Changes in soil physicochemical properties by landslide deposition in Xitou, Central Taiwan

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Abstract

Effects of landslide deposition on soil physiochemical properties were investigated in this study. We established (1) a data set that compared the differences in soil properties between 1977 survey and current soil survey data for soil samples undergone with and without the occurrence of landslides, and (2) a series of sampling sites with varying degrees of landslide effects. The soils comprise of higher rock content and lower O and A horizon thicknesses after landslide deposition and lead to increase soil pH, inorganic C content, and base saturation. By contrast, for the regions without significant landslide depositions, the soils comprise of less rock content and the biological and pedogenic processes facilitate the formation of O and A horizon thicknesses and leads to a lower pH value and higher organic C, total N, and CEC contents.

Introduction

Landslides are important natural disturbances in tropical and temperate areas. In this study, we evaluated the effects of landslide deposition on soil physicochemical properties from a sedimentary rock in a moist montane forest ecosystem in Xitou, central Taiwan **(Figure 1)**. Specifically we asked how did topsoil properties change after landslide deposition? And, how did the degree of landslides affect these properties? .

Materials & Methods

The sampling design comprised two sets. The first set involved using the historical soil survey data conducted in 1976 (Ho, 1977) and the re-sampled soil samples at the same locations that had and had not experienced the landslide deposition to compare the changes of soil physicochemical properties.

The second set focused on evaluating the changes of soil physiochemical properties along a landslide/nonlandslide sequence to test how a varying degree of landslide effects on soil physicochemical properties **(Figure 2)**.

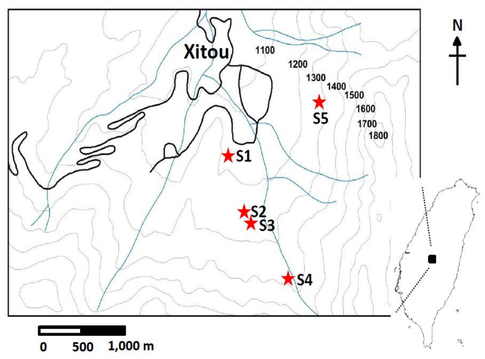

Figure 1. Locations of study site in Xitou, central Taiwan.

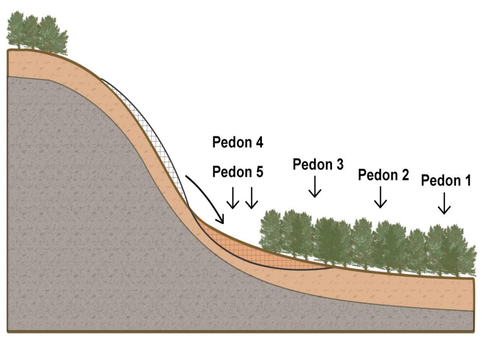

Figure 2. The design of sampling sites along a landslided/nonlandslided sequence. S1 and S2 are the nonlandslided sites. S3, S4, and S5 are the landslided sites.

Results & Discussion

- Comparing soil properties at the same location between 1977 and 2012, the results showed that the landslide depositions resulted in a raised pH by 1 unit, and the values of SOC, N content, and CEC reduced by 30 to 70% **(Table 1)**.
- Changes in soil physiochemical properties along the landslide/nonlandslide sequence were apparent **(Figure 3; Table 2)**. The results indicated that soil pH, bulk density, inorganic carbon, and base saturation increased following landslide deposition and that the greater severity of the landslide was the greater these increases were.
- By contrast, the thickness of O and A horizon, soil organic carbon, total nitrogen, and cation-exchange capacity significantly decreased following a landslide, and the level of decrease declined as the extent of the landslide declined.
- The exchangeable potassium, calcium, magnesium, and available phosphorus contents were unaffected by landslide deposition.

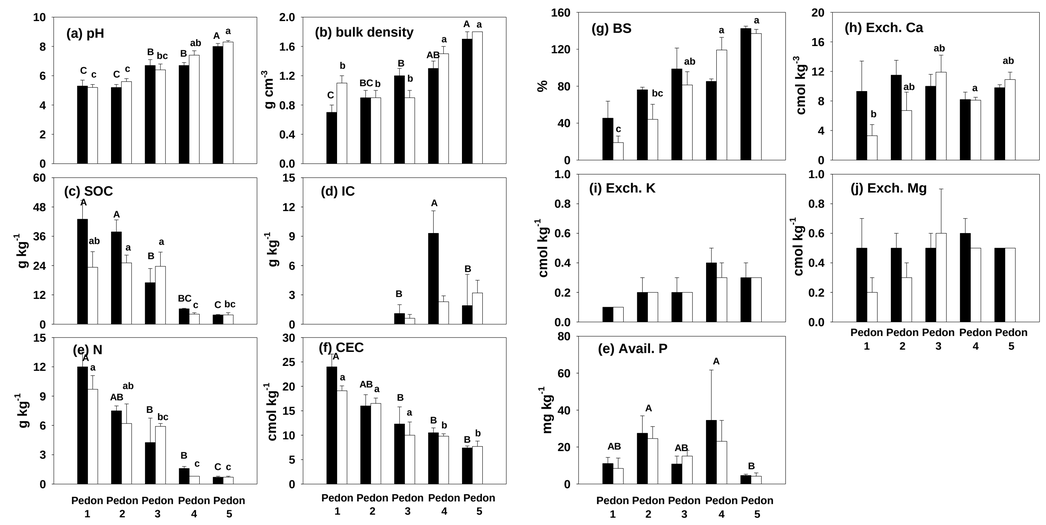

Figure 3. Soil properties along a landslide/non-landslide sequence in Xitou, central Taiwan. The Site 1 and Site 2 are nonlandslided-affected sites and the Site 3, Site 4, and Site 5 are landslide-affected sites.

Table 1. Change in soil pH, soil organic carbon, total N and CEC between 1977 and 2012

Site[a]	year	pH		SOC (g kg^{-1})		Total N (g kg^{-1})		CEC (cmole (+) kg^{-1})	
		0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm
Nonlandslide-affected									
Red cypress	1977	5.1	4.5	89.4	26.8	8.0	2.0	36.1	21.9
	2012	4.8	3.8	67.3	43.2	6.7	4.3	29.2	24.2
Landslide-affected									
158	1977	4.9	4.7	61.0	30.0	6.0	3.0	21.5	18.4
	2012	6.0	5.8	25.6	25.4	2.3	2.6	12.0	12.4
Ginkgo	1977	5.5	4.7	36.5	16.8	3.0	2.0	31.8	21.8
	2012	6.0	5.8	17.6	15.7	1.9	1.8	13.0	12.6
60-3	1977	4.3	4.0	75.4	26.7	8.0	3.0	30.5	20.4
	2012	5.2	4.9	20.2	11.8	2.3	1.4	13.7	10.7

[a]Site is referred to Ho (1977)

Table 2. Soil physical characteristics on the nonlandslided (S1 and S2) and landslided (S3, S4, and S5) sites in Xitou, central Taiwan

	Soil depth (cm)	O horizon (thickness, cm)	A horizon (thickness, cm)	Soil texture (0-10 cm)			Soil color (0-10 cm)[a]		Rock content[b] (> 2 mm, %)	MWHC[b]
				Sand (%)	Silt (%)	Clay (%)	Dry	Moist		(%)
S1	60	1.3	10.8	60	32	8	2.5Y3/2	10YR3/1	17	73
S2	60	1	10.1	60	33	7	2.5Y3/1	10YR2/1	23	68
S3	60	<1	3.3	63	34	3	2.5Y5/4	2.5Y3/3	23	49
S4	< 20	<1	<1	67	30	3	2.5Y6/2	2.5Y4/4	41	23
S5	< 30	<1	<1	61	36	3	2.5Y4/2	2.5Y3/2	28	34

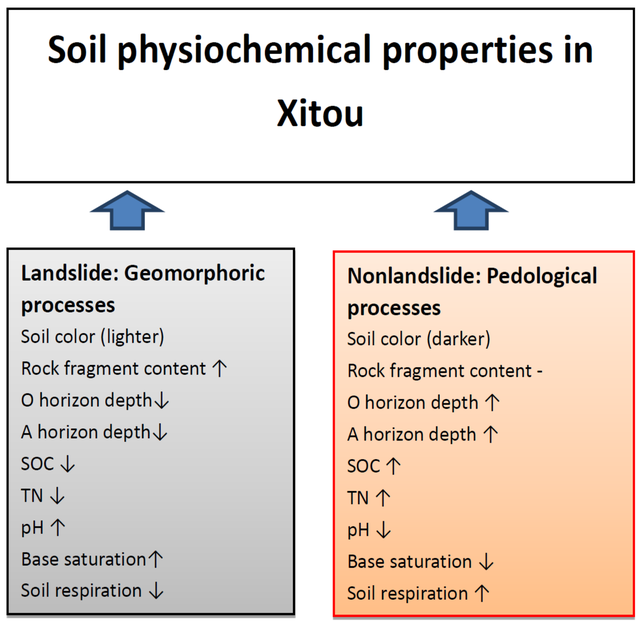

Figure 4. Conceptual model of soil properties in Xitou, central Taiwan.

Summary

The differences of soil properties where landslide depositions had and had not occurred in Xitou can be illustrated by the conceptual model in **Figure 4**. Both geomorphological (landslide) and pedogenic (nonlandslide) processes play important roles in affecting soil properties.