

Introduction

Sanjiangyuan, as the Chinese ‘water tank’, is located in Qinghai province, China. It is the fountainhead of yellow river, Yangzi river and Lancang river. Therefore, it's extraordinary valuable to the environment of China and Asia. The continuous permafrost spreads widely in this area. With the global warming process, the degradation of permafrost becomes faster and consequently changes the distribution of vegetation and hydrological cycle.

In this study, we use Persistent Scatterer InSAR (PSI) technique to efficiently detect the seasonal settlement around Elin lake and Zhaling lake, which are the main parts of Sanjiangyuan region. The subsidence was analyzed by processing 39 Sentinel-1 SAR images from 2017 to 2019 using GAMMA and StaMPS. The results were then inverted to derive the corresponding active layer thickness over this region. Moreover, in order to investigate the detailed influence of degradation on infrastructures, we analyzed 3m resolution TerraSAR-X images in StripMap mode from May to October 2015 to get the heterogeneous subsidence along the Gonghe-Yushu road.

Study area & Data

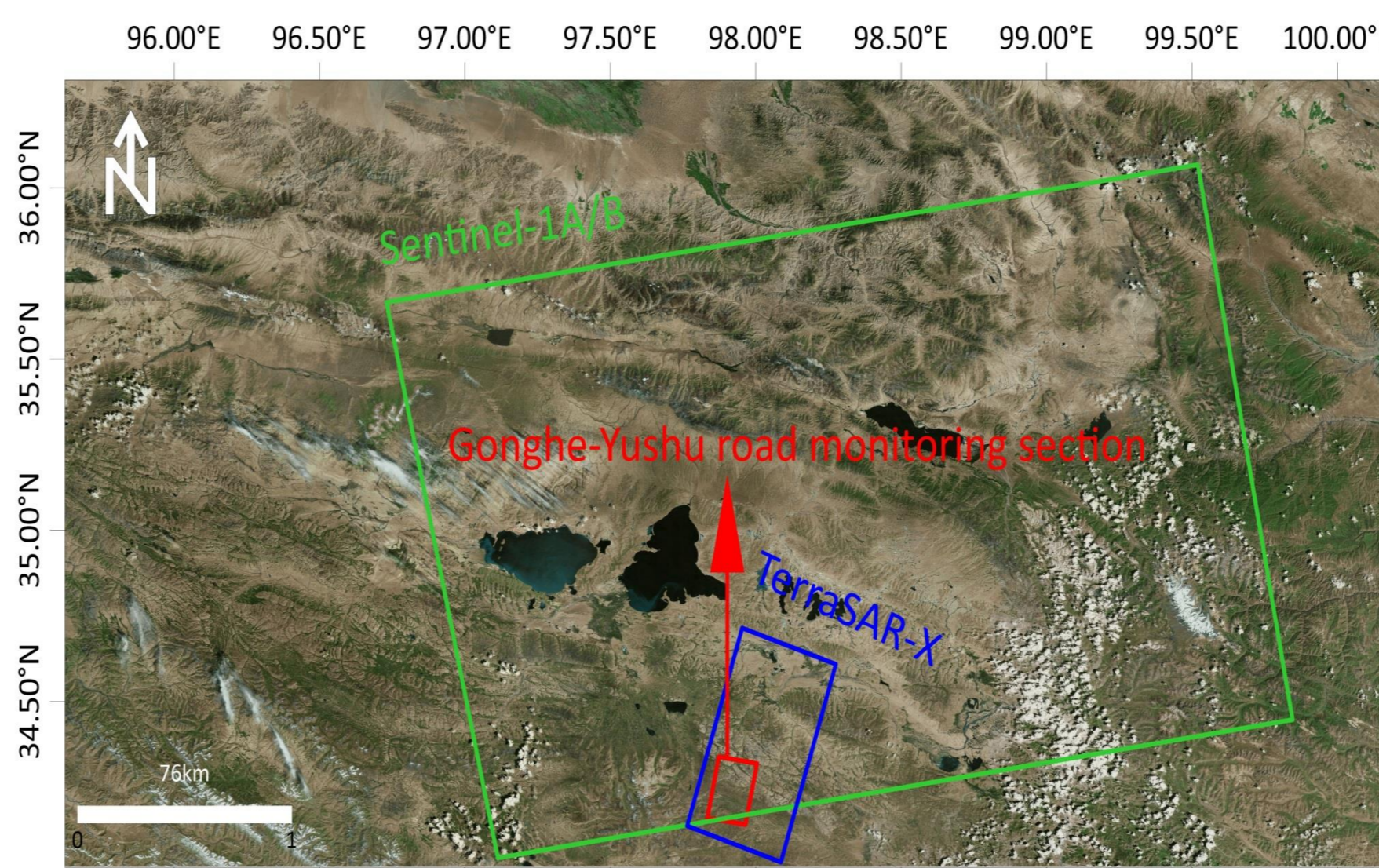


Fig. 1. The study area in Qinghai province, China.

Table 1 The data used to analyze thaw subsidence

Sensor	Acquisition time	Number of images	Operation Mode
Sentinel-1 A/B	20170505-20171020	11	IW
Sentinel-1A/B	20180512-20181027	13	IW
Sentinel-1A/B	20190507-20191022	15	IW
TerraSAR-X	20150509-20151010	12	SM

Methodology

- Sentinel 1-A/B images during summer time in 2017-2019 were processed separately to see how the thaw subsidence in this area changes by time. All interferograms in which the coherence above 0.5 were chosen to analyze the thaw subsidence by StaMPS.
- Interferograms from TerraSAR-X images spanning 22 days in 2015 were processed in StaMPS to get high resolution(3m) displacement map.
- Use GACOS and Linear correction to mitigate atmosphere phase screen.
- Compare deformation obtained by PSInSAR to leveling data.

Sentinel-1A/B results

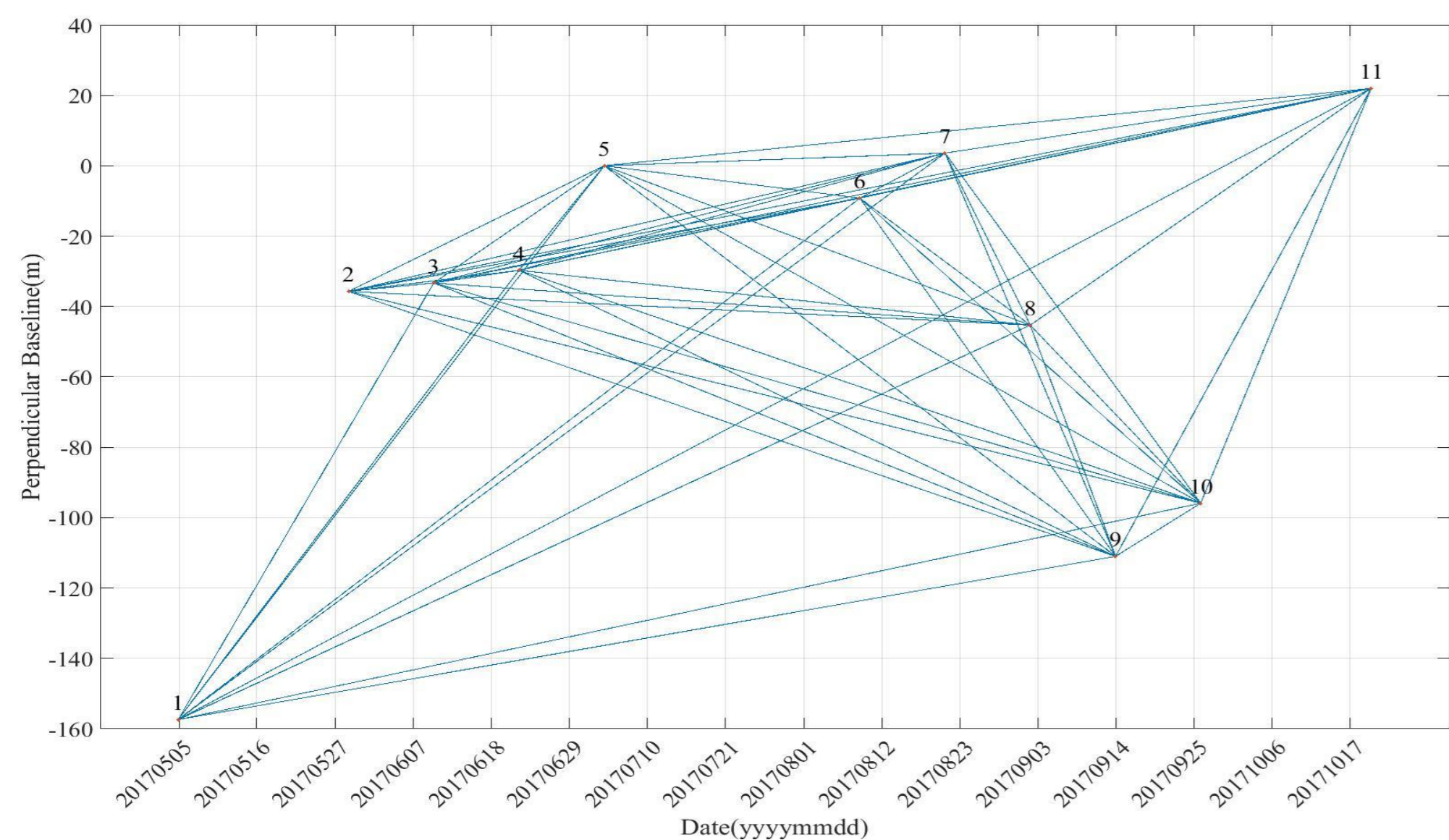


Fig. 2. The network of interferograms in 2017.

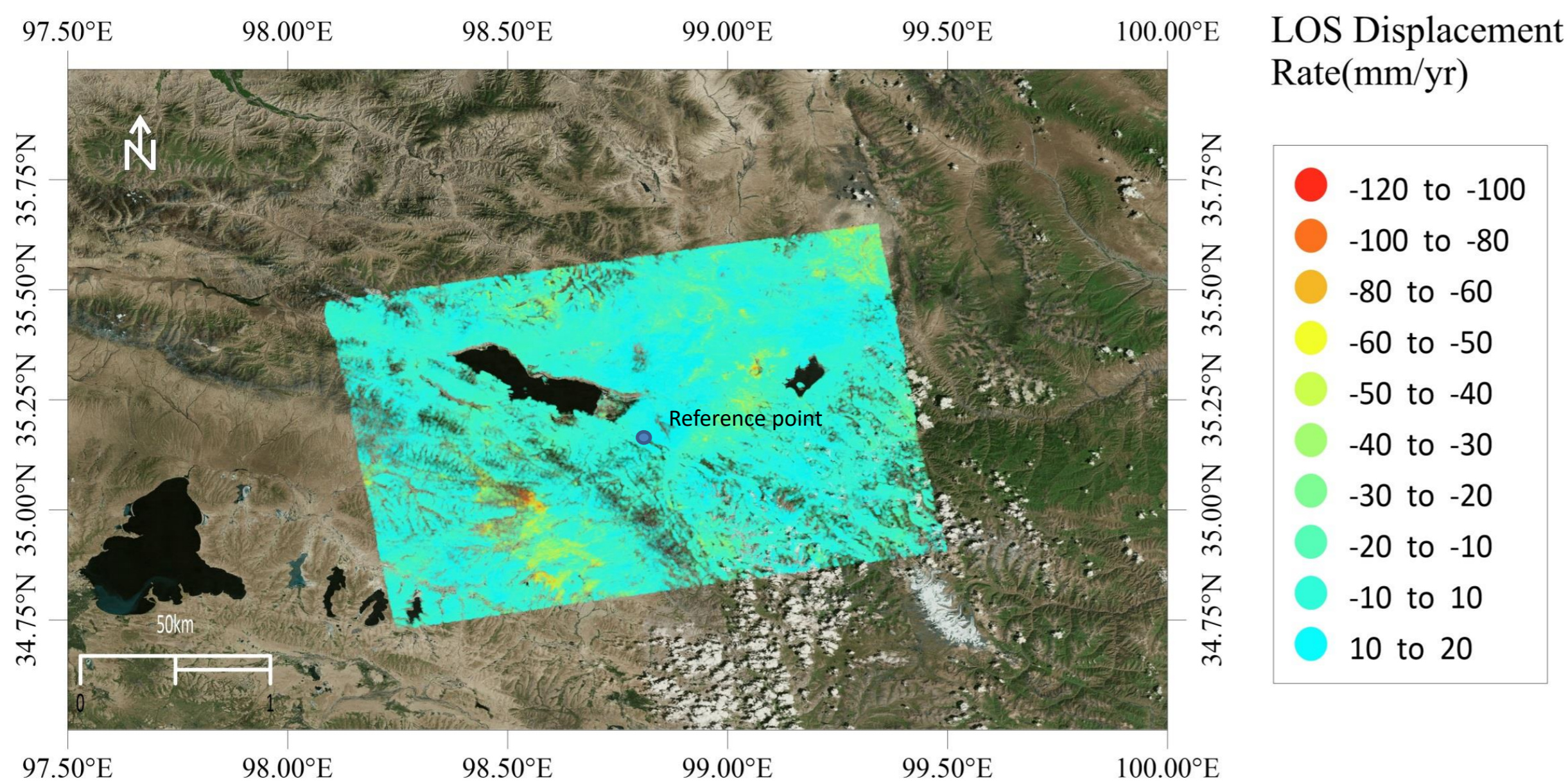


Fig. 3. The mean LOS velocity around Donggecuona lake in Sanjiangyuan.

TerraSAR-X results

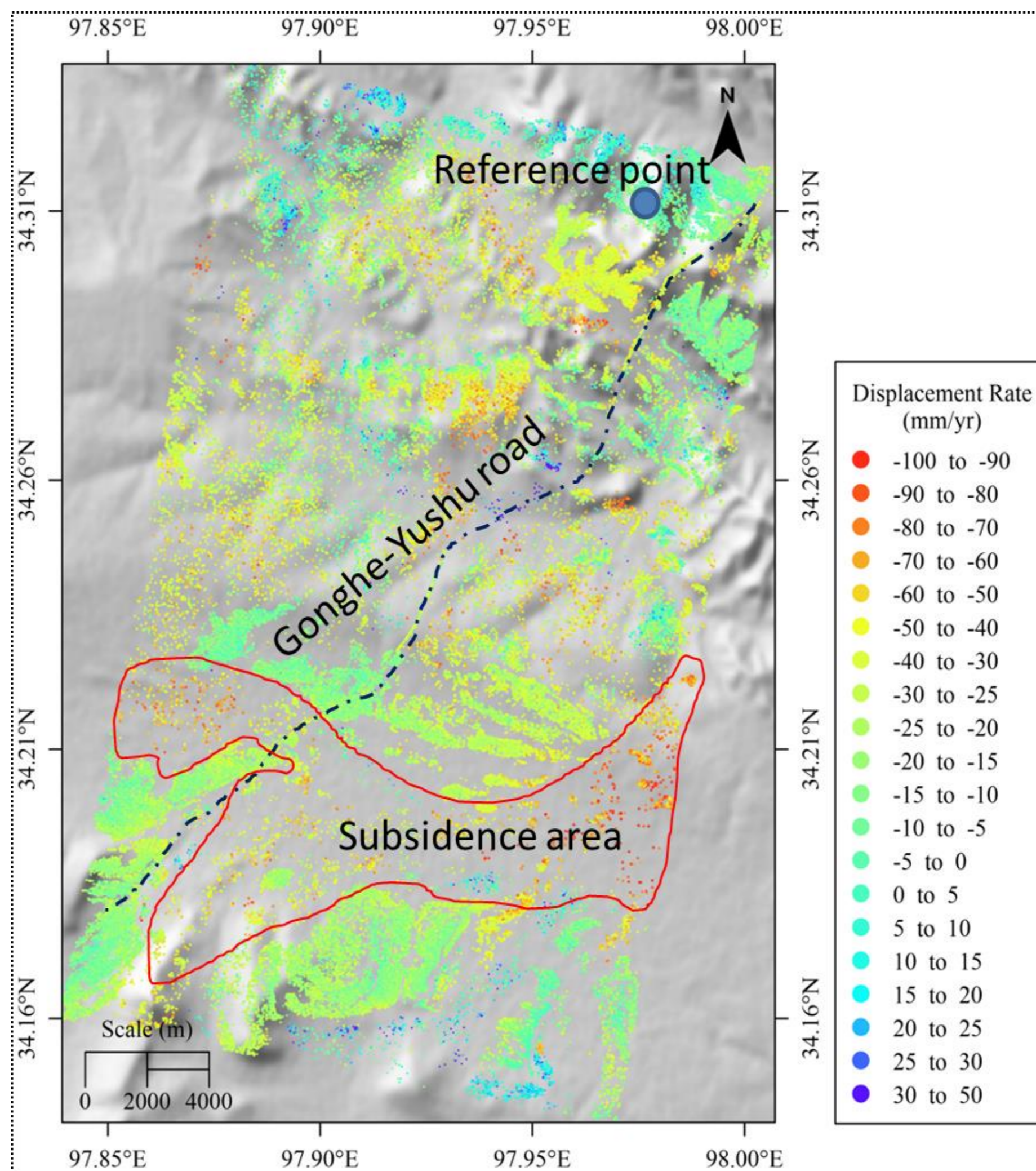


Fig. 4. The mean LOS velocity acquired by TerraSAR-X images in 2015.

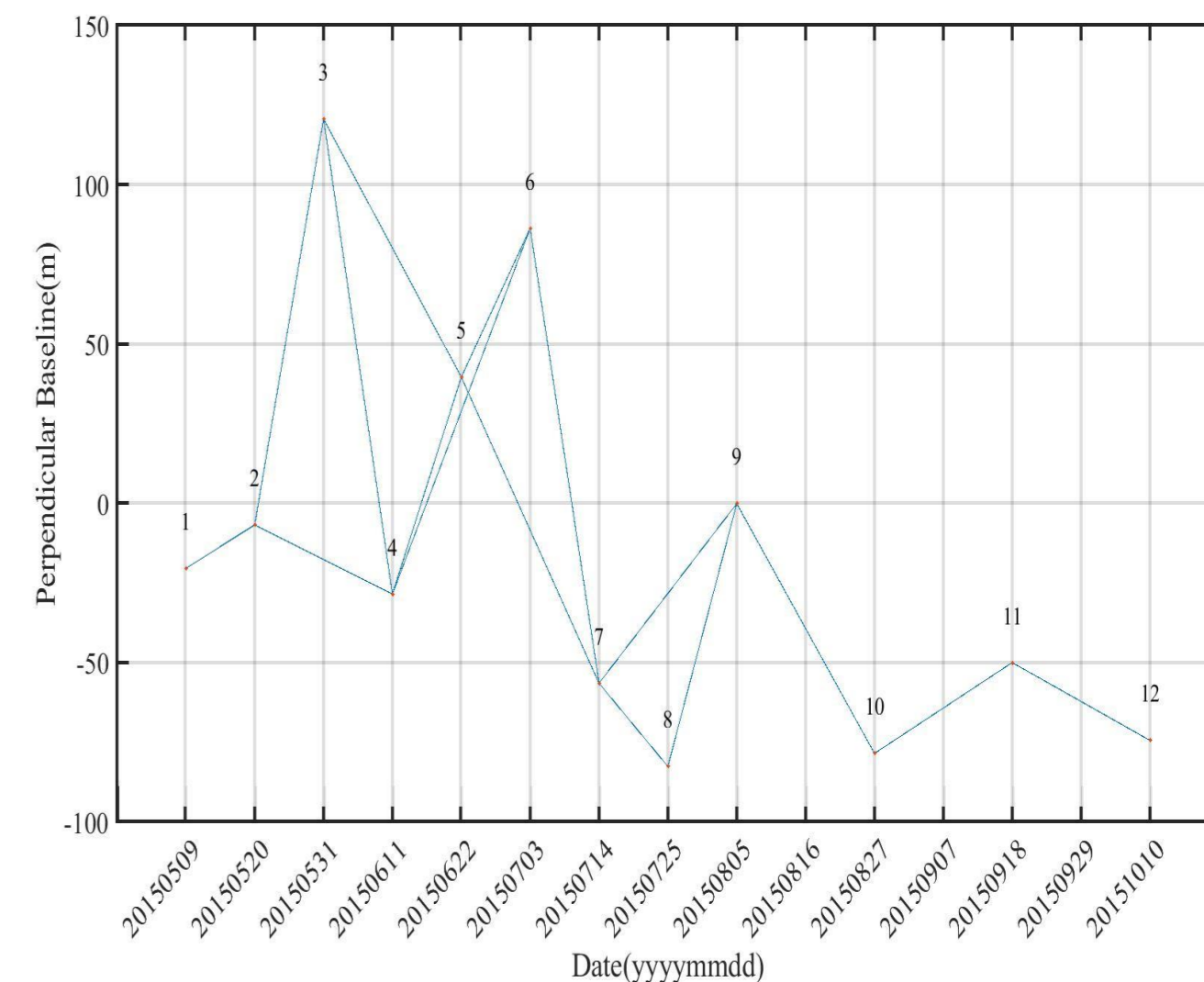


Fig. 5 The baselines of interferograms.

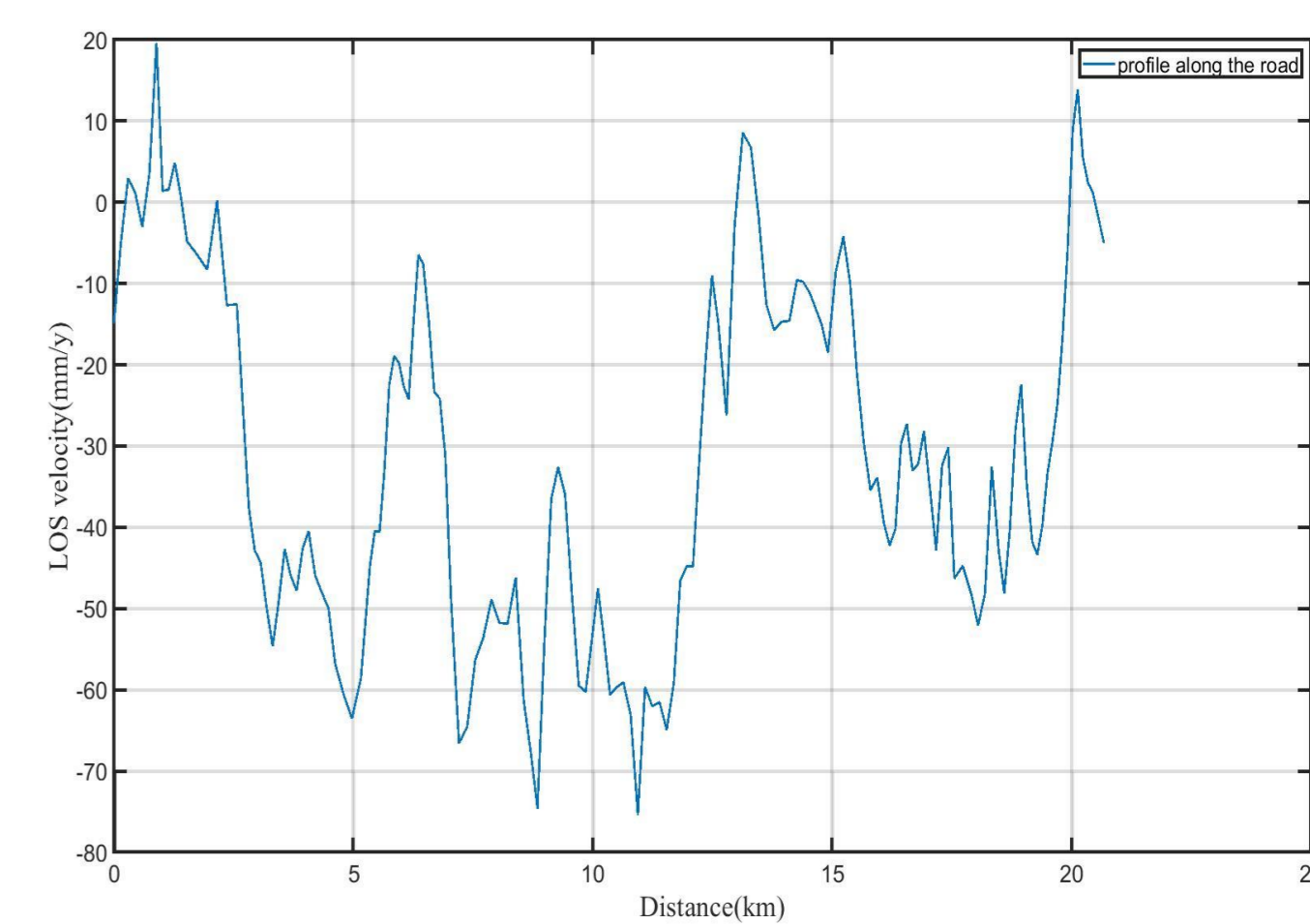


Fig. 6. The mean velocity profile along Gonghe-Yushu road.

Conclusions

- Due to the longer wavelength, Sentinel1-A/B interferogrametric pairs have better coherence than TerraSAR interferograms in this area. Therefore, longer temporal baseline pairs could be used to do PS analysis. However, using only short temporal baseline interferograms generated from TerraSAR-X can minimize phase ambiguity.
- In this area, It's valuable to use Linear method to correct atmosphere phase. The thaw subsidence of permafrost in Sanjiangyaun has been detected by PS-InSAR in wide coverage of Sentinel-1A/B and high resolution TerraSAR images afterwards.
- The magnitude of subsidence rate related to the reference point is up to 120mm/yr. As one of the main transportations in Qinghai-Tibetan Plateau, Qinghai-Tibet Highway suffers from surface change due to permafrost. The heterogeneous displacement damaged the subgrade. The mean velocity detected in Gonghe-Yushu section differs from 20mm/y upward to 76mm/y downward in 2015.