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TITLE: Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Vietnam

AUTHOR: ['Laura Erban', 'Steven M. Gorelick', 'H. A. Zebker']

ABSTRACT:

Groundwater exploitation is a major cause of land subsidence, which in coastal areas poses a flood inundation hazard that is compounded by the threat of sea-level rise (SLR). In the lower Mekong Delta, most of which lies <2 m above sea level, over-exploitation is inducing widespread hydraulic head (i.e., groundwater level) declines. The average rate of head decline is  $\sim 0.3$  m yr<sup>-1</sup>, based on time-series data from 79 nested monitoring wells at 18 locations. The consequent compaction of sedimentary layers at these locations is calculated to be causing land subsidence at an average rate of 1.6 cm yr<sup>-1</sup>. We further measure recent subsidence rates (annual average, 2006–10) throughout the Delta, by analysis of interferometric synthetic aperture radar (InSAR), using 78 ALOS PALSAR interferograms. InSAR-based subsidence rates are 1) consistent with compaction-based rates calculated at monitoring wells, and 2)  $\sim 1\text{--}4$  cm yr<sup>-1</sup> over large (1000s of km<sup>2</sup>) regions. Ours are the first mapped estimates of Delta-wide land subsidence due to groundwater pumping. If pumping continues at present rates,  $\sim 0.88$  m (0.35–1.4 m) of land subsidence is expected by 2050. Anticipated SLR of  $\sim 0.10$  m (0.07–0.14 m) by 2050 will compound flood inundation potential. Our results suggest that by mid-century portions of the Mekong Delta will likely experience  $\sim 1$  m (0.42–1.54 m) of additional inundation hazard.

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