Effect of tsunami on coastal crop husbandry in parts of Nagapattinam district, Tamil Nadu

After the 26 December 2004 tsunami, in order to examine the extent of damage to crops, soil and water bodies caused by the massive inflow of sea water, impounded over the coastal inland agriculture systems (CIAS), the Indian Agricultural Research Institute (IARI), New Delhi made an on-the-spot investigation along with scientists from Tamil Nadu Agricultural University in some of the affected areas in January 2005 (Figure 1).

The team surveyed the coastal villages comprising Serudhur (near Velankanni), Pradhabaramapuram, Vellapallam (south of Nagapattinam), Erukkatancheri, Sathankudi, Kalamanallur, Manickapanngu, Pillaiperumanallur, Neithalvasal, Vellapallam (north of Nagapattinam) and Koozhaiyur, Nagapattinam district and Killai, Parangipettai, Devanampattiman, Thazhanduda and Uppalvadi, Cuddalore District, Tamil Nadu. Surface soil samples from ten sites were collected to study changes in the prominent chemical parameters due to the tsunami. Specific information on soil and crops obtained from a report of Department of Agriculture, Tanjore is presented (Table 1).

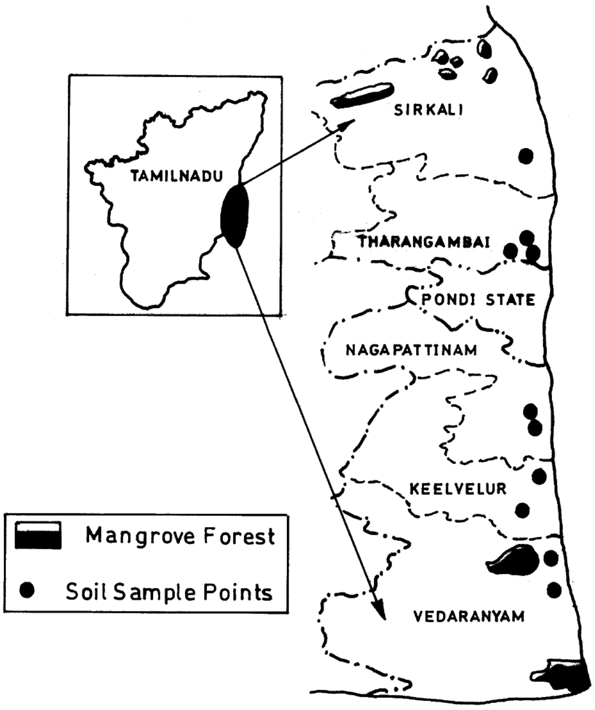

Figure 1. Tsunami-affected coastal villages in Nagapattinam district, Tamil Nadu visited by IARI team.

Figure 2. Contaminated surface water source in Prathabaramapuram village, Nagapattinam district.

In Nagapattinam district at Serudhur and Pradhabaramapuram villages, standing crops of rice (*Oryza indica*) and groundnut (*Arachis hypogea*), in different growth stages were drying due to induced exosmosis. At Vellapalam, Vedharanyam area, the tsunami had left behind a thick (2 to 20 cm) layer of sea sediments as a slushy black layer over rice fields, being too close to the sea and damaging several rice fields. Standing crops of rice, groundnut and vegetable were damaged severely in Erukkatancheri, Sathankudi, Kalamanallur, Manickapangu, Pillaiperumanallur (Tharangakbadi taluk), Neithavasal, Vellapalam and Koozhaiyur (Sirkazhi taluk). Apart from these crops, Sesamum (*Sesamum indicum*), black gram (*Phaseoles mungo*) and onion (*Allium cepa*) were badly affected in Cuddalore and Chidambaram taluks.

The surface water resources meant for irrigation and drinking were affected by the ingress of sea water in all the areas (Figure 2). The massive quantity of sea water that inundated the coastal agricultural lands for 0.5 to 2.0 km area inland, due to reasons of poor drainage, stood for a few days affecting the quality of soil and groundwater. The electrical conductivity (EC) of soil and shallow groundwater increased by about ten times and 15 times respectively, and the degree of variations differed from place to place. From interaction with the local inhabitants, it was learnt that not only have the field crops been affected, but drinking water available in shallow *katcha* wells or irrigation water in ponds have also been contaminated due to sea water ingression. Since there was no corresponding soil sample analysis done from these locations prior to the tsunami, valid quantification of the impact could not be made. However, extensive soil sample analyses in these

Table 1. Specific information on soil and crop data of select sites in tsunami-affected areas, Nagapattinam district, Tamil Nadu[1]

Location and latitude/longitude	Soil type	Crops grown: Irrigated	Crops grown: Rainfed
Serudhur – I N: 10°40′33.2″/E: 79°50′41.0″ Serudhur – II N: 10°40′23.1″/E: 79°50′25.1″	Grey, saline/alkaline soil, coarse loamy calcareous soil	Paddy, banana, groundnut and gingelly	Groundnut and gingelly
Pradhabaramapuram – I N: 10°40′27.3″/E: 79°50′49.2″ Pradhabaramapuram – II N: 10°40′10.4″/E: 79°50′40.4″	Grey, saline/alkaline soil, coarse loamy calcareous soil	Paddy, banana, groundnut and gingelly	Groundnut and gingelly
Vellapalam (Vedaranayam) N: 10°30′51.6″/E: 79°51′16.3″	Melkadu series	Paddy, tobacco, gingelly and vegetables	Groundnut and casuarina
Manikkapangu N: 11°03′44.2″/E: 79°50′43.1″	Brown, fine loamy soils (75%) and dark grey-brown to dark yellowish-brown loamy soil (25%)	Paddy, sugar cane, cotton, banana, vegetables and flowers	Pulses, groundnut, gingelly and eucalyptus
Khozhaiyur – 1 N: 10°40′27.3″/E: 79°50′49.2″ Khozhaiyur – 2 N:10°40′27.3″/E: 79°50′49.6″	Very dark grey brown (90%) dark grey-brown to dark yellowish-brown loamy soil (10%)	Paddy, sugar cane, cotton	Pulses
Erukattancheri N: 11°1′55.0″/E: 79°50′14.4″	Brown, fine loamy soils (95%) and dark grey-brown to dark-yellowish brown loamy soil (5%)	Paddy, sugar cane, cotton, banana, vegetables and flowers	Pulses, groundnut, gingelly and eucalyptus

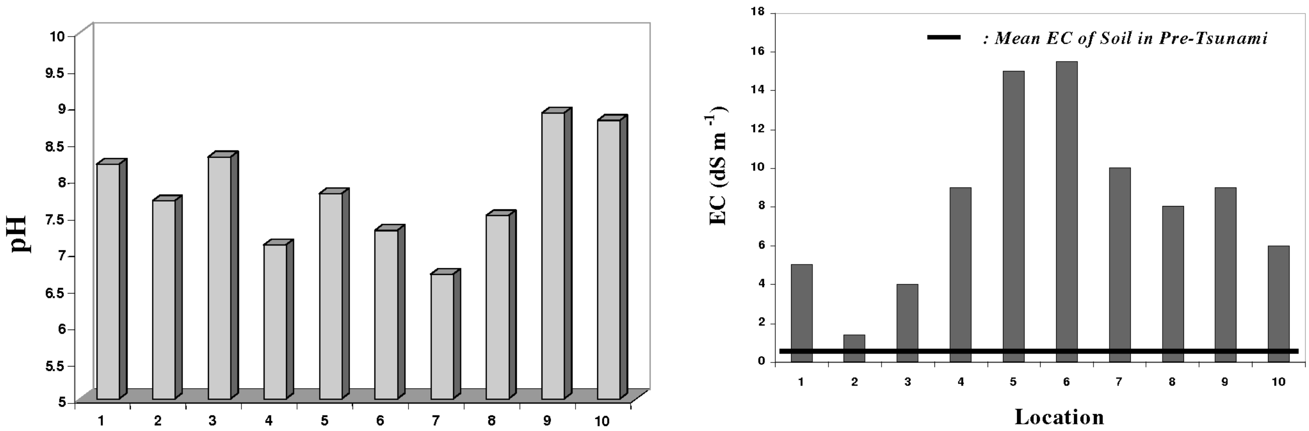

Figure 3. Variations in EC and pH of soil samples from parts of tsunami-affected areas in coastal Tamil Nadu. 1, Serudhur-I; 2, Serudhur-II; 3, Prathabaramapuram-I; 4, Prathabaramapuram-II; 5, Vellapalam (Vedaranyam); 6, Neithavasal; 7, Manikkapangu; 8, Khozhaiyur-I; 9, Khozhaiyur-II; 10, Erukattancheri.

districts are available[1] and hence an educated guess on the effect of sea-water inundation can be made. The EC levels have increased from 5 to 15 times due to the aftermath of tsunami-induced sea tidal-wave ingression. At the same time, the soil pH increased beyond 8 in about 40% of the samples and the pre-tsunami average pH was around 7 (Figure 3). Remediation of such soil cover is difficult, especially when deterioration has occurred due to sea-water ingression. Since the affected areas will get freshwater, adequate enough to leach out the salts, only during the monsoon season (July/August 2005), the next crop of rice is also likely to be affected in these areas. Almost all surface water bodies meant for irrigation have been subjected to various degrees of sea water contamination.

The damage to different crops in the tsunami hit areas of Nagapattinam district is reported to be 5150 ha (B. Chandrasekaran, unpublished report, Tamil Nadu Rice Research Institute, Aduthurai, 2005). In the affected areas, a local land race ‘Kundali’ was observed to withstand the effects of sea-water flooding, while most of other varieties of rice, groundnut, etc. dried up. The following action plan is suggested: (i) To leach out the soil of the affected areas to improve EC and apply gypsum based on soil sample test to bring pH to normal value. This can be achieved by developing suitable sub-surface drainage systems at select locations, (ii) Alternatively, if the salinity of groundwater increases with depth, construct structures for skimming sweet water in such areas, (iii) Raise community nursery of saline-tolerant crop varieties of varying duration from the national collection and make it available to farmers by July/August 2005. Ten rice varieties have been chosen in this regard and (iv) To launch educational programmes on management of problem soils.

1. DOA, *Soil Atlas – Nagapattinam district*, Department of Agriculture, Tamil Nadu, 1998, p. 195.

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Was there active tsunami generation during 28 March 2005 Sumatra earthquake?

When the 8.7 magnitude (March 2005) earthquake (epicentre, 2.074°N, 97.013°E) occurred in the Indian Ocean (near the position of 26 December 2004 giant earthquake, epicentre: 3.316°N, 95.854°E) in northern Sumatra, the world anxiously awaited word of yet another devastating tsunami similar to the earlier one. There was, however, a vast difference. The tsunami warnings were issued in India by India Meteorological Department, quickly in anticipation and were as quickly withdrawn officially. The question arises whether there was a tsunami generation on this occasion? This correspondence looks into some of the differences and the conclusions based on a computer simulation using the TOAST model[1].

There are four major factors determining tsunami generation, its propagation and its build-up near the coastal regions[1]. They are:

(i) The magnitude of ocean surface displacement and its direction (essentially the amount of kinetic energy released from the shaking into the ocean water).

(ii) Amplification of the kinetic energy release at the bottom in terms of tsunami generation at the water surface.

(iii) The tsunami 'focusing' aspect (i.e. the primary direction of the tsunami wave propagation).

(iv) The bathymetry at the coastal regions for tsunami amplification.

The TOAST model is not fully geared for the calculation of tsunami amplification near the coast, as the model is presently limited due to poor bathymetry information. However, tsunami generation at source and its propagation up to the near-coastal regions can be tracked quite successfully. The tsunami height generation at the source is quite preliminary in both cases, since there is no direct measurement of the kinetic energy release at the ocean floor. Kinetic energy estimates are approximated using elastic plate calculations, which are gross.

As a comparison, the magnitude of the earlier earthquake (Sumatra90) was 9.0 (revised to 9.3)[2] and the latest one (Sumatra87) was 8.7 on moment magnitudes M_w and might not mean serious difference from the point of view of available total kinetic energy. However, the effective bulk modulus of rock in the two cases means a large difference due to large difference in the depth of occurrence below the mantle. While Sumatra90 was at the depth of 17 km, Sumatra87 was at the depth of 30 km (as reported in preliminary report from USGS[3]). This means that the efficiency of kinetic energy transmission to the ocean water due to rock resistance is far lower in the latter case. Tsunami generation is affected by dip-slip changes and therefore, the position of the epicentre zone with respect to the subduction zone is important. In the case of Sumatra90, it occurred near the subduc-

Figure 1. Location of Sumatra90 and Sumatra87 earthquakes and general layout of the rupture region. Sumatra87 occurred in an area which was already ruptured during 1861 earthquake.