Revisit coseismic deformation of the Chi-Chi earthquake and its insights into seismic mountain building

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The Mw=7.6 Chi-Chi earthquake, the most destructive seismic event in recent decades in Taiwan, created surface ruptures with maximum offset of ~10 m along the Chelungpu fault. In order to characterize the seismic damage, fault behaviors, and topographic evolution, the amount and distribution of surface movements during the earthquake provides key information. Previous studies have used varied geodesy to estimate coseismic surface displacements along the fault. GPS provides regional but sparse surface measurements in 3D and the DInSAR method generated fringes only in the footwall areas of the Chelungpu fault. The azimuth and range offsets can provide more information in the hanging wall. However, there is no comprehensive information of regional 3D coseismic displacements. In this study, we derive a 3D displacement field of the Chi-Chi earthquake by using optical and radar images. The full 3D coseismic displacements in the both haning wall and footwall provide detail information of how such a large earthquake deforms and creats topography. The coseismic displacements is strongly dominated by fault geometry. The deformation pattern suggests pure fault-parallel motion with significant slip on the ramp and detachment faults. In addition, we used the displacements to estimate rock uplifted volume and the result shows that the volume is ~5 times larger than the coseismic landslide volume, which shows strong mountain building at the frontal orogenic wedge. Moverover, Spatial comparison of the coseismic uplift and landslides shows that the uplift and landslide distributions do not match and correlate more inversely. Thus, although massive earthquake-triggered landslides and following sediment discharge can significantly remove mountain surface, the bulk volume and topography of the front mountain belt should remain outstanding.

Keywords: coseismic uplift, mass balance, topographic evolution

