The Profile of Tsunami Affected Soils and Management Implication

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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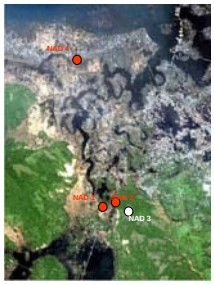
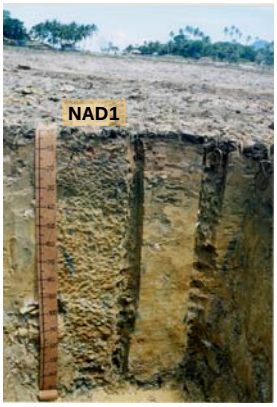


The forces of the waves and the mud brought by the waves, during the December 2004 tsunami, changed the soil profile and nutrient balance in the upper soil layer. We described the soil profile in May 2005 (five months after the tsunami) in Aceh Besar District, Indonesia. This profile serves as a scientific asset for developing future research and management strategies.



Nusa Village (05º 30' 03"N, 95º16'17"E)
Soil: Typic Endoaquepts
Physiography: Fluvio-marine plain
Topography/slope: Flat, 0-3 %
Elevation: 5 m asl
Parent material: Mud & clay sediment
Drainage: Poor
Depth of water table: 160 cm
Land use: Upland agriculture
Electric conductivity C = 7.6 dS/m in the new O horizon

Horizon	Depth (cm)	Texture		pH	Org	P2O5		Exchangeable cation (NH_4-Ac 1N, pH 7)				
		Sand	Clay	H_2O	C	Olsen	Bray 1	Ca	Mg	K	Na	CEC
		-----% ----			%	ppm		----- cmol(+)/kg ---------				
O1	0-5	9	48	7.9	6.11	73	13.0	39.90	20.93	1.44	7.62	34.94
O2	5-11	84	10	8.0	0.80	21	19.6	33.82	5.57	0.28	7.42	9.63
Ap	11-25	28	31	6.1	1.10	17	7.3	5.76	3.70	0.28	7.20	13.17
Bw	25-42	27	43	7.1	0.30	9	3.1	9.78	4.71	0.07	1.45	16.16
Bwg	42-98	31	41	7.7	0.16	7	2.8	8.23	4.45	0.06	1.12	14.74
Bc	98-147	22	39	8.1	0.11	9	3.3	9.59	5.38	0.07	1.68	16.45

There was a clear difference in soil properties between the newly formed O1 and O2 tsunami soil layers and the underlying layers. Sand fraction significantly increased in the O2 layer, but clay dominated the O1 layer. The tsunami mud also brought substantial amount of organic matter as indicated by elevated C content in the O1 layer. P and exchangeable cations also substantially increased. Being a mobile cation, Na has been distributed to the Ap horizon from the O layer.

PROFILE NAD-2
Beradeun Village (05o 30' 06" Nort, 95o16' 21" East
Soil: Typic Eutrudepts
Physiography: Peneplain
Topography/slope: Undulating / 3-5 %
Elevation: 18 m asl
Parent material: Clay stone
Drainage: Well drained
Water table: 165 cm
Land use: Agricultural dry land
Electric conductivity = 8.3 in the new O1 horizon

Horizon	Depth (cm)	Texture		pH	Org	P2O5		Exchangeable cations (1N NH_4-Acetate, pH7)					
		Sand	Clay	H_2O	C	Olsen	Bray 1	Ca	Mg	K	Na	Sum	CEC
		---------%---------			%	--- ppm ---		------ cmol(+)/kg ------					
O1	0-9	42	35	8.0	9.76	38	13.6	27.84	12.77	0.49	3.59	44.69	31.78
Ap	9-29	22	37	5.8	1.46	14	4.2	7.63	2.61	0.09	2.11	12.44	15.57
Bw1	29-52	20	43	5.0	0.59	10	3.6	7.24	3.23	0.07	0.86	11.40	17.17
Bw2-3	52-83	17	59	6.0	0.33	8	3.4	14.82	6.73	0.09	1.36	23.00	27.95
BC	83-149	44	32	6.7	0.10	9	3.9	6.72	3.29	0.04	0.79	10.84	12.23

Sandy loam material dominates the tsunami deposit for this soil pit. Like the NAD1 profile, there is also a clear fact of pH increase and carbon, P and exchangeable cations enrichment in the surface layer.

Surah Village (05º 32' 25" N, 95º16'05" E
Soil: Typic Endoaquepts
Physiography: Fluvio-marine plain
Topography/slope: Flat / 0-3 %
Elevation: 5 m asl
Parent material: Mud and clay sediment
Drainage: Poor
Depth of water table: 160 cm
Land use: dry land agricultural

Horizon	Depth (cm)	Texture		pH H_2O	Org C	P2O5		Exchangeable cations (NH_4-Acetat 1N, pH7)					
		Sand	Clay			Olsen	Bray 1	Ca	Mg	K	Na	Sum	CEC
		--------- % ---------		------- %-	----- ppm -----			------ cmol(+)/kg -------					
1	0-17	93	5	8.4	0.10	23	29.7	5.38	2.13	0.22	1.69	9.42	6.84
Ap	17-24	21	37	6.3	1.14	41	5.4	11.00	11.86	0.45	8.03	31.34	26.67
Bwg1	24-43	17	31	6.6	0.39	11	3.4	18.62	16.51	0.15	1.49	36.77	26.12
Bwg2	43-83	30	20	7.4	0.17	11	3.7	16.91	15.62	0.11	0.48	33.12	24.71
Bwg3	83-122	21	20	7.5	0.14	16	6.1	16.86	16.71	0.08	0.48	34.13	26.30
Bwg4	122-145	53	12	7.1	0.11	20	10.5	13.00	13.25	0.04	0.34	26.63	18.21

Located about 200 m from the coast, the tsunami affected new layer for this profile is dominated by sand fraction. Thus it's not easy to see enrichment of nutrients in the soil surface. However, sodium was much higher in the Ap horizon compared to the underlying layer, indicating salt transport from the surface new layer.

The fresh mud carried by tsunami had an Electric conductivity (EC) of up to 40 dS/m, but this level of salinity quickly decreased to about 8 dS/m in 5 months and further to less than 4 dS/m in less than a year, especially in areas with high rainfall and coarse texture soils. Currently the EC of >2 dS/m are only concentrated in newly formed lagoons, in low rainfall and poor drainage areas.

We also observed that peat soils generally benefited from the addition of mineral materials and nutrient enrichment from tsunami. In these area the farmers voiced that they have been favored by "pupuk tsunami" (tsunami fertilizer).

Electric conductivity of soil, soil water, and surface water in selected sites in Aceh Barat District

Site	EC (dS/m)		
	Soil	Soil water	Surface water
Arongan	0		2.4
Kubu		0.2**	
Seunebok Teungoh	0,05	0.1**	
Kuala Bubon	-	4.2**	12
Paya Lumpat	0.29	-	-
Aloe Raya	2.79*	-	-
Suak Nie	0.25	0.01	-
Gunung Kleng	0.16	0.7	2.04
Gunung Kleng 2	0.17	0.7 – 1.0	1.05
Peunaga Cot	0.1	0.3	0.05

*Source: Subiksa et al (2006) *Accumulation of sea mud ** From well*

The soil problem, however, is more than just salinity. In areas where salinity has been subsided to a negligible level, we observed poor peanut pod filling despite the seemingly thriving vegetative growth. Paddy areas with poor drainage also exhibit empty seeds.

There are still researchable questions with respect to nutrient imbalance (dominance of Mg relative to K and Ca) and micro nutrients deficiency. These questions are more serious for annual crops than perennial crops. Perennial crops seems more resilient and able to cope with the complexity of the soil properties.