SUBSIDENCE MONITORING IN BUILT-UP AREAS BY ANALYSIS OF TIME-SERIES SENTINEL-1 DATA

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Abstract

In this investigation, the time-series InSAR analysis method is adapted and totally 44 scenes of the IW mode data of the Sentinel-1 are collected.

- Firstly, the deformation rate map of Wuhan City is extracted.
- Then, the details and causes of deformation in built-up areas are analyzed by combining with field survey data.
- Deformation monitoring of subways and railways in Wuhan city is carried out.

Introduction

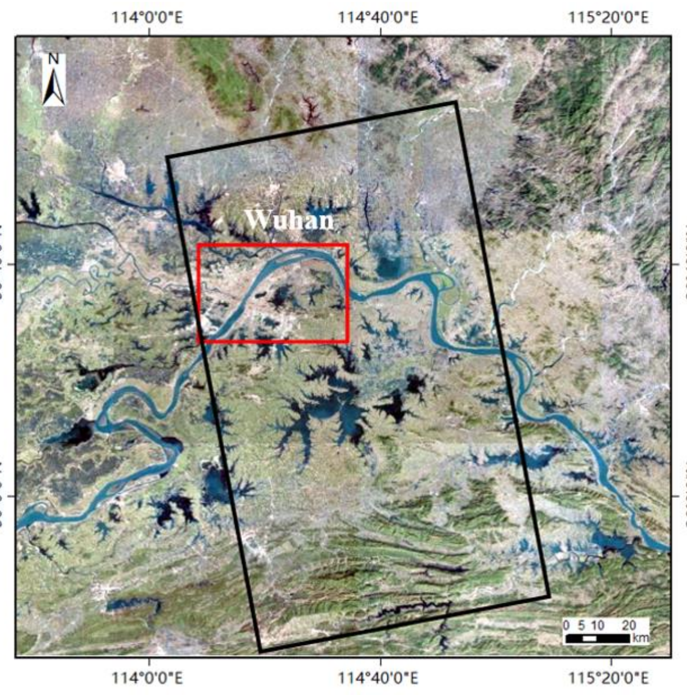


Figure1. Map of study area. The red rectangle represents the Wuhan City, and the black rectangle represents the coverage of the third subswath of Sentinel-1 data.

The study area in Wuhan is along the Yangtze River. Rapid urbanization and extensive carbonate rock strips as well as soft soil layers underground in Wuhan have contributed to land subsidence in most parts of this city. The Sentinel-1 data offers an opportunity for subsidence monitoring in built-up areas.

Results Analysis of Built-up Areas

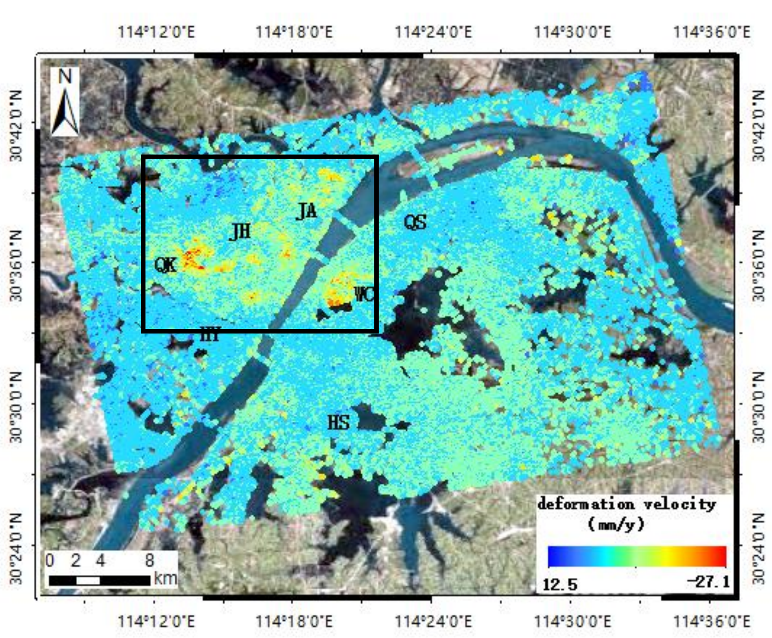


Figure2. The LOS deformation velocity map of Wuhan City

The LOS deformation velocity are approximately in the range of -27 mm/yr to 12.5 mm/yr during the observation period, with a standard deviation of 2.82mm/y.

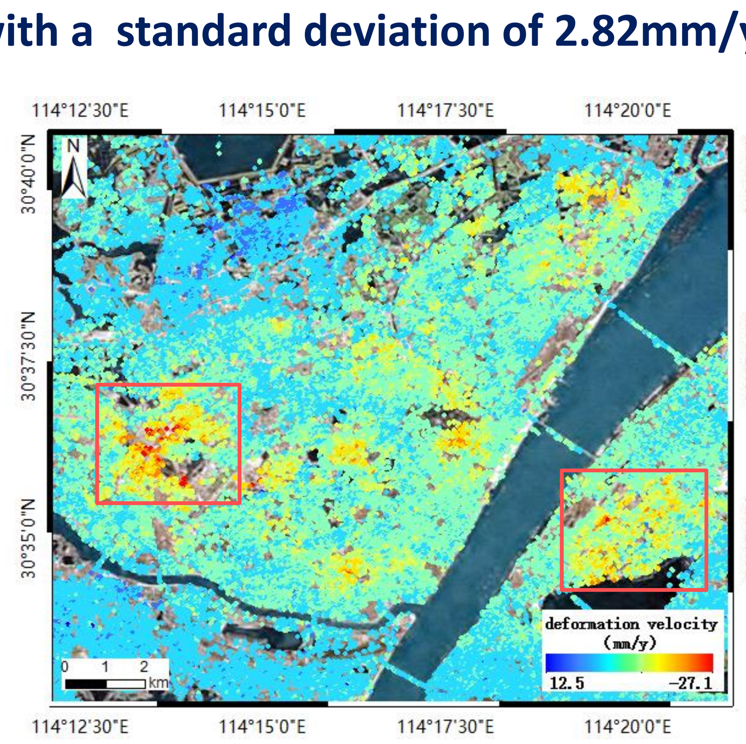


Figure3. The deformation velocity of main built-up areas in Wuhan.

The maximum subsidence rate near Changmatou built-up areas reaches -27mm/y. Time series diagram of PS points displacement shows an consistent and obvious accumulative trend, with a maximum subsidence of -38mm. This is because that there are Metro Lines 12 and 7 under construction in this area during the acquisition of experimental data. . And according to the survey, , it is the old city of Hankou, where the buildings of many communities are already very old and weak. Besides, the reconstruction project of village in the city also contributes to local subsidence.

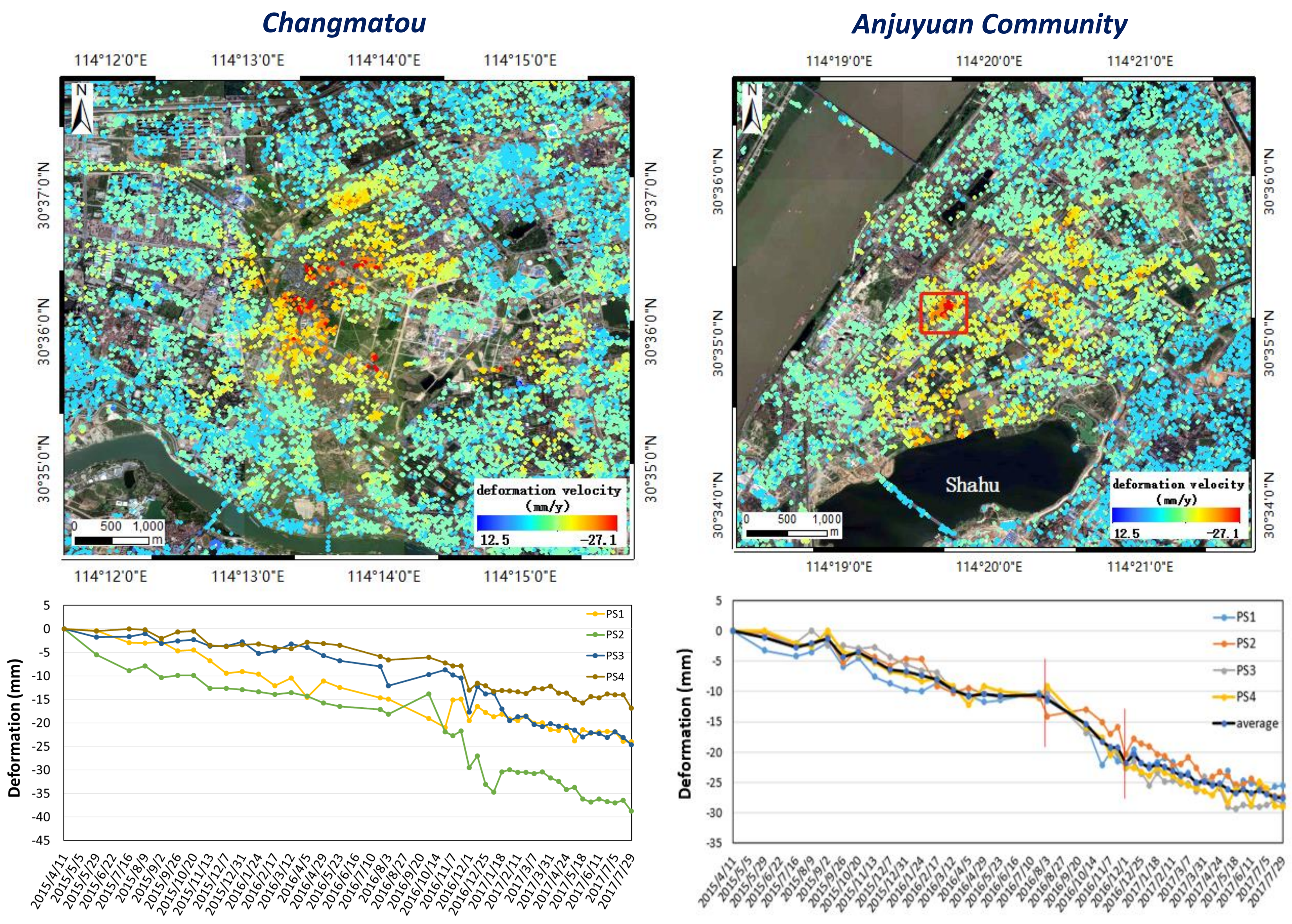
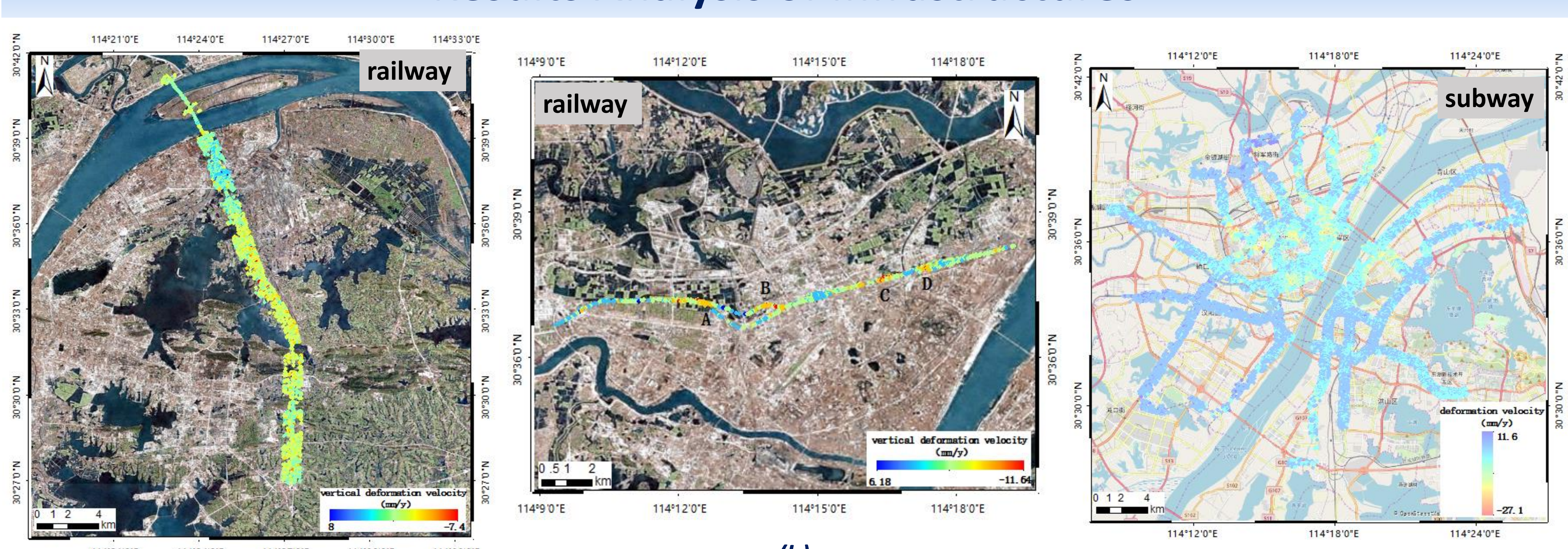


Figure4. The deformation map and time series displacement

Figure4. Wall cracking in Changmatou built-up areas

The accumulative deformation of Anjuyuan Community in Wuchang District (the red rectangle in the right) has exceeded 30mm. And the subsidence rate of the community accelerated from August 2016 to November 2016, during which the subsidence is equivalent to that in the previous 16 months. Exactly, there are subway works on three sides of the community. It is worthy of consideration.

Results Analysis of Infrastructures



(a) (b) (c).

Figure5. The deformation velocity map of infrastructures

The section of Wuhan-Guangzhou high-speed railway passing through Wuhan Railway Station (Figure5(a)) is overall sinking slightly and there is no uneven subsidence. Whereas the section of Shanghai-Wuhan-Chengdu High-speed Railway (Figure5(b)) is suffering from different degrees of subsidence, and the deformation rate in the vertical direction is between -11.64mm/y and 6.18mm/y. The differential subsidence in some railway curves is relatively large, such as the curve at B. Besides, differential subsidence in multiple subway hubs is serious : Wangjiadun East、Zhaojiatiao、Zongguan、Xujiapeng、Sanyang Road.

Conclusions

The InSAR-derived displacement map highlights active motions of built-up areas and infrastructures in Wuhan. The time series analysis shows that some of the communities are suffering from severe subsidence or even accelerated trends. Besides, the analysis of deformation distribution details given warnings for typical curved road sections and differential settlement sections of railways and subways. The subsidence monitoring of built-up areas and infrastructures proved the application potential of InSAR method and the capability of Sentinel-1 data in large-scale deformation monitoring. It can provide technical support for safety monitoring and early warning of built-up areas as well as infrastructures.

Main References

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