



Landslide deformation monitoring along Karakoram Highway based on InSAR technology

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Abstract

The Karakoram region is located on the tectonic belt and is also a high-risk area for geological disasters. Due to the complex terrain, high mountains and deep valleys, geological disasters such as landslides are prone to occur, and traditional monitoring is extremely difficult to carry out, which hinders the understanding of landslides in the region and leads to a lack of disaster prevention and reduction measures for local landslide disasters. This study is based on the 2021 Sentinel-1A data along the Karakoram Highway, and starts from the identification results of Stacking-InSAR technology, focusing on analyzing typical landslides along the Karakoram Highway. Utilizing Small Baseline Subset Synthetic Aperture Interferometric Radar (SBAS-InSAR) technology to monitor the displacement characteristics of landslides, and analyzing the causes of landslides in conjunction with the environment in which they occur. The research results are as follows: (1) Based on Stacking InSAR technology, 7 potential landslides along the Karakoram Highway were obtained, all of which are in an unstable state. (2) In 2021, landslides occurred frequently along the Karakoram Highway, and the displacement data of the landslide line of sight showed significant deformation of the Mostag landslide, with a maximum deformation rate of 94 mm/a. The research results are of great significance to the prevention and control of geological disasters along the Karakoram Highway and to serving the national "the Belt and Road" strategy.

Datasets

Table 1 Detailed Information List of Radar Image Data

Track number (Ascending/Descending)	satellite	Time (year, month, day)	Number of Images	Polarizati on mode
27 (Ascending)	Sentinel	2021.01.03-2021.12.29	31	VV

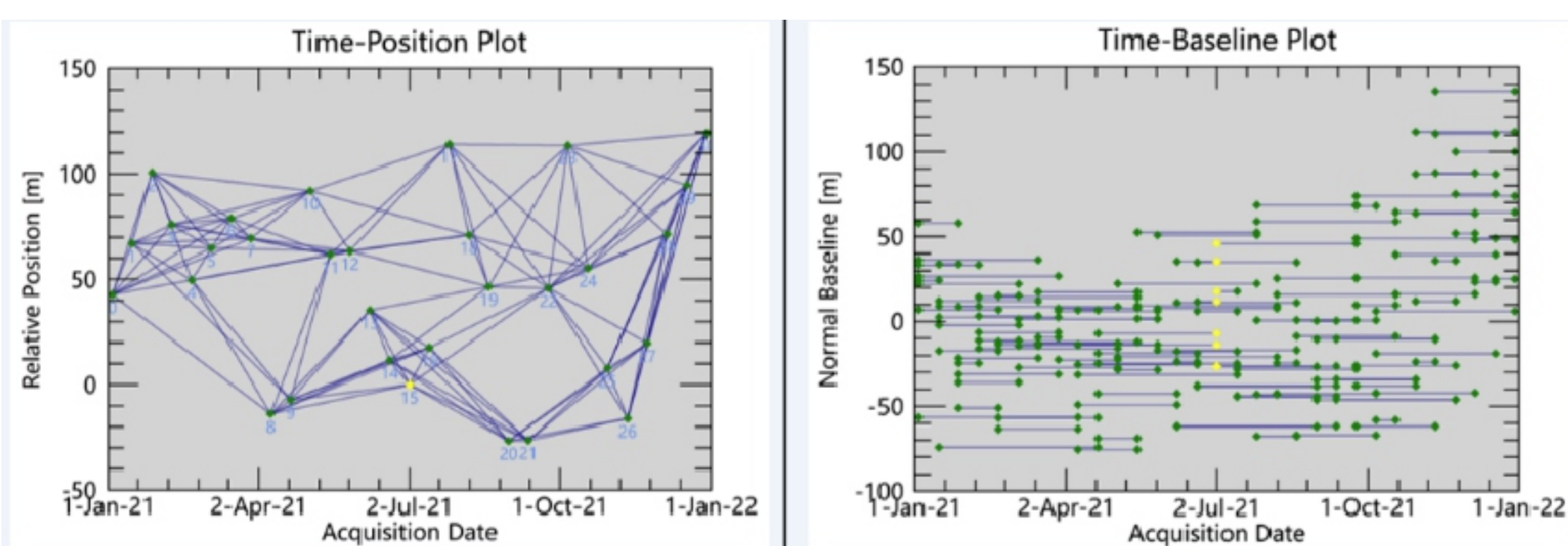


Fig. 1. Sentinel-1A Data Time-Position Plot and Time-Baseline Plot

Discussion

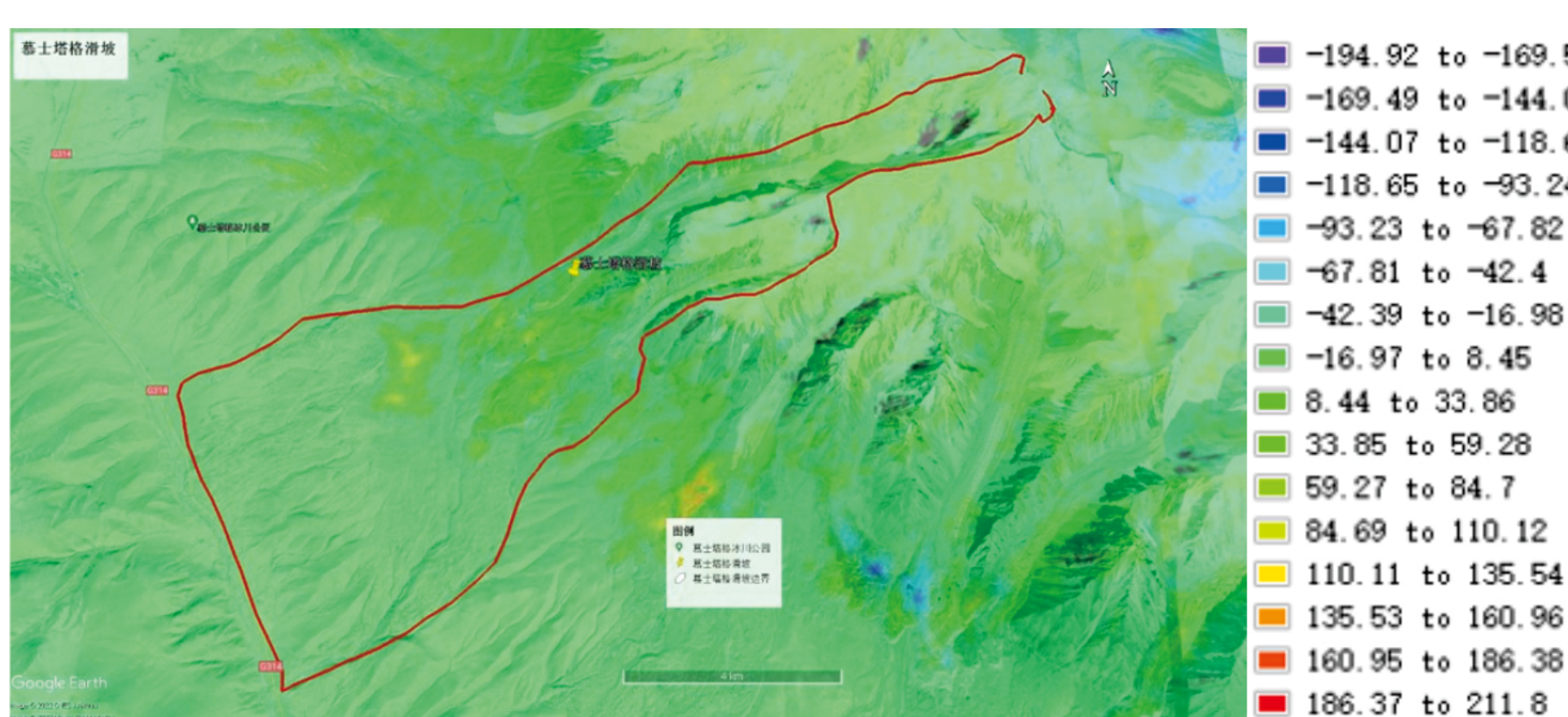


Fig. 5. Deformation rate diagram of Muztag landslide(2021)

In 2021, landslides occurred frequently along the Karakoram Highway, with a significant vertical height difference, making it a typical high-altitude landslide. The landslide line of sight displacement data monitored based on radar data shows that the significant maximum deformation rate of Mostag landslide is 94 mm/a (Fig. 5). We speculate that landslide deformation may be related to precipitation and increased temperature.

Conclusions

SBAS-InSAR technology is suitable for landslide identification in high mountain and canyon areas, and its early warning and prevention of landslides are particularly important. It is also an important means of disaster prevention and reduction at present. It is of great significance to the prevention and control of geological disasters along the Karakoram Highway and to serving the national "the Belt and Road" strategy.

Acknowledgements

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Data Processing and Results

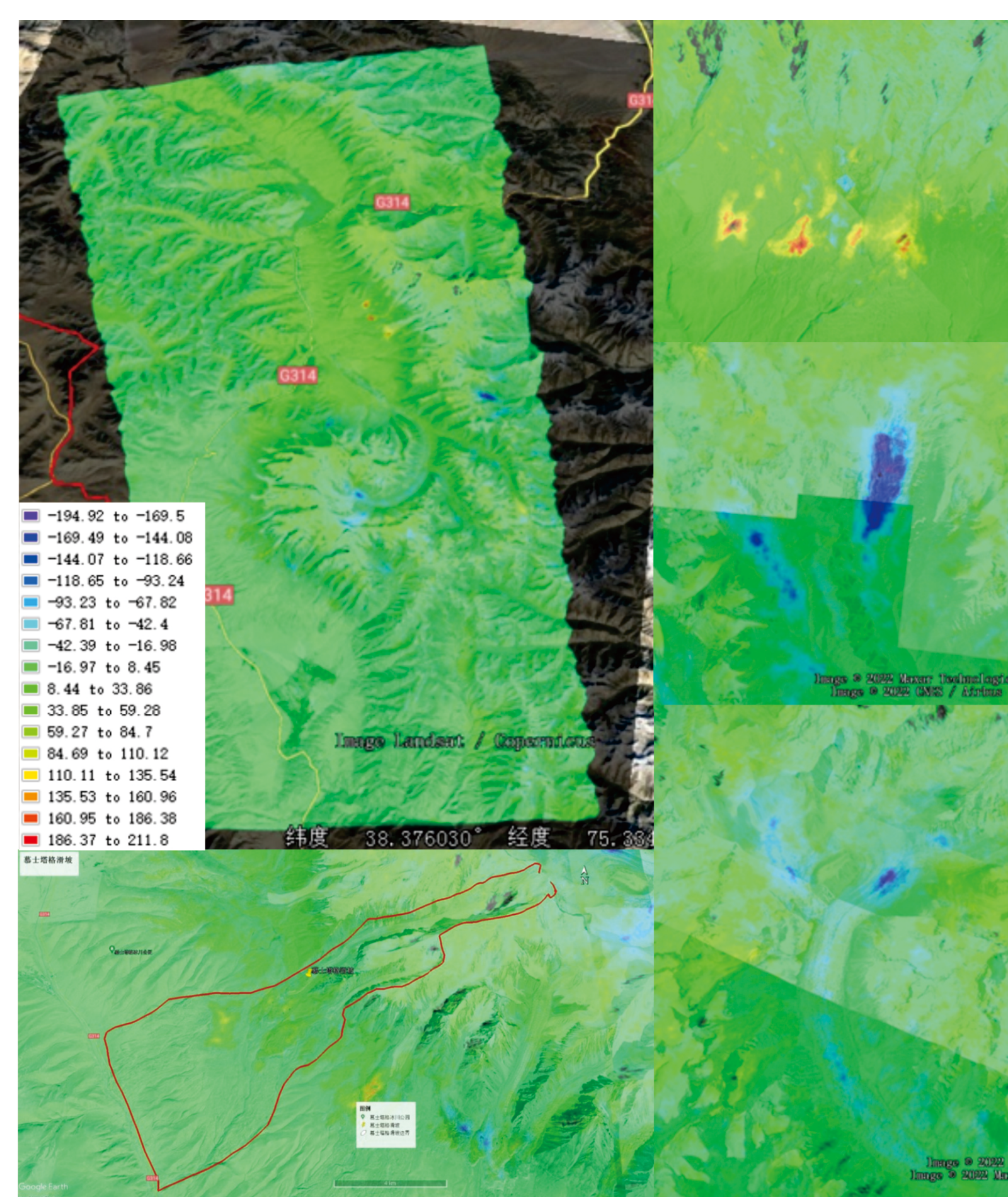


Fig. 2. The deformation rate map of the KKH(Xinjiang) in 2021 (LOS)

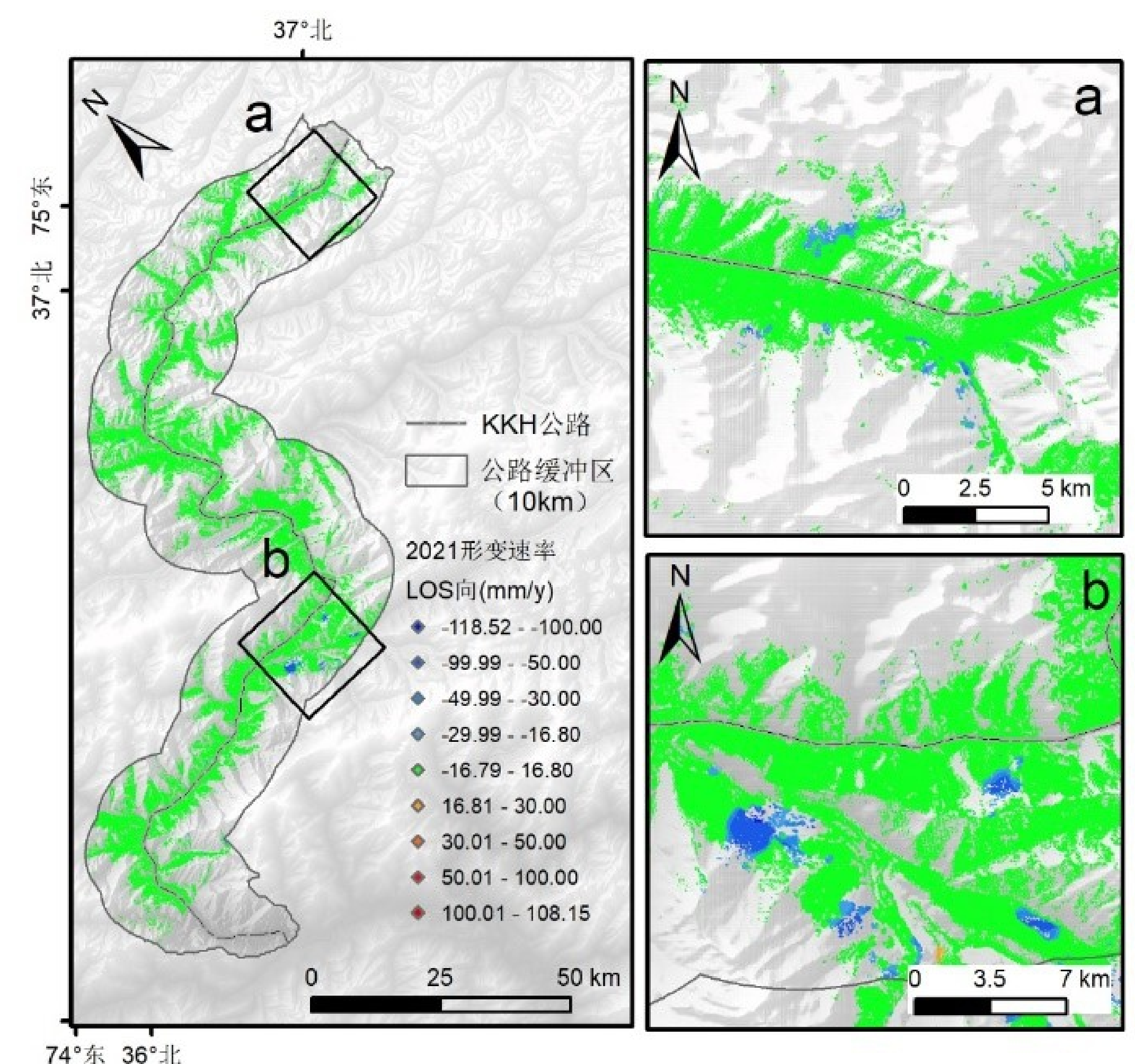


Fig. 3. The deformation rate map of Hunza River Valley in 2021 (LOS)

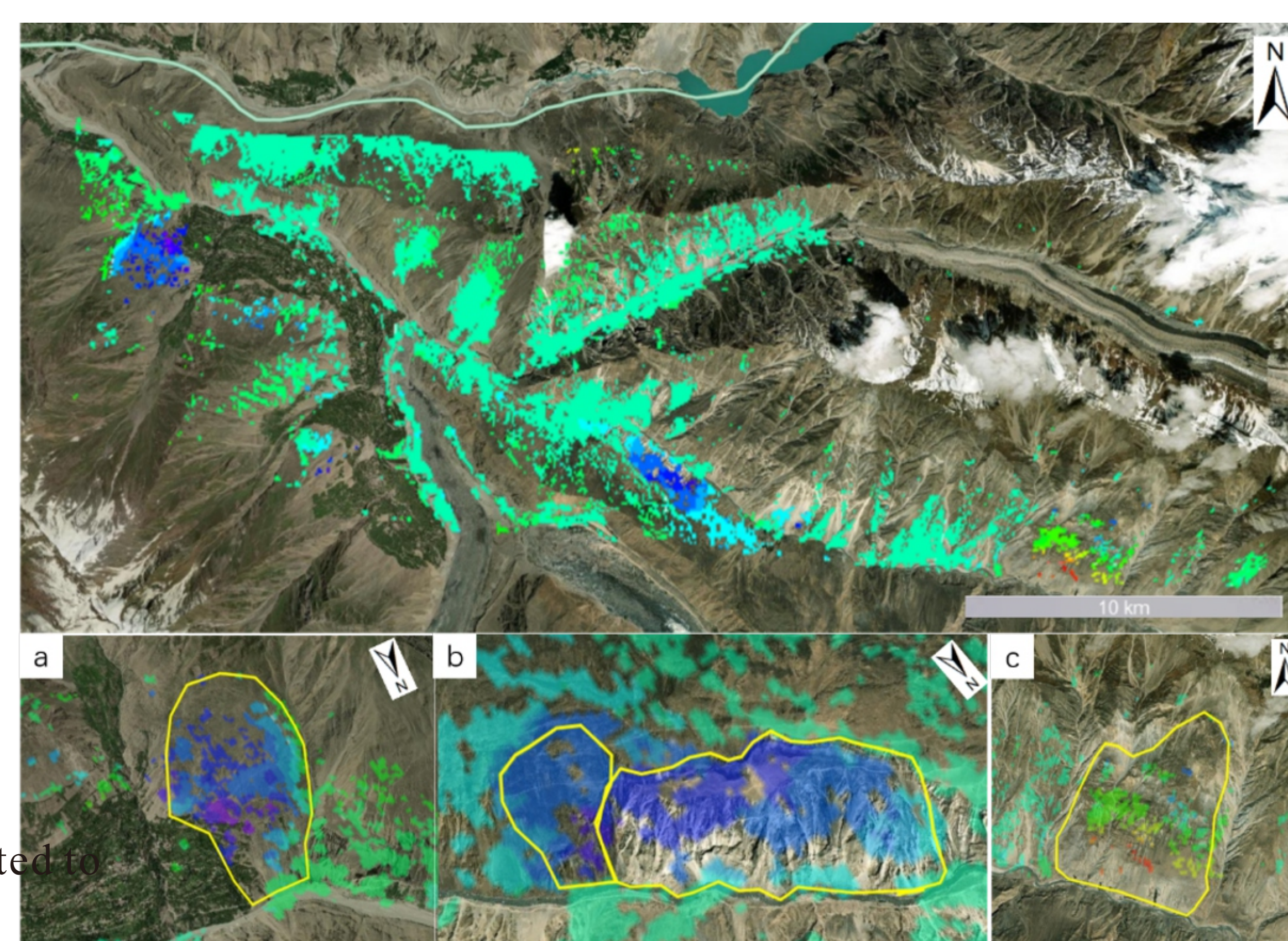


Fig. 4. Typical Landslides Identified by SBSA-InSAR in the Hunza River Valley(2021)

Based on Sentinel-1A data from the Xinjiang section of the Karakoram Highway and the Hunza River Valley section in 2021, using Stacking-InSAR and SBAS-InSAR techniques, we have identified 7 potential landslides along the Karakoram Highway, as shown in Fig. 2, Fig. 3, and Fig. 4. The blue and red in the figure represent areas of severe deformation, while the green represents stable areas. In 2021, the average annual deformation rate of the Xinjiang section of the Karakoram Highway was -194.92-211.6 mm/a, and the average annual deformation rate of the Hunza River Valley section was -118.52-108.15 mm/a. Three typical landslides were identified in the Hunza River Valley section (Fig. 4).