Assessing temporal dynamics of groundwater and soil salinity and their impact on the green infrastructure after the 2004 Tsunami in Aceh, Indonesia

Objectives of the study

- To determine the impact of saltwater intrusion through the tsunami in time, on soil and groundwater quality
- To assess and understand consequences for different tree crops

Material & Methods

Soil and groundwater quality dynamics

- Soil quality parameters: EC, pH, Na+, Mg2+, Ca2+, Sodium Adsorption Ratio (SAR) & Exchangeable Sodium Percentage (ESP)
- Groundwater quality parameters: EC, pH, Mg2+, Ca2+, SO42-, Cl- were derived from data collected in 2005 (by Catholic Relief Service, Bundesanstalt für Geowissenschaften und Rohstoffe, Indonesian Soils Research Institute and University of Hohenheim/ReGrIn) and own datasets from 2007.

Assessment of damage to the economically most relevant tree crops: Coco nucifera (coconut), Hevea brasiliensis (rubber), Theobroma cacao (cacao), Nephelium lappaceum (rambutan), Elaeis guineensis (oil palm) and Mangifera indica (mango).

Tree damage inventory parameters – mortality, yield depression, leaf shedding – were assessed along 10 transects perpendicular to the coastline and major water bodies through farmer interviews and image analysis (years 2005 and 2006) as well as field observations in 2007.

Results and discussion

Groundwater quality:

Salinisation as expressed by electric conductivity generally decreased from 2005 to 2007, with exception to some points which were flooded again in 2007. EC declines with increasing distance to the sea or (see transect B and G) to water bodies connected to the sea. All groundwater samples were appropriate for irrigation and most even passed drinking water thresholds (1000µS/cm).

Soil parameters:

Na+ concentrations in soil correspond well to groundwater dynamics. For both parameters, high rainfall helped to leach salts out of the sandy soils.

Tree damage assessment:

Damage levels between species differed significantly between species for two reasons:

1. Due to species-specific sensitivity to salt- or drought-stress as is known for rambutan or cacao.
2. Because of traditional agroecological zonation: E.g. rubber trees are mostly planted in greater distance to the sea and suffered less than coconut close to the coastline.

Conclusions

Salinisation of groundwater and soils in the affected zones has clearly decreased since the tsunami and does not constrain cultivation of most agricultural crops. Only where subsidence of land has linked open water bodies to the sea, salinisation is still problematic. Tsunami mud depositions often had fertilising effects, but can also cause nutrient imbalances leading to reduced yields (e.g. for peanut; results not shown).

Different levels of tolerance to salt / drought stress were observed and reported between species. In combination with spatial distribution of salt levels, suitable locations and tree species for rebuilding the “green infrastructure” can be recommended. This is relevant since flooding frequently occurs in West Aceh, as happened lately in May 2005.