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Soil Erosion in the Pineapple Fields in Ban Kha Sub-district

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Abstract

This paper focuses on the gully erosion and physical properties of soil in pineapple fields in Ban Kha Sub-district in the Tha Khoei basin in the upstream of Lam Phachi river basin. We surveyed the gully development for 2 years and studied the physical properties of soil in pineapple fields in Ban Kha Sub-district. It clarifies that (1) soil loss rates are medium or high in Southeast Asia; (2) the soil in this area is erodable; (3) soil erosion in pineapple fields easily occurs due to the lack of vegetation cover and the surface layer with a small hydraulic conductivity; (4) the fertility of pineapple fields is supposed to be easily degraded by soil erosion, especially by fine particles in the soil.

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

1. INTRODUCTION

Pineapples are cultivated in a lot of agricultural fields in Ban Kha Sub-district in the Tha Khoei basin of Lam Phachi river basin. Soil erosion has occurred in pineapple fields in sloped fields. In this paper, the authors aim to estimate soil loss by measuring gully development and to analyze 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 PINEAPPLE FIELD

2.1 Gully erosion in a pineapple field

We measured the gully development in a pineapple field located in 2 km southwest from the gauging station K 25A in order to estimate soil loss rates on 30 November in 2000 and on 27 November in 2001. The gradient is 7° at the steepest slope of this field. Pineapple cultivation in this field is at the first year in a cycle of three years in 2000 and at the second year in 2001. The field of the first year, second year means the field experienced a rainy season of 2000, two rainy seasons of 2000 and 2001, respectively.

The result of gully measurement is showed 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 these value neighboring two points in a gully line, are gully lines in 2000 and 2001, respectively. Contour lines are described in red lines at the interval of 0.5 m. Each elevation of contour lines is the height 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 a right angle,
2. Some gully lines in 2000 stretched in 2001, some of gully lines are newly made in 2001,
3. Some gully lines in 2000 disappeared in 2001. The reason some gully lines disappeared can be considered that soil from the upper field, the upper part in this field or from neighboring ridges flowed and accumulated at the disappeared gully lines.

2.2 Soil loss

The distance of a line connecting two points was measured on the 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 of each line and total loss in 2001. The average width and depth is 76 cm, 25cm, respectively and the range of width and depth is 30 – 130 cm, 3 – 25 cm respectively. The soil loss of each line is calculated as the average width × the average depth × 1/2 on the assumption that the cross section of each line is V shape.

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

Gully measurement was conducted in another pineapple field on 28 November in 2001, which is located in 800 m northeast from the gauging station K 25A and in the first year of pineapple cultivation cycle. The steepest slope is a gradient of 8 ° . The result of calculation of soil loss is 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 the region of Southeast Asia. As compared with these soil loss rates in Southeast Asia, the values to be estimated above can be ranked as the medium and highest level.

3. CHARACTERISTICS OF SOIL

3.1 Purpose of Investigation

Studies have shown that soil erosion has occurred in a pineapple field. On the other hand, soil erosion has not occurred within the neighboring forest. This section clarifies the cause of the soil

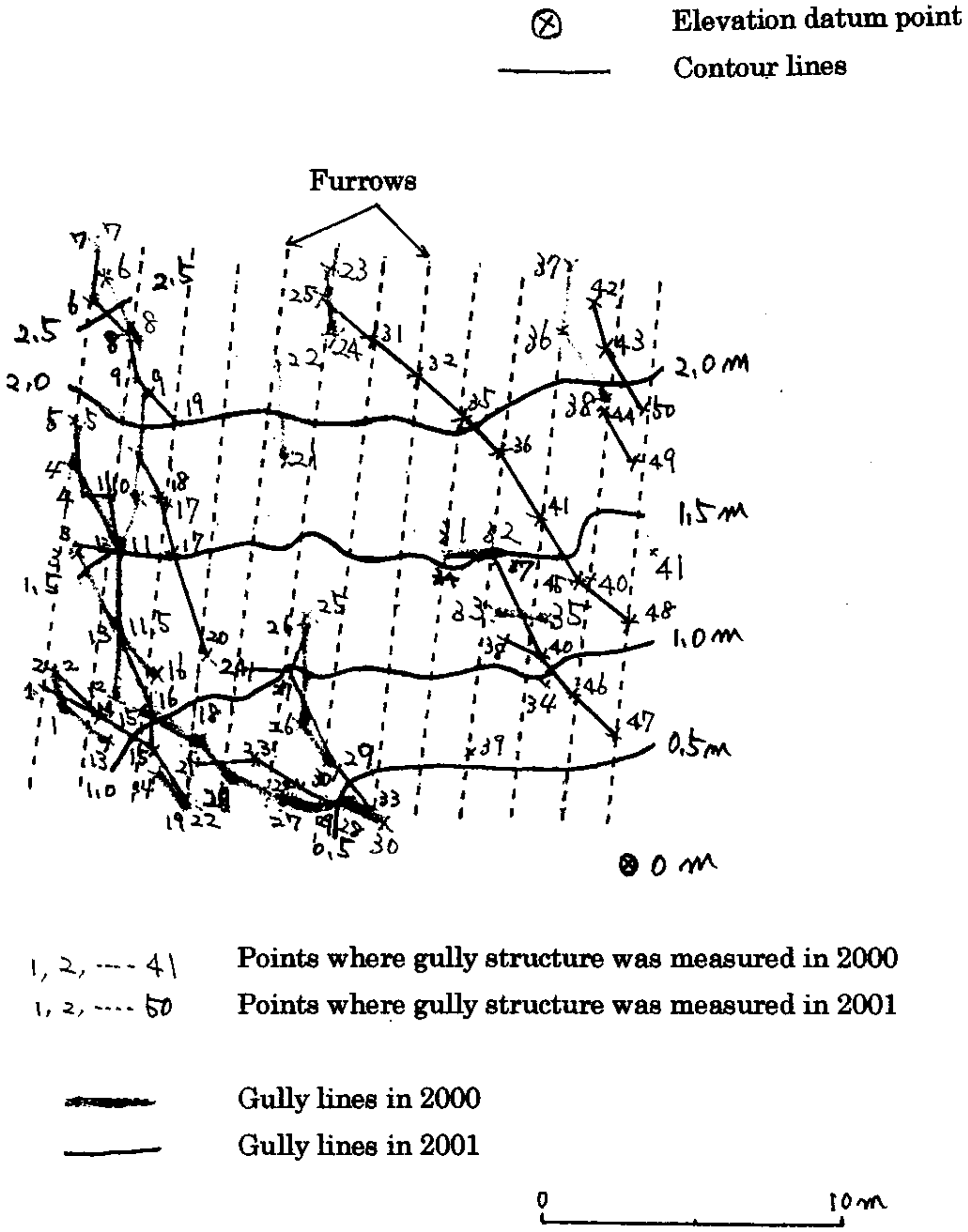

Fig. 1 Gully lines in a pineapple field

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 cm^2	Soil loss of each line m^3	
		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

erosion in the pineapple field by carrying out the comparison examination of the soil in the forest and the soil in the pineapple field.

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

3.2 Soil Profile Characterization

Investigation of soil profile in the forest and the pineapple field, which adjoin each other, was conducted to a depth of 50 cm. In the forest, 5 cm thickness humus layer surface was found, and the brown colored soil was found up to 20 cm in depth, due to the influence of the organic matters. 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 the soil shared the same origination. Also, both the pineapple field and the forest had much gravel which measured from several cm to 10 cm in diameter, and the soil structure other than the humus layer was of single grain structure.

3.3 Soil Texture and Structure

The particle diameter composition (ratios among sand, silt, and clay) of the pineapple field and the forest were obtained from a particle size analysis, and the results were shown in Fig. 2 and Fig. 3, respectively. As it can be seen from the soil texture, the pineapple field and the forest soil were the same to a depth of 50 cm, and it is Sandy Clay Loam (SCL).

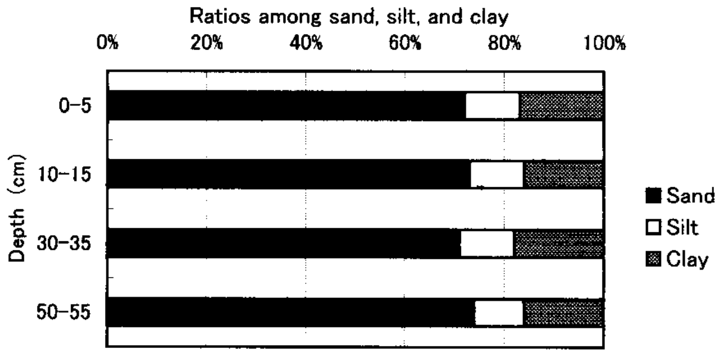

Fig.2 Particle size composition in the pineapple field

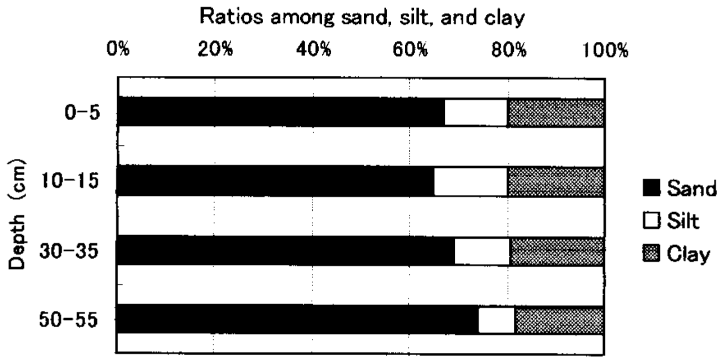

Fig.3 Particle size composition in the forest

Therefore, it is possible to conclude that the soil in the pineapple field and the forest were the soil of the same origin. The soil contains much sand and has a single grain structure, therefore, the soil has high probability of eroding.

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3.4 Soil Physical Property

One of the reasons that cause soil erosion is the low water permeability of soil. That is, if water permeability of soil is low, since rain can not infiltrate easily into the soil, surface runoff increased in number, and soil becomes easily eroded. In this case, the hydraulic conductivity of surface soil influenced greatly. Then, the saturated hydraulic conductivity of soil from zero to 5 cm, 10 to 15 cm, 30 to 35 cm, and the 50-55 cm depth was investigated. The results are shown in Fig. 4. In zero to 5 cm, the saturated hydraulic conductivity of the pineapple field is 1/10 smaller than that of the forest. This is considered to be one of the factors which the gully erosion generated in the pineapple field.

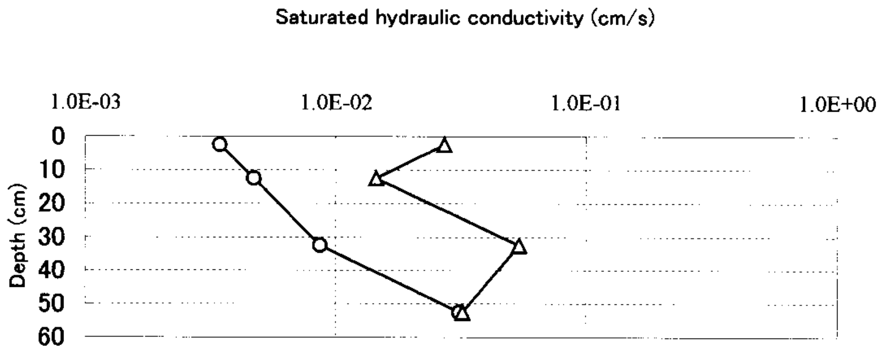

Fig. 4 Saturated hydraulic connductivity at each depth

—O— Pineapple field —△— Forest

Moreover, the dry bulk density of the pineapple field soil and the forest soil in every depth are shown in Fig. 5. In the zero to 5 cm depth, and 10 to 15 cm, the dry bulk density of the pineapple field soil is larger than that of the forest. However, in 30 to 35 cm, and at the 50-55 cm depth, the remarkable difference in the dry bulk density is not seen in the pineapple field soil and the forest soil.

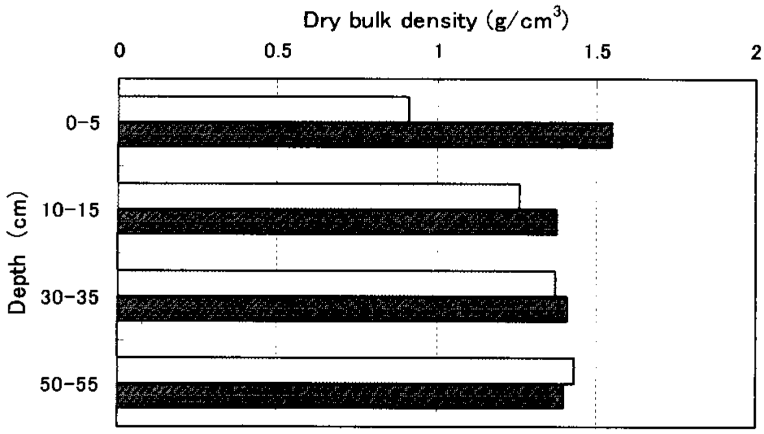

Fig. 5 Dry bulk density at each depth

□ Forest ■ Pineapple filed

It is thought that the surface of a pineapple field was compacted by a certain cause, and since the dry bulk density became large, the water permeability became small as a result. It is possible that surface soil was compacted by the ground contact pressure of a machine or a farmer as a cause at the time of reclamation or cultivation. Or since there was much sand, it is thought that the surface soil was compacted by the rain after reclamation of the field was done.

4. DEGRADATION OF FIELD

Surface soil is usually abundant in nourishment unlike subsoil because of including humus and being fertilized. The surface soil in pineapple fields becomes to be capable of keeping less nourishment in it because fine particles at the surface layer flow out by soil erosion. Though new fine particles are provided from subsoil by plowing which is once every three years, they are less and less in the soil, thus the fertility of pineapple fields will be degraded.

5. CONCLUSION

1. Soil loss rate is medium in a pineapple field or high in another pineapple field in Southeast Asia.
2. From the results of the soil profile investigation and particle size analysis to a depth of 50 cm, it is seen that the forest soil and the pineapple field soil were the same. It was concluded that the soil is erosive soil since it contains much sand and has a single grain structure.
3. In the forest, to which the soil is covered with vegetation, rain does not hit on the soil surface directly, so soil erosion can not occur easily. On the other hand, the pineapple field has a great portion of soil surface uncovered, so raindrops hit the soil surface directly. Therefore, soil tended to disperse and it was thought that soil erosion tended to occur.
4. Since permeable large humus layer existed in the zero to 5 cm surface of the forest, rain tended to permeate into soil. Therefore, since surface runoff is low, as a result, there is no soil erosion. On the other hand, since the surface of the pineapple field has a small hydraulic conductivity and there is much rain on the surface, as stated in conclusion 2., the surface runoff increased, and soil erosion tended to occur.
5. The fertility of pineapple fields is supposed to be easily degraded by soil erosion, especially by fine particles in the soil.

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