Use of Interferometric Synthetic Aperture Radar (InSAR) Parameters for the Evaluation of Hazardous Conditions in Urbanized Areas

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Introduction

One of the most important applications of remote sensing (RS) technologies is about the detection and monitoring of ground changes using remotely-sensed images (e.g., [1–3]). In this framework, the last three decades has shown the development and the subsequent application of several interferometric synthetic aperture radar (InSAR) approaches [4-7] for the continuous monitoring of state of conservation/maintenance of public/private infrastructures. In this work, we clarify the potential of InSAR methodologies, complemented with naïve artificial intelligence (AI) approaches, to automatically discover differential displacement signs over single infrastructures. We made profit from the recent advances in the field, as reported in the following principal publications [8-12], to find out a list of synthetic coherent indices (e.g., conservation criticalities, angular distortion, etc.) whose relevance has been tested in a real context.

Objective and methodology

A set of Sentinel-1 SAR data collected over the highly urbanized area of Shanghai has been used. Preliminary, the ground displacements and the relative movements of buildings/infrastructures have been retrieved by processing the SAR data at the single-look scale [13] implementing conditioned multi-temporal phase unwrapping operations [14]. Overall, more than 12 millions of single measurement points have been recovered, over which the selected coherent synthetic indices have been tested. Experimental results demonstrate the importance of integrated methods, fostered by InSAR and AI, for the fast mapping of hazardous conditions and can further be extended to perform analyses in other contexts, considering the specific characteristics of these new environments.

Conclusion

In this work, we have shown the potential of coherent methodologies for the monitoring of buildings/infrastructures in highly urbanized regions. Specifically, we have investigated the role and potential of different synthetic coherent indices based on the measurement of the ground/structures displacements and their mutual interactions for the rapid mapping of “changed areas”. A classifier based on random forest was trained combining different information.

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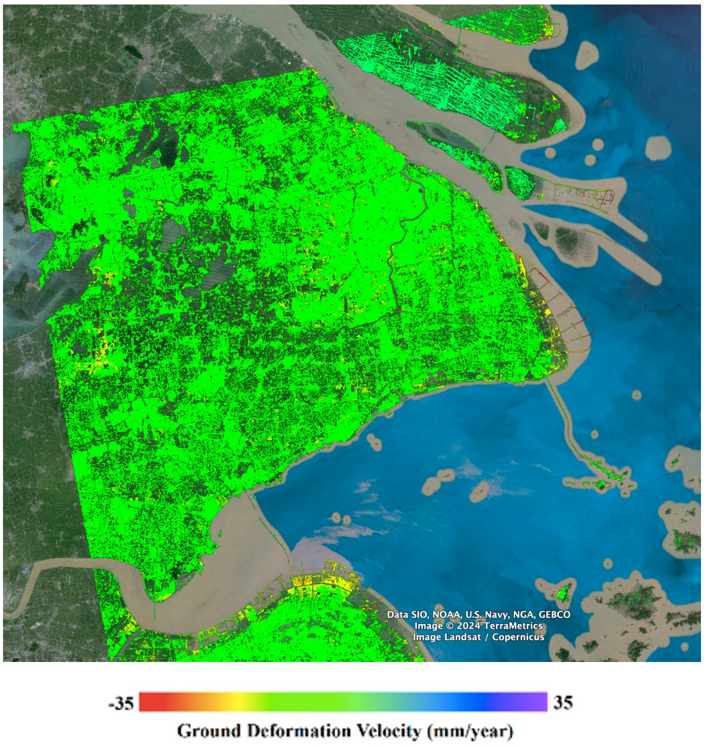

Figure 1. Multi-looked 2016-2023 mean deformation velocity of Shanghai area

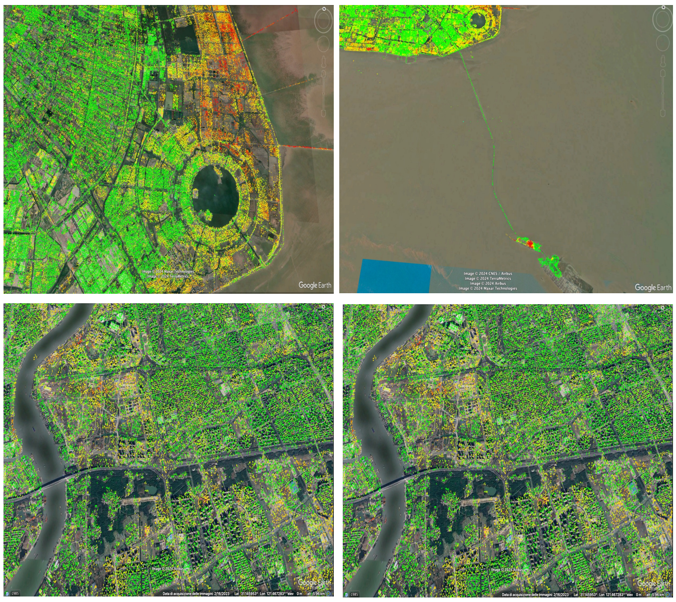

Figure 2. 2016-2023 Mean deformation velocity of Shanghai computed at the single-look scale using [13].