

## **Impact of the December 2018 volcano-triggered tsunami in Krakatau complex on the coastal geomorphology and the buildings of the Sunda Strait (Indonesia)**

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On December 22, 2018, a tsunami was generated near the Krakatau volcano complex in Sunda Strait between the Western Java and the Southern Sumatra (Indonesia). It is attributed to the collapse of the flank of the Anak Krakatau volcano, especially in its southern and southwestern sectors. The volcano-triggered tsunami devastated the coastal areas of western Java and southern Sumatra, and in particular Banten Province and Lampung Province respectively. It caused 437 fatalities and about 14059 injured people mainly attributed to the tsunami generation during the night and to absence of early tsunami warning. The tsunami arrived at the coastal areas of western Java and southern Sumatra in 24 to 37 minutes after the eruption of Anak Krakatau occurred at 21:03 of December 22 and with heights varying from almost 1 to 6 m based on recordings of tidal stations, eyewitnesses and tsunami marks on structures and vegetation.

The research team of the University of Athens visited the worst tsunami-affected areas shortly after the disaster aiming to investigate the impact on the natural and built coastal environment.

As regards the impact on the natural environment, coastal geomorphological changes, soil erosion, tsunami sediment deposition and boulder emplacement were caused along the affected coasts. Waves locally removed beach sand about 1 m vertically and 20 to 30 meters wide and deposited it further inland. Moreover, boulders were either detached from and emplaced on shallower parts of the sea bed close to the affected beaches or displaced for a small distance.

As regards the built environment, buildings are mainly classified to (a) wooden structures, (b) reinforced concrete (R/C) buildings, (c) mixed types with prevailing wooden and secondary concrete elements and (d) light steel frame structures. All structures founded along the beach front suffered heavy structural damage. More specifically, the wooden structures were washed away by the tsunami waves. The R/C structures suffered mainly heavy non-structural damage. Their infill walls of the ground floor were blown away due to the impact with tsunami waves, mobile objects and tsunami debris. Columns of the first floor were damaged due to the aforementioned impact. The damage observed in the first floor depends on the height of the tsunami waves, while the upper floor remained intact. However, many small R/C buildings located along the beach front in the heavily tsunami-affected areas were also swept away. The tsunami washed away many of them, leaving only their concrete base and buckled the remaining still standing columns. The structures with light steel frame also suffered heavy structural damage with intense deformation of the frame and complete destruction. Similar damage was also observed in the mixed structures.

The tsunami was a medium one, but caused large human losses and damage to buildings and infrastructures. This fact is attributed to the synergy of the tsunami generation during the night and the lack of warning among other aggravating factors including construction of buildings on the beach front and shallow sea bed morphology. This combination gave no chance for immediate evacuation and increased the resulted damage.