

Impact of subsidence on coastal areas: Drainage and salt related issues

The earthquake and resulting tsunami of December 2004 occurred along the Sunda-Andaman Arc where the Indo-Australian Plate subducts under the Burma Micro-Plate of the Eurasian Plate. The movement along this divide caused not only a major earthquake, but also uplift and subsidence. This vertical movement is reported to be as high as several meters for islands close to the arc. Major uplift and subsidence had been reported in the Andaman and Nicobar Islands as well as the islands off the Aceh coast and Aceh mainland. Since the tsunami, several groups of scientists have been investigating the nature and degree of vertical movement along with horizontal displacement that also took place. On average, the movement was around two meters, but up to five meters or more on some islands. In Aceh, where subsidence is visible, it is less than one meter. However, signs of uplift and subsidence were immediately visible. Arable lands close to the sea are now submerged, either permanently or with high tide. Coconut trees that were close to the coast and were not uprooted by the tsunami are now surrounded by the sea; jetties are deeper or submerged. Uplift is evident by the new occurrence of shallow or exposed coral; mangroves are now dry in some places.



Left: *West Aceh* The land subsided 1 to 2 m during the earthquake; the treetops were snapped off by the tsunami.

Source: USGS: <http://soundwaves.usgs.gov/2005/03/>

Right: *Meulaboh (West Aceh)*: Coconut trees withstood the waves, but now have their roots in sea water due to a rise in mean sea level.

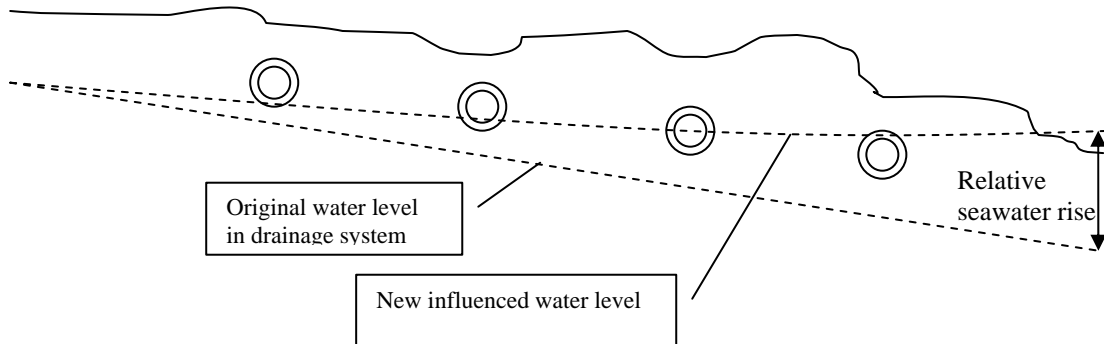
Impact on agriculture

Subsidence and uplift are permanent and land lost to the sea (Class D of the FAO Damage Classification) cannot be reclaimed. The immediate impact of subsidence is that farmers have to be relocated if they lost their land. Furthermore, these areas are now very close to sea and will have continuing problems with lateral seawater intrusion.

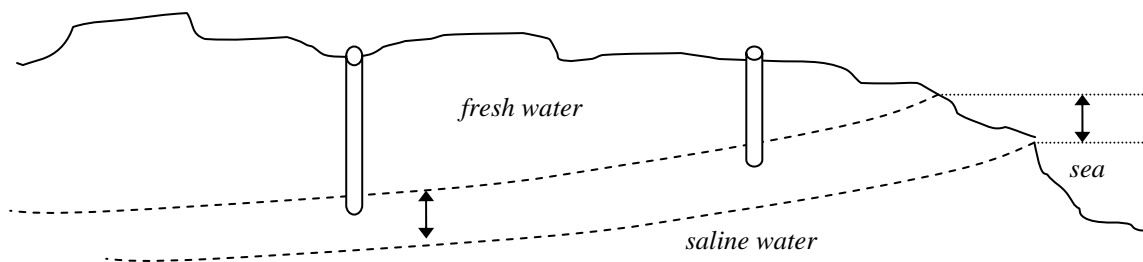


Other less visible and slow-onset problems can be expected; however:

- 1) Because of subsidence, the drainage system has changed. Field and channel drainage could be submerged because of higher water levels in estuaries and river mouths due to the higher sea water table. Submersion reduces the drainage capacity and may cause waterlogging and salinization problems.



- 2) The relative rise of the sea level will cause a change in water balance between the fresh water layer and the saline water layer. Generally, saline water will push the fresh water lens further inland. This can affect a strip of several hundred meters, especially in areas where groundwater is pumped for irrigation. This effect has to be carefully monitored to prevent saline water intrusion and degradation of water quality.



Other problems related to lateral and vertical movement of the islands are slow changes in island morphology that may occur over time through scouring and sedimentation. The result could have various effects on agricultural land. All these processes are slow and not easily determined. Assuming that in-depth research is not possible in all areas, it is best to do regular monitoring and when problems become apparent, to do an in-depth analysis.

West Aceh: Due to land subsidence the drainage system is now influenced by the higher sea water level and drainage capacity is reduced.