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Insights the transpressioanl deformation patterns in the western zone of Sulaiman Fold-and-Thrust belt from spaceborne geodesy

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Continental convergence of Indian and Eurasian plates produces Himalayas in the north, while tectonically complex transpressional zones of the Sulaiman Fold and Thrust (SFT), and Kirthar Fold and Thrust (KFT) belts in the East. Seismic hazards in the zones are very high and less understood due to complex tectonic settings, and lack of GPS network. Here, we take advantage of spaceborne SAR interferometry and use the Sentinel-1, and ALOS-2 ScanSAR satellite observations to estimate the coseismic deformation caused by the 2021 Mw 6.0 Harnai earthquake in the western zone of the SFT belt. We find the line-of-sight (LOS) displacement of ~80 and ~70 mm from Sentinel-1 descending and ascending interferograms respectively. We find the ~50 mm of LOS displacement from ALOS-2 descending interferogram, but it is majorly biased by lower and upper atmospheric noises even after the GACOS and ionosphere corrections. In order to avoid the major noise components in inversions that may affect the accuracy, we discarded the ALOS-2 LOS displacement and relied only on the ascending and descending interferograms of Sentinel-1data. The deformation has an oblique component, but mostly dominated by thrusting on the NW-SE trending Harnai fault. First, we invert the LOS displacement using geodetic Bayesian Inversions approach, and find two plausible fault plane the NW-SE trending, and the NE-SW trending solutions. The simplified fault parameters have a strike of 327° ± 12, a dip of 31° ± 9, the length of 8.3 ± 2.1 km, and the width of 2.5 ± 2.0 km, which fits well the ISC and USGS fault models. Then, we determine the finite slip distributions on both plausible faults. The NW-SE trending fault shows the maximum slip is found to be 70 cm at around 8 km depth. The slip distribution along the down dip and strike of the fault shows that 85% of the slip is concentrated in an area of (9 × 9) = 81 km^2 at a down dip distance of 3 - 12 km. Furthermore, the results show the earthquake is propagated equally along strike and dip. For the NE-SW trending fault the maximum slip is similar but has higher residuals and scattered slip along depth. Therefeore, we preferred the NW-SE trending fault plane solution because based on the compatibility with fault structures in the region, and higher accuracy in the inversions. We also determine postseismic movement using time series analysis of spaceborne Sentinel-1 SAR data, but no significant afterslip and viscoelastic relaxation signals is found on the fault after the earthquake.