

## **Effect of Tsunami on Some Physico-Chemical Properties of Soil Under Different Land Use Systems of Nicobar Islands**

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### **Abstract**

Investigation was carried out during 2007-2008 of the existing Tsunami affected area under various land use system to study the changes occurred in physico-chemical properties of soil between pre-Tsunami and post-Tsunami period and to find out the effect of five different land use system. The results revealed that due to effect of Tsunami, soil texture, and soil reaction slightly changed i.e. sand percentage, bulk density, pH and EC value increased whereas organic carbon, total nitrogen, available phosphorus and potassium content decreased. Among the different land use systems forest soil had low bulk density, high porosity and water holding capacity and high nutrient status in both pre-Tsunami and post-Tsunami period in respect of organic carbon percentage, total nitrogen and available phosphorus and potassium.

**Key words :** Physico-chemical soil properties, Tsunami affect, Land use system, Nicobar Islands.

An unprecedented deadly wall and water called Tsunami triggered by one of the biggest earth quake having 9.3 magnitudes in the Richter scale that rolled across the Bay of Bengal and Indian Ocean. The mega earth quake was immediately followed by the giant Tsunami waves which have badly affected the Indonesian provinces, coast of Thailand, Sri Lanka, India and Andaman-Nicobar Islands in the Bay of Bengal killing lives and damaging properties being one of the biggest natural disasters in the recorded history and human memory. After Tsunami different adverse situation arose, mainly coastal areas land increasing depth of impounded sea water with high tide, so the farmers of Andaman and Nicobar Island lost their farm land completely and or dealt with twin problems of soil salinity, sodicity or leaching loss of plant nutrient in which crop growth was hampered by salt accumulation in the root zone and deficiency of major nutrients. With this background in view, an attempt was made to study the effect of Tsunami on some physico-chemical properties of soil, and effect of different land use system on soil properties of pre- and post-Tsunami period.

### **Methods**

A study was conducted in existing Tsunami

affected soil of coconut plantation, banana orchard, root crops (Tapioca, Dioscoria), evergreen forest and grass land in Teresa Island under Noncowry group of Island in Nicobar district of Andaman and Nicobar Island.

To assess the changes occurring in soil physico-chemical properties composite surface soil (0–15 cm depth) sample in triplicate were collected after two years of Tsunami from five different land use system of existing Tsunami affected areas. After collection the soil samples were air dried processed and passed through a 2 mm sieve for analysis of pH, electrical conductivity (EC), organic carbon, total nitrogen, available phosphorus, potassium, bulk density, porosity, water holding capacity and textural classification.

The pH and EC of the soil sample were measured by using pH meter and conductivity meter respectively as per the standard procedure. The organic carbon, total nitrogen, available P and K were measured by Black wet digestion methods (1), Kjeldahl method (2), Spectrophotometer method and Flame photometer method (3) respectively. Bulk density, water holding capacity of soil was estimated by using Keen Rackzowskis box. The percent distribution of soil separates i.e. mechanical analysis (Sand, silt

**Table 1.** Effect of Tsunami on changes of some physical constants of soil under different land use systems.

Land use system	Before Tsunami			After Tsunami		
	Bulk density (Mg/m <sup>3</sup> )	Porosity (%)	Water holding capacity (%)	Bulk density (Mg/m <sup>3</sup> )	Porosity (%)	Water holding capacity (%)
1. Coconut plantation	0.93	63.9	42.46	0.98	62.4	41.98
2. Banana orchard	0.88	60.8	41.28	1.08	58.5	40.66
3. Root crops	1.00	61.6	41.98	1.06	59.3	41.49
4. Grass land	1.02	60.8	42.42	1.10	57.7	41.98
5. Forest land	0.93	64.3	43.93	0.97	62.7	43.02
Mean	0.95	62.28	42.41	1.034	60.12	41.82
	Effect of Tsunami			Land use system		
SE ( $\pm$ )	NS	0.62	NS	NS	0.98	NS
CD ( $P = 0.05$ )	NS	1.84	NS	NS	2.91	NS

**Table 1.** Continued.

Land use system	Before Tsunami			After Tsunami		
	Sand (%)	Silt (%)	Clay (%)	Sand (%)	Silt (%)	Clay (%)
1. Coconut plantation	65.3	12.0	22.9	71.9	11.0	17.1
2. Banana orchard	68.2	4.2	27.6	73.9	4.1	22.0
3. Root crops	64.1	6.3	29.6	68.0	6.0	24.0
4. Grass land	62.3	12.4	25.3	63.0	11.9	25.1
5. Forest land	62.5	12.0	28.0	65.8	11.8	22.4
Mean	64.44	9.38	26.68	68.52	8.96	22.12
	Effect of Tsunami			Land use system		
SE ( $\pm$ )	0.94	NS	NS	1.50	0.77	1.42
CD ( $P = 0.05$ )	2.20	NS	NS	4.46	2.28	4.24

and clay) was determined by hydrometer method.

After analysis of the soil parameters the results were compared with pre-Tsunami periodical data of the existing land use system to find the effect. Data were analyzed using standard statistical procedure.

### Results and Discussion

To assess the changes of various physical and chemical constants of soil due to Tsunami effects and variation due to different land use system are discussed below.

#### *Physical properties of Soil*

The bulk density of the soil under different land use system varied from 0.88 to 1.02 during pre-Tsu-

nami period but after Tsunami affect soil increased which may be due to deposition of sand particles and removal of organic matter from the surface soil.

Among different land use system the lowest value of bulk density was found under forest land followed by coconut plantation in both pre-Tsunami and post-Tsunami period.

Porosity of the soil is reversibly related with bulk density and it ranged from 60.8 to 64.3% during pre-Tsunami period. But in the post-Tsunami period this value slightly reduced and ranged from 57.7 to 62.7% with an average value on 60.12%. The highest porosity value found in forest soil in both pre- and post-Tsunami affected soil. There was significant variation in the effect of Tsunami and land use system.

The water holding capacity of soil also showed similar trend of results as for porosity (Table 1).

**Table 2.** Effect of Tsunami on changes of some chemical properties of soil under different land use systems.

Land use systems	Before Tsunami			After Tsunami		
	pH (1:2:5)	EC (ds/m)	Organic carbon (%)	pH (1:2:5)	EC (ds/m)	Organic carbon (%)
1. Coconut plantation	7.00	0.60	3.10	7.40	0.86	2.20
2. Banana orchard	6.80	0.55	2.00	7.30	0.72	1.70
3. Root crops	6.90	0.47	2.30	7.30	0.69	1.90
4. Grass land	5.30	0.38	2.70	6.60	0.44	2.30
5. Forest land	6.50	0.42	3.10	7.10	0.50	2.70
Mean	6.50	0.48	2.64	7.10	0.64	2.16
		Effect of Tsunami		Land use system		
SE ( $\pm$ )	0.12	0.02	0.17	0.20	0.04	0.21
CD ( $P = 0.05$ )	0.38	0.07	0.39	0.60	0.12	0.64

Among textural analysis of soil the sand percent under different land use system during pre-Tsunami period varied from 62.3 to 68.2% with a mean value of 64.44%. But in Tsunami affected soil it ranged from 63.0 to 73.9% with a mean value of 68.52% (Table 1). The data failed to show the significant variation due to Tsunami influences but the result showed significant variation in different land use system. Silt and clay percent also did not differ significantly due to Tsunami affect.

#### *Chemical Properties of Soil*

The pH of a soil during pre-Tsunami period under different land use system varied from 5.3 to 7.0 indicating strongly acidic to neutral in reaction. However, in post-Tsunami period these values significantly increased and ranged from 6.6 to 7.4 exhibiting

neutral to mild alkaline reaction (Table 2).

The electrical conductivity of the pre-Tsunami period of soil under different land use system ranged from 0.38 to 0.60 ds/m in which the highest value was found in coconut plantation and lowest in grass land with a mean value of 0.48 ds/m. But in Tsunami affected soil this value significantly increased and ranged from 0.44 to 0.86 ds/m with an average value 0.64 ds/m.

These results indicated that intrusion of saline sea water carrying significant amount of soluble salts during the Tsunami have replaced the usual hydrogen ion-concentration in these soils with toxic salts, leading to increased soil pH. The high EC values in Tsunami affected soils have also confirmed this observation. All the soils (before Tsunami and after Tsunami) under different land use system were non-saline in nature. The development of salinity in the

**Table 3.** Effect of Tsunami on changes of some chemical properties of soil under different land use system.

Land use system	Before Tsunami			After Tsunami		
	Total N <sub>1</sub> (%)	Available P <sub>2</sub> O <sub>5</sub> (kg/ha)	Available K <sub>2</sub> O (kg/ha)	Total N <sub>2</sub> (%)	Available P <sub>2</sub> O <sub>5</sub> (kg/ha <sup>2</sup> )	Available K <sub>2</sub> O (kg/ha)
1. Coconut plantation	0.24	28.40	315.4	0.19	30.50	302.7
2. Banana orchard	0.16	33.80	284.2	0.13	32.16	289.6
3. Root crops	0.22	31.50	287.6	0.15	27.80	292.5
4. Grass land	0.27	29.60	118.6	0.21	22.20	156.2
5. Forest land	0.29	39.40	330.0	0.23	37.20	318.4
Mean	0.23	32.54	267.1	0.18	29.97	271.8
		Effect of Tsunami		Land use system		
SE ( $\pm$ )	0.007	NS	NS	0.012	1.92	10.46
CD ( $P = 0.05$ )	0.02	NS	NS	0.035	5.80	31.07

Tsunami affected soil was not so intense due to leaching of soluble salts from the surface layers of the soils with heavy rainfall in the experimental site. Besides, the addition of organic waste, through decomposition of leaves and branches from plantation, forest and crops might have decreased the salinity level of these soils.

The organic carbon content of soil ranged from 1.7 to 3.2 irrespective of land use system and Tsunami effect indicating rich in organic matter. The values are more under forest land followed by coconut plantation. Higher bio-mass production associated with stimulating effect of growth and activity of micro-organisms may have the reasons for high organic matter content in soil. Similar opinions are expressed from the results of several authors (4, 5). However, these values were reduced slightly from pre-Tsunami period (ranged 2.0–3.1%) to post-Tsunami period (ranged 1.7–2.7%). The decreased organic carbon content in the post-Tsunami affected soil might be due to the washout of organic matter by the Tsunami waves (Table 2).

The total nitrogen content in post-Tsunami affected soil varied from 0.13 to 0.23%. The highest value of total nitrogen was found in forest land and lowest in banana orchard in both pre- and post-Tsunami period. The total nitrogen content has decreased from pre-Tsunami period to post-Tsunami period in every land use system and the effects of Tsunami and that of land use system, both are found significant (Table 3).

The available phosphorus content under differ-

ent land use system varied from 22.20 to 39.40 ka/ha with mean values of both pre- and post-Tsunami period were 32.54 and 29.97 respectively. However, the data failed to signify the effect of Tsunami.

The available potassium content of pre-Tsunami soil under different land use system ranged from 118.6 to 330 ka/ha with a mean value of 267.1 ka/ha. On the other hand, in post-Tsunami period soil under different land use system, the available potassium content ranged from 156.2 to 318.4 kg/ha with a mean value of 271.8 kg/ha. The overall highest amount of available potassium content was found in forest land followed by coconut plantation. But the data failed to show the effect of Tsunami. However, the effect of different land use system on available potassium content was found to be significant (Table 3).

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