Plant are all located.

4. Conclusions

➤ The causes of subsidence in Wuhan are complex.

➤ Under the influence of soft soil, the Houhu area consolidated rapidly from 2013 to 2015. According to the deformation curve of the long time series, it can be seen that the area has entered into the late stage of soft soil consolidation after the rapid consolidation period of soft soil, which is basically stable.

➤ Xinrong area is the intersection point of two subway lines, and Hankou CBD is the concentration area of skyscrapers and are all populated areas.

➤ The phenomenon of excessive groundwater extraction in construction and use is serious, and the subsidence curves of these two regions show obvious seasonal changes, which are highly correlated with the changes of water level and precipitation.

➤ The deformation in Qingshan area has a high spatial correlation with the location of industrial area.

➤ The spatio-temporal characteristics of large area surface subsidence in Wuhan and its relationship with the influencing factors are determined in this research.

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