Jakarta Symposium Proceeding On

PEATLANDS FOR PEOPLE NATURAL RESOURCES FUNCTION AND SUSTAINABLE MANAGEMENT

editors:

JACK RIELEY

SUSAN PAGE

chairman o.c:

BAMBANG SETIADI

PEATLANDS FOR PEOPLE: NATURAL RESOURCE FUNCTIONS AND SUSTAINABLE MANAGEMENT

Proceedings of the International Symposium on Tropical Peatlands, held in Jakarta, Indonesia on 22nd and 23rd August 2001

Editors

J.O. Rieley

Professor of Geography, University of Nottingham, UK

S.E. Page

Lecturer in Ecology, University of Leicester, UK

Chairman of Organizing Committee

Bambang Setiadi

Deputy Chairman of Technology for Natural Resources Development, BPP Teknologi, Jakarta, Indonesia

PROCEEDINGS OF JAKARTA PEATLAND SYMPOSIUM
ADDITIONAL PAGE NEAR FRONT

Recommended form of citation:

Rieley, J.O. and Page, S.E. (eds) with Setiadi, B.:

Peatlands for People: Natural Resource Functions and Sustainable Management. Proceedings of the International Symposium on Tropical Peatland, 22-23 August 2001, Jakarta, Indonesia. BPPT and Indonesian Peat Association. 272 pp.

ISBN: 979-95183-3-4

Published by : Agency for the Assessment and Application of Technology (BPPT)
Indonesian Peat Association (IPA)

Distributed by : International Peat Society

Printed by : Ril Nusa Indah, Jakarta Indonesia

Available from:
Within Indonesia: Indonesian Peat Association, c/o Dr. Bambang Setiadi, BPPT Building II, 19th Floor, Jalan M.H. Thamrin 8, Jakarta 10340, Indonesia- Rp. 100.000,- including postage and packing

Outside Indonesia: International Peat Society, Vapaudenkatu 12, FIN-40100 Jyväskylä, Finland - US $ 30 plus money transfer charge, including postage and packing.

MACROMORPHOLOGY AND MICROMORPHOLOGY OF COASTAL PEATLAND FROM KAPUAS/BARITO AND KAHAYAN RIVER AREAS, CENTRAL KALIMANTAN

F. Lusiana[1], Widiatmaka[2], S. Hardjowigeno[2]

[1]Postgraduate Program, Bogor Agric. Univ., Jln Meranti, Kampus IPB Darmaga, Bogor 16144, INDONESIA (fenty2002@yahoo.com)

[2]Dept. of Soil Science, Fac. Of Agriculture & Center for Wetland Studies, Bogor Agric. Univ., Jln Meranti, Kampus IPB Darmaga, Bogor 16144, INDONESIA

SUMMARY

This study was carried out on macromorphology and micromorphology of coastal peat from Kapuas/ Barito and Kahayan River areas, Central Kalimantan. The study consisted of field observation, physical and chemical laboratory analysis and micromorphological observation. The profiles consisted of Oa and Oe horizons in the organic soil material and Cg horizon in the mineral material. The degree of decomposition of organic material varies from hemic to sapric. The textures of mineral material are clay for the soil in Kahayan River area and clay to silty clay for the soil in Kapuas/Barito River area. The soils from Kapuas/Barito River area have higher fiber content, exchangeable bases, base saturation, N-total and P-available compared to the soil from the Kahayan River area. Micromorphological analysis indicated similarity of soil properties in the two areas, especially in the relative position of mineral material to organic material and excreted material. The different micromorphologic characteristics were in fine organic material texture, size and quantity of the excrement. The analysis gave an indication of the existence of moder formation in the organic material and clay coating character in the mineral material.

Keywords: coastal peat, macromorphology, micromorphology

INTRODUCTION

Peatland is one of the marginal lands in which its characteristics and potential need to be researched intensively, in the context of national food requirement. This land has variable characteristics related to its environment and formation factors. Coastal peat is generally developed in the alluvial formation. In this environment, soil formation in an alluvial deposition is influenced mainly by river water quality and discharge, topography, marine condition and type of vegetation. Previous research (CSR, 1997) has indicated that coastal peat has variable macromorphological character. Micromorphological observations on peat soil, up to now, have been a low priority. According to Bullock *et al.* (1985), micromorphological study relates to soil genesis, so that soil characteristics need to be recognized first. This research aimed to discover macro and micromorphological characteristics of coastal peat in Kapuas/Barito and Kahayan River areas, Central Kalimantan.

MATERIAL AND METHODS

The research was carried out on coastal peatland in the area of Kahayan and Kapuas/Barito Rivers at the area of development of the one million hectare project, Central Kalimantan. Three soil profiles in Kahayan River area (KPL_1, KPL_2, and KPL_3) and three soil profiles of Kapuas/Barito River area (BPL_1, BPL_2 and BPL_3) were studied. representing soil with peat thickness of 20 - 40 cm, 40 - 130 cm. and 130 - 300 cm.

The soil samples have been taken to perform laboratory chemical analysis, greenhouse experiments, and micromorphological analysis (Lusiana, 2001). This article will discuss only the result of macro and micromorphological study, while several chemical data will be presented in summary form as an illustration. For micromorphological analysis, undisturbed soil samples were taken. The thin sections were prepared according to the procedure of Murphy (1976).

RESULTS AND DISCUSSION

Difference of Water Properties

The water of the Barito River has total bases concentration (K, Na, and Mg) higher than those in Kahayan River (Appendix A). The high Total Dissolved Solids (TDS) in Barito River (134.61 g l^{-1}) compared to the Kahayan River (91.27 g l^{-1}) indicates a higher amount of soil erosion in river upper part of the former.

Physical and Morphological Properties

Degree of decomposition of peat varies from hemic to sapric. The textures of mineral material under the peat layer are clay to silty clay (Appendix B).

Horizonization and Organic Soil Material Type. Each horizon is characterised by organic-C content, degree of decomposition (fiber content) and their pedogenetic processes. The Oa and Oe horizons are found in all pedons. The sapric horizon (Oa) has fiber content <17%, and hemic horizon (Oe) have fiber content 17 – 75%. The mineral soil horizon, Cg is gleyed.

Colour. There is no difference in soil colour at the two locations. The soil with sapric material is dark in colour (10 YR) owing to decomposition effect, while the soil with hemic material has a reddish colour (5 YR). The mineral material horizons have are grey asa a result of the gleying process.

Organic-C. Comparison of organic-C of some pedons with the same peat thickness indicates that C-organic content of KPL is usually higher than BPL. This is because the decomposition process is more intensive in BPL than in KPL. The Cg horizon has a relatively high organic-C content.

Soil Texture. The mineral materials under the peat layer have a clay and silty clay texture (Appendix B). There is no texture difference between KPL pedon (clay content: 61.81% - 69.14%) and BPL pedon (clay content: 56.38% - 76.11%). This fine texture is the cause of the low drainage and permeability of these soils.

Soil Chemical Properties

pH. In the organic soil material layer, pH of BPL tends to be higher than pH of KPL. This relates to the higher content of basic cations of Kapuas/Barito River than Kahayan River. But in soil with peat thickness of 40-130 cm and of 130-300 cm, there is no significance different between the two soils owing to the higher base content of BPL than KPL (Appendix B).

Base Saturation, Total Base and Cation Exchange Capacity. In all soils, base saturation and total bases were usually higher in BPL than KPL. The base saturation increased with depth. This fact was very clear in mineral material. The CEC of mineral soil material was relatively high, owing to a high organic content, which was visible under an optical microscope.

Soil Micromorphology

I. The Organic Soil Material

A. Organic Basic Component

Micromorphologycal Properties of Fine Organic Material. Organic soil material types classified according to their degree of decomposition could not be related to those determined by fiber content analysis or macromorphological observation. Despite this, the decomposition characteristics could be identified on the basis of their content of fine material. The more decomposed material was expressed by the darkness of groundmass resulting from release of pigment.

Micromorphological Expression of Coarse Organic Material. Root residues are characterized by a thin epidermis, without cuticule (Fahn, 1982), and with a rounded form in cross section, which can be seen by its high interference colour. Leaf residues are characterized by the presence of parenchyma palisade cells. Stem residues are characterized by the outer epidermis.

Comparison of Micromorphological Characteristic of KPL Vs BPL. The ratios of coarse organic material to fine organic material (c/f ratio) on KPL samples are generally higher than the BPL samples. Fine organic material texture and colour on BPL samples were more varied, while the texture and colour of fine organic material on KPL samples tended to be more uniform (Fig. 1).

B. Mineral Basic Component

Frequency of Basic Mineral Component in Soil Organic Material. Frequency of mineral particles identified inf all thin section samples was low, between 1 to 5%. The real frequency is supposed to be higher, because the soil horizons have high ash content, varying from 1.50 to 25.17%.

Relative Chronologic Interpretation. The appearance of basic mineral material could be classified into two types: (i) part of the mineral basic components appear well sorted and fresh; these facts indicate that the mineral material is deposited more recently compared to the existing organic material; (ii) the other part of the mineral material appear obscured, characterised only by the weak birefringence in cross polarised light (XPL); these mineral material are covered by organic material, indicating that the decomposition of the covering fine organic material is more recent than mineral deposition. These relative position could be interpreted in term of relative chronology of the processes of mineral deposition and the processes of organic matter decomposition. Both of the two kinds of appearance of mineral material related to their relative position to the fine material, exist coincidently, both in KPL and BPL. These facts indicate that the development of organic material in both areas is affected by river transported material, from past to present. This means that the characteristic of organic soil on this area is closely related to the characteristic of the rivers' transported material.

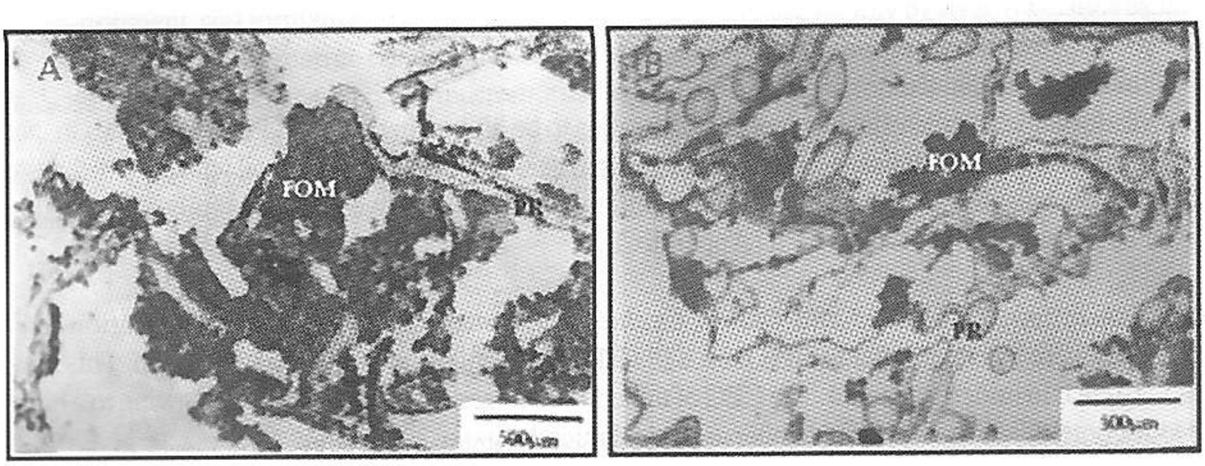

Figure 1. Micromorphological characteristics of organic soil material from Kapuas /Barito River areas (A) and Kahayan River areas (B). Fine Organic Material (FOM), Plant Residue (PR), vertical section, 10X.

The difference of this c/f ratio, textural pattern and colour of fine organic material may relate to the type of its original vegetation. Inversely, there are no specific patterns, which differentiate the root residue, stem, and leaf, between the BPL samples and the KPL samples.

C. Excrement Pedofeatures

Birefringence Appearance of Excrement Pedofeatures. The excrement pedofeatures, which indicate activity of soil fauna, are found in ellipsoid form (Bullock *et al*., 1985). The appearances of excrement groundmass could be classified into 2 types, clearly differentiated in XPL: (i) excrement with groundmass appearance of dotted birefringence, and (ii) excrement without dotted birefringence. The excrement of the first type could be interpreted as primary excrement, while the second type of excrement could be interpreted as secondary excrement.

The Comparison of Excrement Pedofeatures of BPL Vs KPL. Relatively, the KPL samples have more excrement content compared to BPL samples. The existence of excrement in the KPL samples is more easily identified than those in BPL. This fact could be interpreted in 2 directions: (i) it is possible that the KPL environment had more faunal activity than the BPL environment, and (ii) the BPL environment allowed for excrement destruction to be more extensive (Dijkstra, 1998). From the point of view of excrement position, excrement in BPL samples tends to be close to fine organic materials, while the excrement in KPL samples tend to be close to coarse organic materials (Fig. 2).

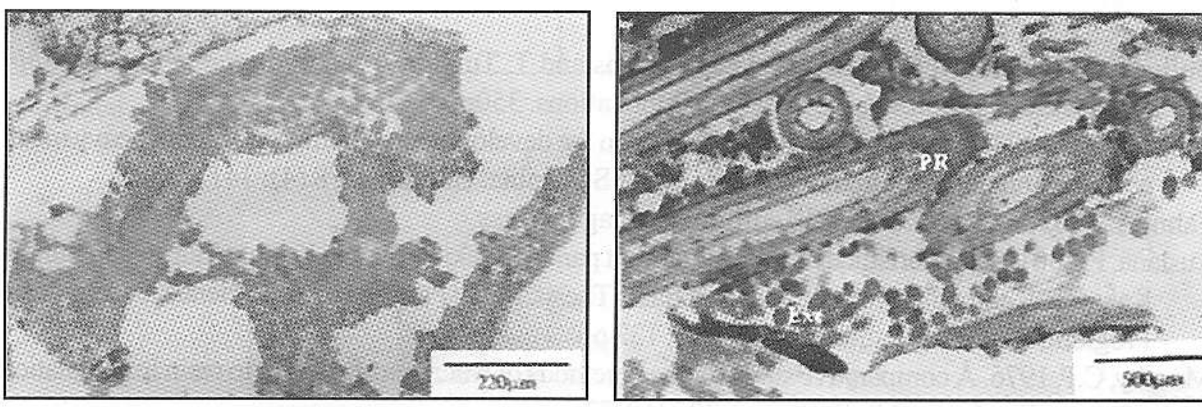

Figure 2. Micromorphology of excrement on thin section from Kapuas/Barito River areas (A) and Kahayan River areas (B). Excrement (Exc.), Plant Residue (PR), vertical section, 25X (A), 10X (B)

Mixing of Fine Organic Materials and Mineral Materials. According to van Heuveln *et al.* (1960), the intensive mixture of fine organic material with mineral particles is called a mull. The non-intensive mixed allows the formation of moder. In this research, there is no indication that the mixture is intensive, the excrement with mineral material inside has not found; the form is close to moder. Moder, is characterised by excrement, of variable size 25 – 60 mm, dispersed in a small group between the morphologically intact peat particles. The moder formed in peat profiles in humid conditions under which the excrement, partly or totally disintegrated to a friable material hitherto undescribed, which is a mixture of plant remains and very fine soil material. Related to the moder condition formation, the moder existence indicates that the soils in the research area have relatively low fertility.

II. Mineral Soil Material

Clay Coating. In soil mineral material, clay coating has been found in low frequency, both in BPL and KPL samples. The clay coating found is similar to primary coating (Widiatmaka *et al*., 1994), with strong integration with the groundmass. This fact indicates that pedological processes took place before peat formation and before transgression.

CONCLUSION

1. The pedons in the research area consisted of Oa and Oe horizons in organic soil materials and Cg horizons in mineral material. The decomposition degree of organic soil material varies from hemic to sapric. The texture of mineral soil material are clay in Kahayan and clay to silty-clay on Kapuas/Barito
2. Soil chemical properties in Kapuas/Barito River area are better than soil in the Kahayan River area. This is indicated by the higher amount of exchangeable bases and base saturation in BPL than KPL. These better soil characteristics were related to the quality of the water in the river transporting the material.
3. Micromorphological analysis indicates several similarities between the micromorphological character of Kapuas/Barito River area and Kahayan River area, especially in the relative position of mineral material to organic material, excremental pedofeatures and micromorphological characters of plant residue. Several distinctive characters have been found in the amount and position of excrement pedofeatures and fine organic material texture appearance. Even so there are no specific major processes, this analysis indicates moder formation on organic material and clay coating on mineral soil material.

REFERENCES

Bullock, P., N. Fedoroff, A. Jongerius, G. Stoops and T. Tursina. 1985. *Handbook for Soil Thin Section Description*. Waine Research Publications. 350p

Dijkstra, E.F. 1998. A micromorphological study on the development of humus profiles in heavy metal polluted and non-polluted forest soils under Scotspine. *Geoderma*, 8 (4): 341 – 358.

Fahn, A. 1982. *Plant Anatomy*. 3rd edition. Permagon Press.

Lusiana, F. 2001. Karakteristik dan genesis gambut pantai di sekitar Sungai Kapuas/Barito dan Sungai Kahayan, Kalimantan Tengah. Magister Sains Thesis. Study Program of Soil Science, Postgraduate Program, Bogor Agricultural University. 132 pp.

Murphy, C.P. 1976. A comparative study of three methods of water removal prior to resin impregnation of two soils. *Journal Soil Science*. 30: 719-735

CSR. 1997. *Laporan Survey Daerah Kerja D Proyek PLG Sejuta Ha*. Pusat Penelitian Tanah dan Agroklimat. Bogor.

van Heuveln, B., A. Jongerius, and L.J. Pons. 1960. Soil formation in organic soils. 7th Intern. Congress of Soil Science, Madison, USA.

Widiatmaka, P. Curmi, J. Pellerin, A. Ruellan. 1994. Saprolite influence on formation of well-drained and hydromorphic horizon in an acid soil system as determined by structural analysis *In* A.J. Ringrose-Voase and G.S. Humphreys *(Eds.)*. 1994. *Development in Soil Science*. 22:135-154 Elsevier, Amsterdam.

APPENDIX A

Water analysis of Barito and Kahayan Rivers

No.	Analisis	Upper Course of		Lower Course of	
		Barito R	Kahayan R	Barito R	Kahayan R
1.	N (mg/l)	5,42	13,55	3,61	6,32
2.	P (mg/l)	0,07	0,10	0,50	0,10
3.	K (mg/l)	0,50	0,50	0,50	0,50
4.	Ca (mg/l)	0,02	0,06	0,02	0,06
5.	Mg (mg/l)	0,20	0,17	0,19	0,17
6.	Na (mg/l)	3,00	2,00	3,10	1,00
7.	Fe (mg/l)	0,70	0,70	1,12	0,70
8.	Cu (mg/l)	tr	tr	tr	tr
9.	Zn (mg/l)	tr	tr	tr	tr
10.	Mn (mg/l)	tr	tr	tr	0,02
11.	B (mg/l)	0,095	0,177	0,651	0,143
12.	Cl (mg/l)	4,97	3,10	4,83	4,54
13.	SO_4 (ppm)	0,40	0,40	2,10	1,30
14.	TDS (g/l)	134,61	91,27	156,72	87,21
15.	DHL	23,8	27,0	32,00	52,1

tr = trace

APPENDIX B

Physical and chemical characteristics of BPL and KPL pedon at research location

Depth (cm)	Hor	Colour	Org-C (%)	Fiber (%)	pH	Total Base	CEC cmol(+)/kg	BS (%)	Texture
PEDON BPL1									
0 – 28	Oa_1	10 YR 2/1	43.4	14 (sapric)	4.2	7.56	92.16	9.73	-
28 – 34	Oa_2	10 YR 2/1	45.3	8 (sapric)	4.5	11.30	136.70	8.25	-
34 – 65	Cg_1	10 YR 5/2	9.5	-	4.8	5.85	28.20	20.76	Clay
65 – 94	Cg_2	5 Y 5/1	7.8	-	4.5	9.08	27.93	32.51	Clay
94 – 134	Cg_3	5 Y 4/1	6.1	-	4.2	13.52	26.07	51.83	Clay
134 – 160	Cg_4	5 Y 4/1	5.9	-	3.6	17.23	30.32	57.68	Silty clay
PEDON BPL2									
0 – 30	Oa_1	10 YR 2/1	54.6	12 (sapric)	4.0	11.35	113.55	10.09	-
30 – 62	Oa_2	10 YR 2/1	53.4	14 (sapric)	4.1	12.31	105.46	11.67	-
62 – 78	Oe	5 YR 2.5/1	53.7	30 (hemic)	4.3	16.01	120.14	13.36	-
78 – 94	Cg_1	10 Y 4/1	10.8	-	4.0	18.07	27.66	65.42	Clay
94 – 116	Cg_2	10 Y 4/1	9.1	-	4.0	15.65	24.47	63.93	Clay
116 – 150	Cg_3	4 Y 4/1	8.9	-	3.9	13.91	25.27	55.07	Clay
PEDON BPL3									
0 – 26	Oa_1	5 YR 3/2	53.5	6 (sapric)	4.3	5.07	12.15	110.7	-
26 – 47	Oa_2	10 YR 2/2	54.2	8 (sapric)	4.3	6.07	11.40	87.18	-
47 – 60	Oa_3	7.5 YR 3/2	55.1	8 (sapric)	4.3	6.79	12.47	87.03	-
60 – 88	Oa_4	10 YR 3/1	55.6	16 (sapric)	4.2	7.34	14.08	100.67	-
88 – 138	Oe_1	7.5 YR 3/2	53.1	32 (hemic)	4.2	8.51	17.34	111.30	-
138 – 155	Oe_2	7.5 YR 3/2	26.9	20 (hemic)	4.1	8.15	16.63	51.38	-
155 – 165	Oa	7.5 YR 3/1	24.8	11 (sapric)	3.7	7.16	17.12	48.24	-
165 – 200	Cg	2.5 YR 4/2	10.6	-	3.6	3.63	15.60	31.12	Silty clay
PEDON KPL1									
0 – 17	Oa_1	10 YR 2/2	54.4	10 (sapric)	3.6	8.40	147.97	5.94	-
17 – 35	Oa_2	10 YR 2/2	54.6	15 (sapric)	3.7	5.04	135.17	3.72	-
35 – 71	Cg_1	10 YR 4/1	11.4	-	3.2	13.04	32.98	40.22	Clay
71 – 102	Cg_2	2.5 YR 3/0	8.7	-	3.0	14.78	30.59	48.30	Clay
102 – 150	Cg_3	2.5 YR 3/0	9.1	-	3.3	17.99	27.40	66.08	Clay
PEDON KPL2									
0 – 16	Oe_1	5 YR 3/2	56.3	30 (hemic)	3.5	4.535	88.83	5.11	-
16 – 34	Oe_2	5 YR 3/2	55.9	18 (hemic)	3.7	8.100	125.44	6.50	-
34 – 65	Oe_3	5 YR 3/2	55.3	24 (hemic)	3.8	6.643	93.70	7.14	-
65 – 82	Oe_4	10 YR 2/1	54.9	36 (hemic)	4.1	7.012	128.51	5.46	-
82 – 91	Oa	10 YR 2/2	23.8	15 (sapric)	5.1	8.314	132.10	6.30	-
91 – 114	Cg_1	10 YR 5/2	8.4	-	4.6	15.380	25.27	60.81	Silty clay
114 – 140	Cg_2	10 YR 3/2	7.4	-	5.0	15.296	26.87	56.89	Clay
140 – 200	Cg_3	2.5 YR 3/1	7.0	-	3.7	16.935	27.13	62.51	Clay
PEDON KPL3									
0 – 12	Oa	10 YR 2/1	54.9	14 (sapric)	3.7	6.038	97.07	6.24	-
12 – 41	Oe_1	10 YR 2/2	56.4	32 (hemic)	3.7	6.003	120.06	5.02	-
41 – 65	Oe_2	10 YR 2/2	56.3	44 (hemic)	4.4	6.816	104.70	6.65	-
65 – 100	Oe_3	10 YR 2/2	57.0	56 (hemic)	4.3	3.214	135.17	2.38	-
100 – 122	Oe_4	10 YR 2/3	56.6	36 (hemic)	4.7	3.612	155.65	2.32	-
122 – 180	Oe_5	7.5 YR 3/3	43.7	32 (hemic)	4.3	3.569	114.18	3.48	-
180 – 200	Cg	10 YR 3/1	8.0	-	3.4	14.890	30.06	49.54	Clay