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# Determining the Controlling Factors of Coastal Development along an Active Margin – A Case Study from Aceh, Indonesia

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Understanding the recovery of shorelines after catastrophic events is crucial for sustainable coastal development and future hazard mitigation. Here, we present post-seismic coastal development data from West Aceh, Indonesia, an area that was severely affected by the 2004 Sumatra Andaman earthquake and ensuing Indian Ocean tsunami. Using a combined approach of spatial data analysis, field surveys and numerical modeling, we reconstruct the build-up of a new beach ridge along a 10 kilometer long stretch of the western Acehnese coast after the complete destruction of the beach in 2004. The coastline of West Aceh can be characterized as a microtidal, wave dominated environment with the wave climate being controlled by the monsoon seasons reaching a significant wave height of Hs = 1.2 m during the more energetic West Monsoon from April to September. Waves approach the shoreline at a very low angle resulting in minor and variable longshore sediment transport. The beach has an average foreshore slope of 0.07 and is composed of well sorted medium sand. Recently obtained bathymetric data indicates a steep upper shoreface with a slope of 0.03. Further offshore the slope decreases to 0.01 with 14 m water depth being reached in about 700 m distance to the shoreline. Grab samples obtained in 10 m water depth are composed of fine to medium sand but lenses of medium to coarse sand with abundant shell debris do also occur. Beach ridges can be traced up to 2 km inland and indicate long-term coastal progradation and abundant sediment supply to the littoral zone. The western Acehnese shoreline parallels the Sunda trench and subsided 50 to 100 cm during the 2004 rupture. Modeled land elevation changes as a result of afterslip and viscoelastic mantle relaxation, indicate rapid post-seismic uplift of 4.4 cm/year in the year following the earthquake, but more moderate uplift rates of 1.4 cm/year since mid-2006. In 2004, co-seismic subsidence and tsunami scouring caused the coastline to recede on average 110 m. However, by 2006 a new 22 m wide beach ridge had formed probably due to reworking of sediment transported offshore by the back flow of the tsunami. In the following two years the coast prograded by an additional 30 m, but experienced only minor changes between 2009 and 2011. 2012 and 2013 were characterized by a renewed retreat of up to 41 m, which might be attributed to seasonal hydrodynamic variations. Field surveys in 2015 show that the coastline most recently grew back to its approximate 2011 position. The application of the coastal model UNIBEST allows us to simulate cross-shore profile changes using the acquired field data, to investigate the complex interaction of vertical ground movement, sediment supply, and hydrodynamic parameters and to gain insights into the controlling factors of long-term coastal development and the short-term effects of seismic events on coastal morphology.