MANAGING TSUNAMI-AFFECTED SOILS
IN ACEH AND NIAS

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Abstract

The impacts of the earthquake and tsunami in NAD province and North Sumatra caused large changes to the landforms, soils and the hydrology of coastal floodplains used for agriculture. These changes include reductions in land elevation, opening of estuaries, erosion of beach sands, deposition of transported soils and marine sediments, and salinisation of soil and water resources. The extent of these changes was highly variable across the affected area which resulted in site specific effects on soil properties and crop production. This paper summarises the main tsunami impacts affecting soils and strategies to manage tsunami affected soils for cropping.

INTRODUCTION

The impacts of the earthquake and tsunami in NAD province and Nias on agricultural lands were most severe on the narrow coastal strip along the west coast of Sumatra. They were also wide spread on the coastal river floodplains of the east and west coasts. The impacts caused major changes to the hydrology of the floodplains, coastal wetlands and estuaries. The earthquake resulted in a reduction in land elevation along the west coast of Sumatra and east coast of Nias, causing previous coastal agricultural land to become submerged under the sea (Figure 1).

The erosive forces of the tsunami opened estuaries, transferred beach sands and coastal acid sulphate soils inland and reshaped wetlands. The tsunami also deposited sediments from the sea floor on the land. These transported terrestrial and marine deposits blocked drainage and irrigation systems. The deposition of variable depths of sand, clay and peat materials (Figures 2-5) resulted in a more heterogeneous soil landscape. There was also significant salinisation of soils due to sea water inundation. The salinity impacts were most severe in low lands closest to the sea where landscape changes were greatest.
Figure 1. West coast of Sumatra showing submergence of land 14 months after the earthquake

Figure 2. Deposited sand, stones and gravel at Lhoong on west coast of Sumatra
Figure 3. Tsunami mud deposit in Banda Aceh at BPTP demonstration plots

Figure 4. Iron oxide crust from oxidation of deposited sulfidic sediment
IMPACTS ON SOILS AND CROPS

The effects on soils and crops in affected areas were very site specific and highly variable over small scales of distance (e.g., hundreds of meters). Soil salinity after the tsunami was particularly spatially variable with levels depending on time of inundation, depth of marine deposit and site drainage capacity.

Agricultural production losses in the year following the tsunami were associated with a combination of social and biophysical constraints. These included lack of farmer capacity and confidence, high soil salinity, waterlogging and flooding due to inadequate drainage and poor local seed quality. Farmers were often not living close to their farms and could not perform timely management. Production losses from high soil salinity could not be ameliorated in the first growing season after the tsunami. Rapid field soil salinity assessments using electro-magnetic induction (EM-38) were used to provide advice to farmers so they could avoid growing crops on the most saline land.

Salinity reduction in alluvial floodplain soils used for rice was dependent on flushing of salts from shallow depths in the soil into surface waters using irrigation water or wet season rainfall and subsequent removal in surface drainage. Salts were more readily vertically leached from the rootzone in peat and sandy coastal soils if
they were not affected by tidal estuarine water. Areas affected by tidal inundation have remained too saline for crop production and are more suited to aquaculture.

Monitoring of rootzone salinity using ground based electromagnetic induction technology (EM38) in conjunction with soil and water analysis over time provided useful information on the impact, location and recovery of agricultural soils in NAD province following the tsunami. Provision of necessary technical equipment and training of key personnel immediately following the tsunami was successful in providing insights into salt levels and movement at various sites and in advising farmers when salt levels were satisfactory for cropping.

Classic stress responses of rice to salinity were observed. These included lack of grain filling with more severe effects observed in areas of rice paddies where water circulation was poor (i.e. lowest parts of the field) (Figure 6). This is because salt tends to be transported to low areas of rice fields and then concentrate through evaporation. The lack of rice grain filling also declined in subsequent seasons which would be expected as the salinity also decreased.

![Figure 6. Rice is low part of field was affected by salinity more severely and did not produce grain](image)

Some of the mud deposits were higher in phosphorous, iron and zinc than the underlying soil. However, the levels of micronutrients (Cu, Fe, Mn, Ni, and Zn) in soils affected by the tsunami were not consistently
higher than those which occurred in soils not affected. Some tsunami clay and organic deposits may have potential to provide additional nutrients suitable for crops. However, the potential benefits of these additional nutrients can not be realised until soil salinity declines and soil structure is adequate.

Changes to drainage patterns at both field and landscape levels caused waterlogging and flooding losses to palawija crops in large areas (Figure 7). Production losses were also associated with lack of irrigation water in the dry season. Coastal peanut crops in very light sandy soils showed empty pods consistent with calcium deficiency and moisture stress during pod-fill. It is expected that the use of organic amendments in these soils will assist peanut production by improving soil water holding capacity and plant available calcium. Soybean variety evaluation conducted at Desa Baro successfully identified some new varieties with adaptation to production in NAD province and potentially higher yields than current local varieties.

Figure 7. Water logged and salt affected peanuts in 2005

CONCLUSIONS

Agricultural land rehabilitation approaches need to be site specific and tailored to local conditions. It was not possible to make generalised “one size fits all” agricultural recommendations in assisting farmers restore their production systems. Besides social and economic recovery and access to crop inputs, the most critical and common
factors observed to be limiting crop establishment and production were: 1) drainage and 2) access to non-saline water for irrigation of crops and flushing salt from the soil profile. In many areas the provision of pumps would have assisted in the initial removal of saline water from fields where drainage had changed and saline water was trapped in the field.