Coastal changes in West Aceh, Indonesia, since the 2004 Indian Ocean tsunami

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The western Acehnese coastline in northern Sumatra, Indonesia, receded on average 134 m due to subsidence and tsunami inundation in the course of the December 26, 2004 Sumatra-Andaman earthquake and tsunami. Here, we investigate the re-growth of the coast since 2004 through field surveys, spatial imagery analysis, and numerical modeling. Three automatic level surveys were conducted in 2009, 2012, and 2013 over a beach ridge plain 15 km north of the city of Meulaboh in West Aceh. The surveys followed a transect from the coast up to 1.8 km inland. An 18.8 km long stretch of the same coastline was analyzed by digitizing the shoreline on satellite and aerial images taken between 2002 and 2013 and by computing the shoreline change rates using the Digital Shoreline Analysis System (DSAS) developed by the US Geological Survey. Following the initial erosion during the December 26, 2004 event, the coast prograded rapidly and a new wide beach ridge formed. However, the coastline never fully recovered and in 2011 was still an average of 52.7 m from its pre-2004 position. The topographic surveys show that the top of the newly formed beach ridge stands out 80 cm higher than older beach ridges further inland, probably a response to the higher relative sea level induced by coseismic subsidence in 2004. While topographic surveys and satellite images indicate coastal progradation until 2011, most recent data show a renewed retreat of the coastline of up to 40 m since 2011. In order to understand the complex interaction of land level changes, sediment supply, and hydrodynamic parameters, we have applied the coastal model UNIBEST-TC developed by Delft University of Technology to the Aceh coastal system to get further insight into the mechanisms of beach ridge formation and modifications by earthquakes and tsunamis.