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Soil Erosion in the Pineapple Fields of the Ban Kha Subdistrict

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Abstract

This paper focuses on the gully erosion and physical properties of the soil in the pineapple fields of the Ban Kha Sub-district of the Tha Khoei basin, upstream of the Lam Phachi river basin in Thailand. We surveyed thegully development for 2 years and studied the physical properties of soil in pineapple fields in the Ban KhaSub-district. Our research clarified that (1) soil loss rates in this region are high; (2) the soil in this area is highlyerodable; (3) the lack of vegetative cover and a surface layer with a small hydraulic conductivity contribute tosoil erosion problems in pineapple fields; (4) the fertility of pineapple fields is degraded by soil erosion, especially by the erosion of fine particles.

Keywords: pineapple field, gully erosion, soil loss, soil physical properties

1. INTRODUCTION

Pineapples are cultivated on much of the agricultural land in the Ban Kha Sub-district of the ThaKhoei basin, upstream of the Lam Phachi river basin in Thailand. Soil erosion has especially occurred in those pineapple fields that are sloped. In this paper, the authors estimated soil loss by measuring gully development and analyzed the physical properties of soil in pineapple fields. The survey sites are located near the gauging station K 25A in Ton Ma Ka village, Ban Kha Sub-district.

2. GULLY EROSION IN A SAMPLE PINEAPPLE FIELD

2.1 Gully erosion in a pineapple field

We measured the gully development in a pineapple field located 2 km southwest from the gauging station K 25A in order to estimate soil loss rates. Measurements were taken on 30 November in 2000 and 27 November in 2001. The gradient is 7° at the steepest slope of this field. In 2000, pineapple cultivation in this field was in the first year of a three-year cycle. This means that the field in its first year (2000) had experienced one rainy season (2000); in its second year (2001), it had experienced two rainy seasons (2000 and 2001).

The results of gully measurements are shown in Fig. 1.

Red-colored numbers and black-colored numbers are the points where the width and depth of gully were measured in 2000 and 2001, respectively. The orange lines and black lines, which were drawn by connecting neighboring points, are the gully lines for 2000 and 2001, respectively. Contour lines aregiven in red at intervals of 0.5 m. Each elevation of contour lines is the height based on the assumption that the elevation datum point is zero.

Some information Fig. 1 indicates is as follows:

1. Most gully lines and contour lines cross at right angles,
2. Some gully lines in 2000 stretched in 2001; some gully lines in 2001 were new,
3. Some gully lines in 2000 disappeared in 2001. It can be inferred that the reason for this disappearance was that soil from more highly elevated fields and neighboring ridges flowed into and filled the gullies.

2.2 Soil loss

The distances of the lines connecting two points are shown on Fig. 1. The soil loss of each line is estimated from the width and depth of gully at two points and the distance between them. Table 1 shows the calculation of soil loss for each line and the total loss in 2001. The average width and depth were 76 cm and 25 cm, respectively, and the range of width and depth were 30 – 130 cm and 3 – 25 cm, respectively. The soil loss for each line was calculated as the average width × the average depth × 1/2, on the assumption that the cross section of each line is V-shaped.

The results of our calculations indicate that the total soil loss in the field was 49.4 m³/ha in 2000, which was given in the first paper in session 2, and 81.2m³/ha in 2001; therefore, the increase in soil loss in 2001 was 31.8m³/ha, which is about 2/3 of that in 2000. If, taking in advance the results of next section, the dry bulk density in a pineapple field is assumed to be 1.4 t/m³, the soil erosion rate can be estimated to be 69.2t/ha/yr in 2000, caused by the rainfall in the first year of the pineapple cultivation cycle, and 44.5 t/ha/yr in 2001, caused by the rainfall in the second year.

Gully measurement was conducted in another pineapple field located 800 m northeast from the gauging station K 25A. The date of this measurement was 28 November in 2001, and the field was in the first year of its cultivation cycle. The steepest slope is a gradient of 8 °. The result of calculation of soil loss was 147.7 t/ha/yr.

According to Sidle (2002), for vegetable crops grown on moderate-to-steep hillsides, the highest levels of soil loss (38-140 t /ha/yr) occurred when cultivation was oriented up and down the hillslope, a typical practice in Southeast Asia. Compared to other soil loss rates in Southeast Asia, the values estimated above can be ranked as the highest level.

3. CHARACTERISTICS OF SOIL

3.1 Purpose of Investigation

Our study showed that soil erosion definitely occurred in the pineapple fields. On the other hand, soil erosion has not occurred in the neighboring forest. This section clarifies the cause of the soil erosion in the pineapple field by examining and comparing the soils in a pineapple field and an

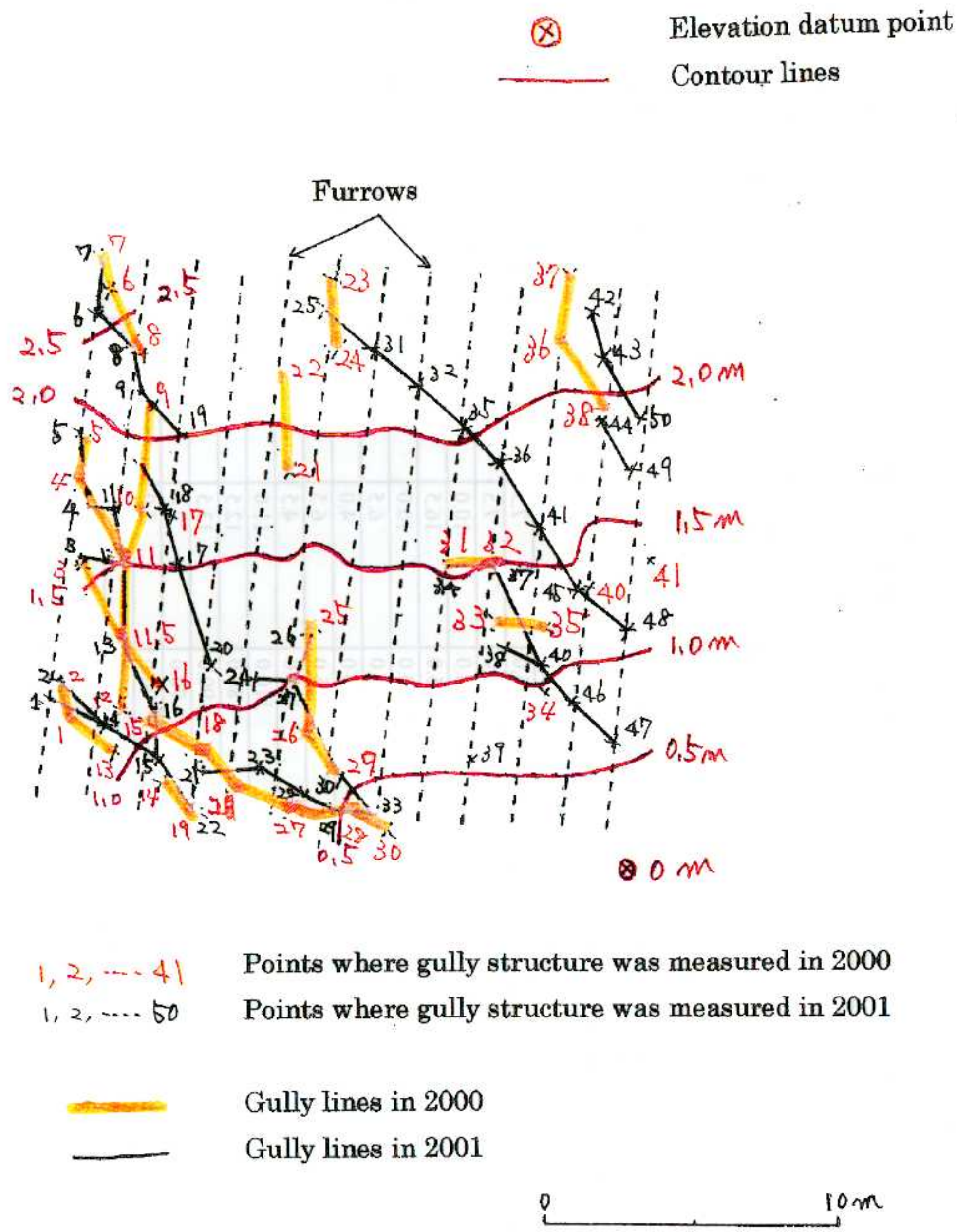

Fig. 1 Gully lines in a pineapple field

Table 1 Calculation of soil loss

Gully line	Distance of gully line m	Upper point		Lower point		Avarege width of two points cm	Avarege depth of two points cm	Average area of cross section cm²	Soil loss of each line m³	
		Width cm	Depth cm	Width cm	Depth cm					
1-14	2.18	85	10	70	10	77.5	10.0	387.5	0.08	
2-14	2.08	30	7	70	10	50.0	8.5	212.5	0.04	
3-12	1.80	60	5	80	25	70.0	15.0	525.0	0.09	
5-4	2.55	60	15	70	10	65.0	12.5	406.3	0.10	
4-11	0.95	70	10	50	20	60.0	15.0	450.0	0.04	
7-6	2.13	100	5	80	6	90.0	5.5	247.5	0.05	
6-8	1.65	80	6	90	7	85.0	6.5	276.3	0.05	
8-9	1.58	90	7	60	10	75.0	8.5	318.8	0.05	
11-12	1.85	50	20	80	25	65.0	22.5	731.3	0.14	
12-13	2.93	80	25	70	10	75.0	17.5	656.3	0.19	
14-15	2.05	70	10	80	8	75.0	9.0	337.5	0.07	
13-16	2.55	70	10	50	25	60.0	17.5	525.0	0.13	
10-18	1.75	70	5	40	10	55.0	7.5	206.3	0.04	
9-19	2.05	60	10	90	5	75.0	7.5	281.3	0.06	
18-17	2.08	40	10	80	10	60.0	10.0	300.0	0.06	
16-15	1.40	50	25	80	8	65.0	16.5	536.3	0.08	
15-22	2.28	80	8	40	12	60.0	10.0	300.0	0.07	
17-20	3.70	80	10	100	3	90.0	6.5	292.5	0.11	
21-23	1.75	100	5	120	3	110.0	4.0	220.0	0.04	
20-24	1.58	100	3	130	10	115.0	6.5	373.8	0.06	
23-28	1.98	120	3	80	6	100.0	4.5	225.0	0.04	
24-27	1.25	130	10	90	12	110.0	11.0	605.0	0.08	
26-27	1.75	70	13	90	12	80.0	12.5	500.0	0.09	
27-30	3.83	90	12	90	15	90.0	13.5	607.5	0.23	
28-29	1.18	80	6	60	8	70.0	7.0	245.0	0.03	
25-31	2.20	80	5	100	5	90.0	5.0	225.0	0.05	
31-32	2.00	100	5	70	6	85.0	5.5	233.8	0.05	
30-33	1.73	90	15	40	20	65.0	17.5	568.8	0.10	
29-33	1.35	60	8	40	20	50.0	14.0	350.0	0.05	
32-35	2.10	70	6	100	3	85.0	4.5	191.3	0.04	
35-36	1.70	100	3	80	3	90.0	3.0	135.0	0.02	
34-37	1.63	100	12	70	10	85.0	11.0	467.5	0.08	
37-40	3.78	70	10	90	15	80.0	12.5	500.0	0.19	
38-40	1.38	80	7	90	15	85.0	11.0	467.5	0.06	
36-41	2.60	80	3	90	7	85.0	5.0	212.5	0.06	
40-46	1.65	90	15	60	10	75.0	12.5	468.8	0.08	
41-45	2.50	90	7	60	8	75.0	7.5	281.3	0.07	
42-43	1.75	60	7	70	8	65.0	7.5	243.8	0.04	
43-50	2.38	70	8	90	10	80.0	9.0	360.0	0.09	Area of a field ha
45-48	2.20	60	8	80	5	70.0	6.5	227.5	0.05	0.038
46-47	2.00	40	10	90	5	65.0	7.5	243.8	0.05	Soil loss per ha
								Total	3.09	81.2

adjoining forest.

The survey site was a pineapple field located 800 m northeast from the gauging station K 25A.

3.2 Soil Profile Characterization

Soil profiles in the forest and pineapple field were conducted to a depth of 50 cm. In the forest, a 5 cm thick surface layer of humus was found, followed by brown colored soil up to 20 cm in depth, due to the influence of the organic matter. On the other hand, there was no humus layer found in the pineapple field. Since both soil profiles were the same from 5 cm to 50 cm in depth, it is surmised that both soils shared the same origination. Also, both the pineapple field and the forest contained gravel, measuring from several cm to 10 cm in diameter, and apart from the forest's humus layer, the soil structure was of single grain structure.

3.3 Soil Texture and Structure

The particle diameter composition (ratios among sand, silt, and clay) obtained from particle size analyses of the pineapple field and the forest soils are shown in Fig. 2 and Fig. 3, respectively. As can be seen, the texture of the pineapple field and forest soils were the same to a depth of 50 cm; both can be classified as Sandy Clay Loam (SCL).

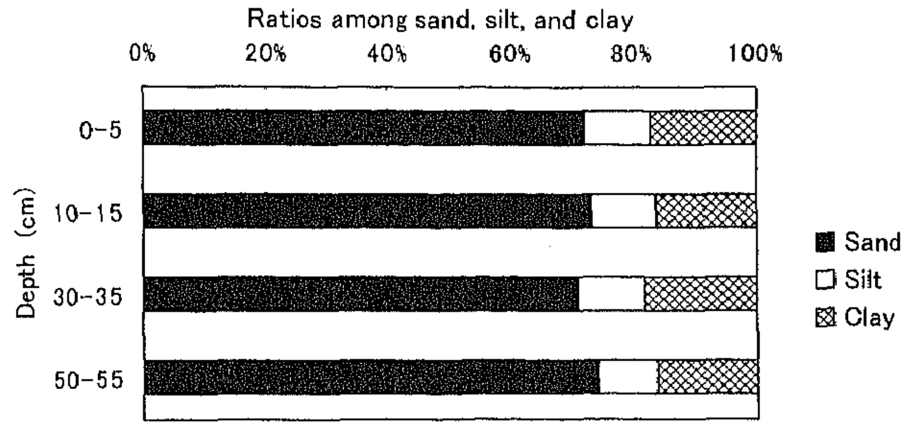

Fig.2 Particle size composition in the pineapple field

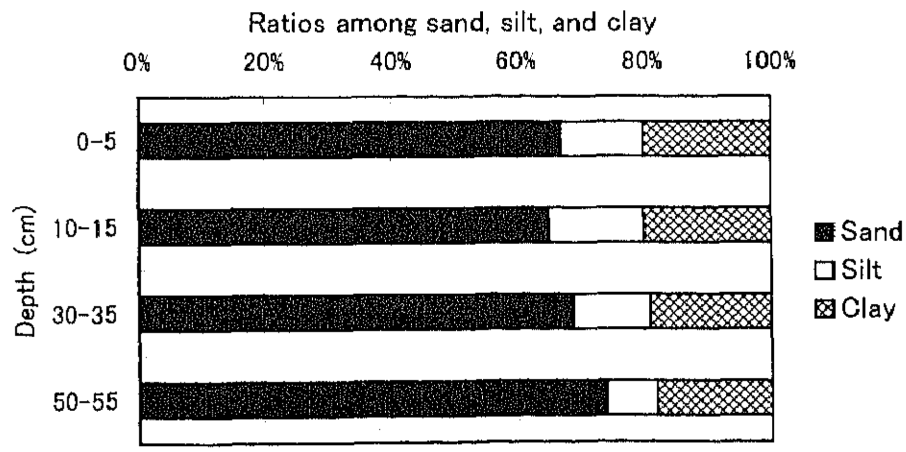

Fig.3 Particle size composition in the forest

Therefore, it is possible to conclude that the soils in the pineapple field and the forest had the same origin. The soil contains a large component of sand and has a single grain structure, giving it a high probability of eroding.

3.4 Soil Physical Property

One of the factors leading to soil erosion is a soil's low water permeability. That is, if water permeability of a soil is low, since rain could not infiltrate easily into the soil, surface runoff increased in number, and soil became easily erosional. The hydraulic conductivity of surface soil influenced greatly. We measured the saturated hydraulic conductivity of soils in both the field and the forest at depths from zero to 5 cm, 10 to 15 cm, 30 to 35 cm, and 50 to 55 cm. The results are shown in Fig. 4. From zero to 5 cm, the saturated hydraulic conductivity of the pineapple field is $1/10^{th}$ of that of the forest. This is considered to be one of the factors generating gully erosion in the pineapple field.

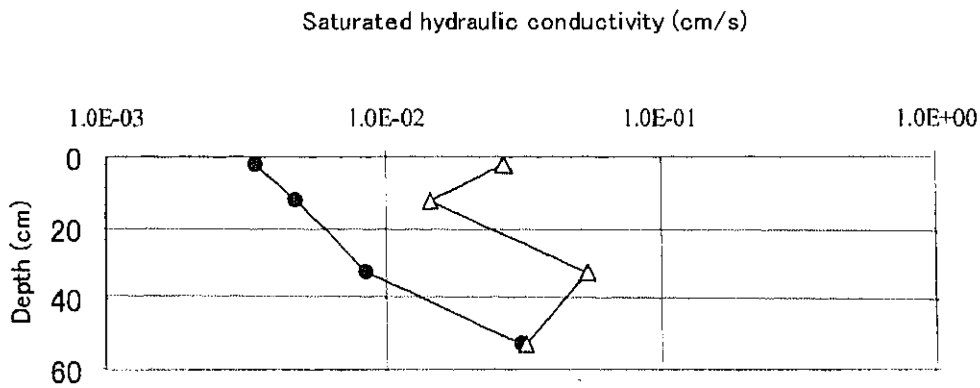

Fig. 4 Saturated hydraulic connductivity at each depth

—●— Pineapple field —△— Forest

Compaction, measured by dry bulk density, is often the source of lowered permeability. The dry bulk densities of the pineapple field and the forest soils at every depth are shown in Fig. 5. In the zero to 5 cm depth, and from 10 to 15 cm, the dry bulk density of the pineapple field soil is larger than that of the forest. However, from 30 to 35 cm, and from 50-55 cm, no remarkable difference in the dry bulk density can be seen between the two.

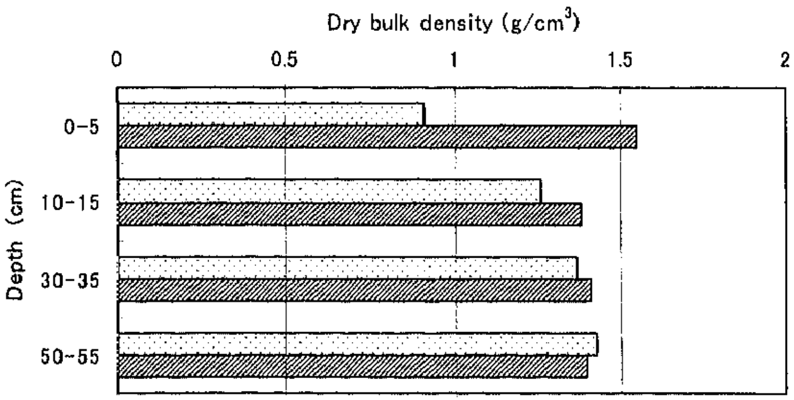

Fig. 5 Dry bulk density at each depth

□ Forest ▨ Pineapple filed

It is likely that the surface of a pineapple field has been compacted by various causes, and since the dry bulk density increased, the water permeability decreased as a result. It is possible that surface soil was compacted by the ground contact pressure of a machine or a farmer at the time of reclamation or cultivation. Or since there was a large component of sand in the soil, it is also possible that the surface soil was compacted by rains after reclamation of the field.

4. DEGRADATION OF FIELD

Surface soil usually contains more nutrients than subsoil because of humus and fertilizer application. The surface soil in sloped pineapple fields becomes less capable of maintaining these nutrients because fine particles at the surface layer flow out by soil erosion. Though new fine particles are provided from the subsoil by plowing every three years, their presence still declines; hence, the overall fertility of the pineapple fields becomes degraded.

5. CONCLUSIONS

1. The soil loss rate in pineapple field we examined was high in comparison to rates in Southeast Asia.

2. From the results of the soil profile investigation and particle size analysis to a depth of 50 cm, it was discovered that the forest soil and the pineapple field soil are essentially the same. It was concluded that the soil is erosive soil since it contains a large component of sand and has a single grain structure.

3. In the forest, where the soil is covered with a vegetation, rain does not hit on the soil surface directly, so soil erosion does not occur readily. On the other hand, a great portion of the soil surface in the pineapple field is uncovered, so raindrops hit the soil surface directly. This was thought to be the main cause of soil erosion.

4. Since a permeable, largely humus layer existed in the zero to 5 cm surface of the forest, rain tended to permeate into soil. This also contributed to its lack of soil erosion. On the other hand, the surface of the pineapple field has a small hydraulic conductivity. This, combined with the exposure discussed in conclusion 2, makes soil erosion a problem in the pineapple fields.

5. It can be assumed that the fertility of pineapple fields is easily degraded by soil erosion, especially by the erosion of fine particles in the soil.

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