TECTONIC ACTIVITY OF THE PULI BASIN IN CENTRAL TAIWAN: OBSERVATION FROM SPACE AND FIELDS

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ABSTRACT: The Puli Basin is the largest basin in the Taiwan active orogeny. In terms of geology, the Puli Basin spreads over the Western Foothills (WF) and the Hsuehshan Range (HR), and the lithofacies are quite different between the north part and the south part of WF. Thus, Puli is formed at a kinematic transition zone, which makes the tectonic evolution of Puli Basin complicated.

Many different tectonic models have been proposed by previous studies to interpret the formation of the Puli Basin. In this study, we aim to measure the deformation for analyzing the tectonics and to understand the mechanism of Puli Basin by the method of satellite remote sensing and field observation. Since the Puli Basin is bordered by the mountains with steep topography and dense vegetation, we applied Persistent Scatter Interferometric SAR (PSI) to monitor the long term deformation. Our works show that this area has undergone a continuing deformation. This deformation can be explained as the compression of the west-moving Central Range. This Interferometric result can be compared with our field observation to examine the activity of faults of this area.

INTRODUCTION

Since Taiwan is converged by Eurasian Plate and Philippine Sea Plate, compression-dominated stress builds up lots of high mountains. However, there are several basins surrounded by the high mountains in the southern Hsuehshan Range. The Puli basin is the largest one in this area. Previous studies have proposed some possible formations so far. While the reasons that caused a series of basins develop is an interesting problem.

The surrounding mountains and the basement are slightly metamorphic rocks which are formed in early Tertiary. Inside the basin are Quaternary layers. There are several NNE-SSW faults have been found such as Dili Fault, Meiyuan Fault, and Shuilikeng Fault. The basins develop as the same direction as the faults. From northwest to southeast are Puli Basin, Yuchi Basin, Sun-Moon Lake, Touche Basin, and Tungkuei Basin. In order to understand the tectonic activity of Puli basin, monitoring the surface deformation in and around this basin should be a top priority.

In recent years, Differential Interferometric Synthetic Aperture Radar (DInSAR) and Persistent Scatterer InSAR (PSI) has played an important role for monitoring tectonic activities. Due to several limitations of DInSAR such as surface feature and atmospheric effect, PSInSAR provides a relative stable and strong scatterer which is brighter than the background ones increases the quality of surface deformation monitoring. Since the topography condition of Puli basin, we applied PSI to monitor the long term deformation.

Method

Satellite remote sensing has been applied to measure the surface deformation successfully in recent year. Synthetic Aperture Radar (SAR) system is widely used nowadays. Persistent Scatterer InSAR is an advanced technique which was developed by Hopper at el. (2004). Extracting the deformation of land surface with independent signal is the most spectacular feature of PSI. It selects the largest contributor scatterers as the main signal in order to increase the accuracy of the estimated displacement of a research area even with dense vegetation. In this study, we apply Hopper's method, the StaMPS (Stanford Method for PS, Hooper et al. 2007), for identifying PS pixels and estimating their displacement. Due to several error corrections, the residual phase, ϕ, could be written as the sum of 5 terms below (Eq. 1):

$$\phi_{x,i} = \phi_{def,x,i} + \phi_{\alpha,x,i} + \phi_{orb,x,i} + \phi_{\varepsilon,x,i} + n \qquad \text{(Eq. 1)}$$

Where ϕ_{def} is the phase change due to movement of the pixel in the satellite line-of-sight (LOS) direction, ϕ_{α} is the phase equivalent of the difference in atmospheric retardation between passes, ϕ_{orb} is the phase due to orbit inaccuracies, ϕ_{ε} is the residual topographic phase due to error in the DEM and n is the noise term due to variability in scattering from the pixel, thermal noise and coregistration errors. We can use mathematical calculations to remove the error above from PSI in order to extract the more precise results.

In this study, we applied the image from ERS and Envisat (Fig. 1, Track: 461; Frame: 3123). The pairs of scenes that we used in our Interferometric analysis are listed in Fig. 2. We selected 21 ERS images from 1995 to 2001 and 11 Envisat images from 2004 to 2008.

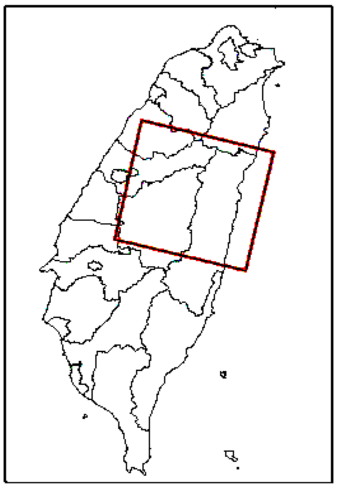

Fig. 1 ERS and Envisat orbit graph pass across Taiwan. The red square is our research area.
(Track: 461; Frame: 3123)

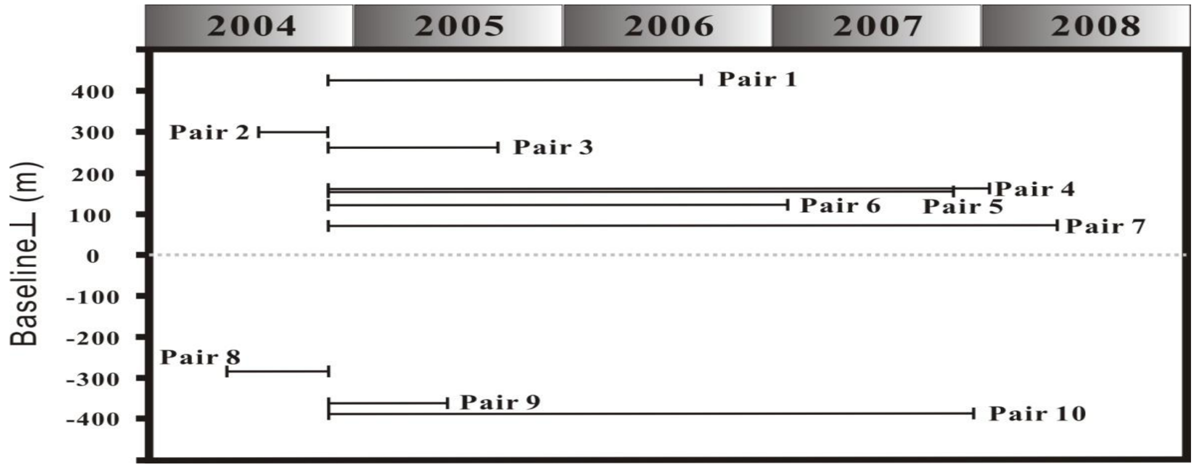

Figure 2a. 11 images from Envisat (2004-2008)

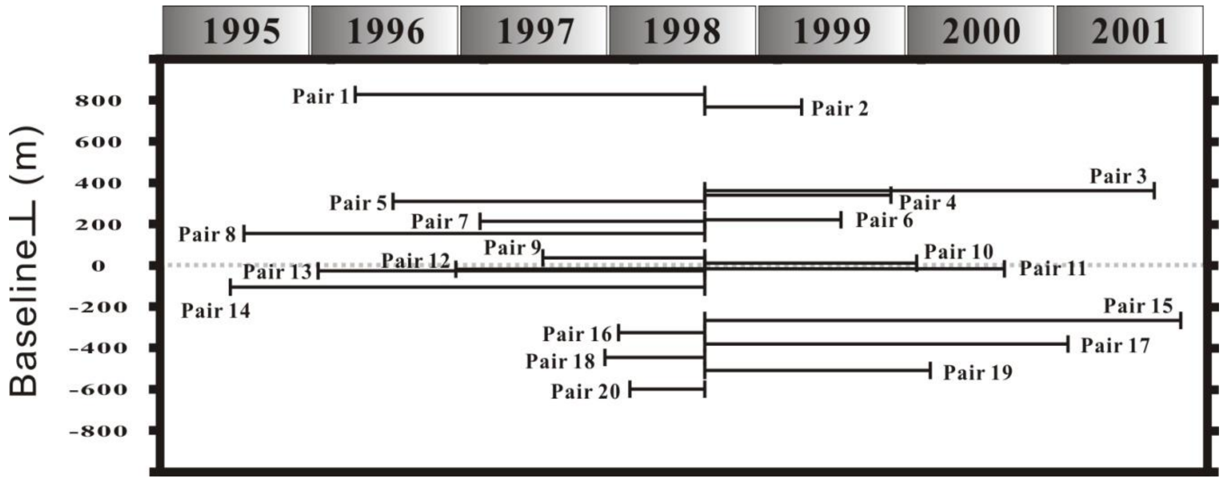

Figure 2b. 21 images from ERS (1995-2001)

Conclusion

We made two images of ERS (right) and Envisat (left) below (Fig. 3) which are the change of average velocity from line-of-sight (LOS). The blue dots are the reference point. In Puli Basin, the activities of the west part (8-10mm/yr) and east part (3-5mm/yr) showed differently from both two results. The east part subsided apparently than the west part relatively. Besides, the average deformation decrease gradually from northwest to southeast which means Puli Basin has the largest deformation of the basin groups. Moreover, we can also observe that there are differences between two images. That might be the time period we selected are different. The ERS image includes the 921 earthquake event may be the main reason.

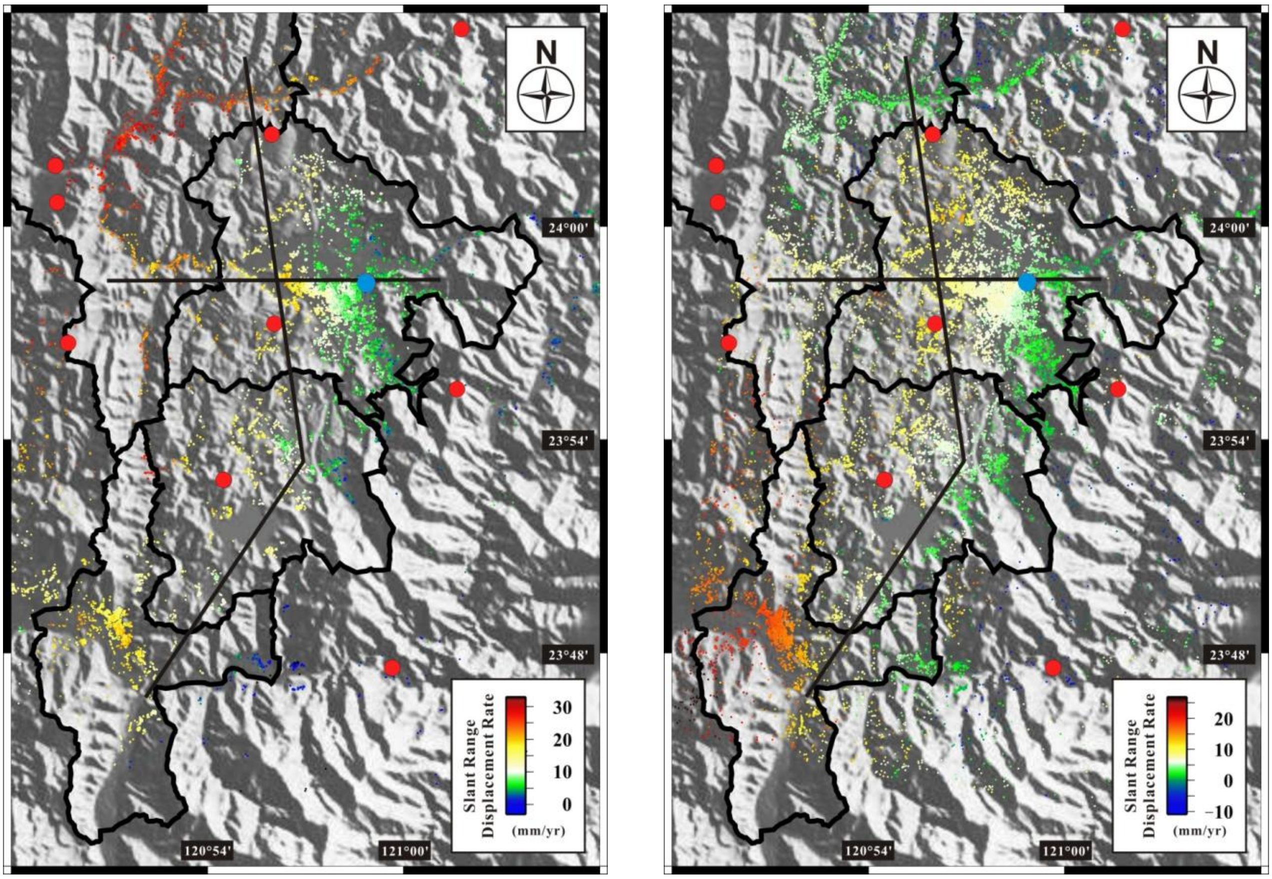

Fig. 3 Change of average velocity from ERS and Envisat. Warm colors represent shortening at LOS which means the surface uplift In other words. Otherwise, the cold colors represent the subsidence of the land surface.

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