MAPPING OF PEAT HYDROLOGICAL UNIT AND PEAT DOME OF INDONESIA IN SUPPORTING SUSTAINABLE PEAT MANAGEMENT

Baba Barus, K. Gandasasmita and Reni Kusumo

Staff of Laboratory of Remote Sensing and Spatial Information,
Department of Soil Science and Land Resources, Faculty of Agriculture, IPB
E-mail : bababarus61@gmail.com

ABSTRACT

Recently, there is a serious awareness for destruction of peat land in Indonesia especially for its utilization in palm oil crop and industrial forest development. In order to prevent further destruction, the Government of Indonesia has regulated to avoid using deep peat land. Beside that, the Ministry of Environment currently proposes a new additional regulation for not using peat dome area, based on peat hydrological unit area; which data have not yet available in Indonesia. This study informs the progress of hydrological peat and peat dome mapping in Indonesia, using remote sensing data and available spatial data, with limited field data. The result shows the distribution and the variation of peat hydrological unit and peat dome throughout Indonesia.

***Keywords**: Peat hydrological unit, peat dome unit, mapping, Indonesia*

INTRODUCTION

Background

Peat soil is derived from accumulation of organic matters through anaerobic decomposition process in specific environment. Peat ecosystem is influenced by peat, air, water, flora and fauna, hydro-topography and its sediment, which interacts producing a specific and fragile system. Some of peat areas in Indonesia, of predicted more than 20 million Hectares, currently have been utilized for many purposes. As vulnerable and unique areas, it is suggested to manage them prudently. So far some peat areas are identified in condition of degraded severely and have negative impact to current activities; but some are being utilized, and many are still needed for further development. For areas that have been already destructed and degraded require a particular management and might be rehabilitation, whereas for undeveloped peat areas, need further understanding before further development.

With current peat area developments, without any additional policy, the peat land might be destroyed further, or might be no benefit for community. So far, based on the current existing regulation, it may bring further destruction for peat in some areas especially peat dome areas, and prohibit further development in other places, such as regulation for not allowing to use peat with depth more than 3 meter (Act no 41, 1999 about Forestry and Act no 26, 2007 about Spatial Planning). However, some of peat with depth more than 3 m have been utilized, and

proved to be beneficial for owners; and some districts in Indonesia are dominated by deep peat areas, which need additional lands for their development activities.

To accommodate this situation, the Ministry of Environment has initiated to develop a new regulation for using peat land area using hydrological peat unit (HPU) as basis for development, and peat dome (PDU) area as protection area. Peat hydrological unit is a peat ecosystem bordered by river and or sea, which has specific properties, may contain peat dome. Peat dome is a part of peat ecosystem having convex shape and higher than its surrounding, control water balance and movement, which should be as protection area. Some private companies in Indonesia have been protecting their peat dome areas, not for cultivation area, and have proved for their beneficial especially protecting areas from drought and fire, and better supply water its area.

However, these data (HPU and PDU) have not been available in Indonesia. The Ministry of Environment is pioneering to provide a preliminary data for peat hydrological unit and peat dome. This paper tries to inform brief information of data and its development, characteristics, and the need for further investigation.

Aims

The purposes of the research are: (a) to investigate peat hydrological and dome areas in Indonesia, (b) to develop map of peat hydrological and peat dome areas

METHODOLOGY

Framework for analysis

To fulfill research requirement, three aspects constructed, are

a. Identification and delineation of peat hydrological unit (PHU)
   Data of Landsat image, river data, land system of RePPProT and Peat soil of Wetland International, were used to identify a PHU. Characters of swampy low land are easily recognized in Landsat Image, which was sometime it exhibit very clear boundaries between swampy and non swampy areas. For areas, not clear visible in images, then the aid of land system and river were very important. The Land system of low land or peat land direct interpreter to validate the possible areas interpreted; meanwhile river data help interpreter in deciding river boundary of hydrological unit, is invisible in Landsat Images. In general boundaries of PHU are river, sea and dry land.
b. Identification and delineation of peat dome unit (PDU)
   Peat dome area, recognized as part of back-swamp area, was generally located in the middle of PHU. The characters are identified from surface picture which reflected as particular image such as darker or lighter, or using rive data, reflected in upper part of rivers which can be concluded as low catchments areas. The size of peat dome to be protected area was considered to at least 30 percent PHU in PHU, if recognized. Not all PHU contain a PDU, particularly hydrological peat unit in inland areas (not swampy peat land). The quantitative number was generated from spatial planning regulation for development.

c. Analysis of peat hydrological and dome areas
Character of PHU and PDU of Indonesia are investigated in term of size, distribution, and pattern. This character may produce particular information for peat land management in high level especially for policy development.

Materials and tools

Materials used for development of map and research are : Landsat TM 2006-2007 images of Indonesia (KLH, 2006); RePPProT data, Peat Soil of Wetland International (from Internet); Peat map from Ministry of Energy and Mineral; River data, administration boundary data, and others.

The facilities used were ArcGIS and Erdas in the Laboratory of Remote Sensing and Spatial Information, Department Soil Science and Land Resources, Faculty of Agriculture, IPB

Location and time

The research location is Indonesia, and conducted in 1997-1998, with source of fund from Ministry of Environment of Indonesia.

Method

Processes of the research consists of 4 steps, are :

a. Data collection and management
Collecting digital data of Landsat imagery, land system map, river map, peat soil map, peat of ESDM data. Some data have in digital format, and were corrected geometrically. Some data such as peat soil and peat data were digitized in standardized format.
b. Processing and printing data
Landsat data were overlaid with river and selected land system of low land map, and printed per island for simplicity of processing and printing.
c. Interpretation and delineation
Based on featured on Landsat covered by river and lowland area printed data, interpretation of PHU and PDU were carried out. Feature characteristic for PHU and PDU based on tone, texture and relative location of data to river and sea position.
d. Digitation and Validation
Interpretation PHU and PDU polygons were then digitized. Some corrections of the interpretation results were conducted using peat soil and other peat data.

The complete process of work is presented in Figure 1.

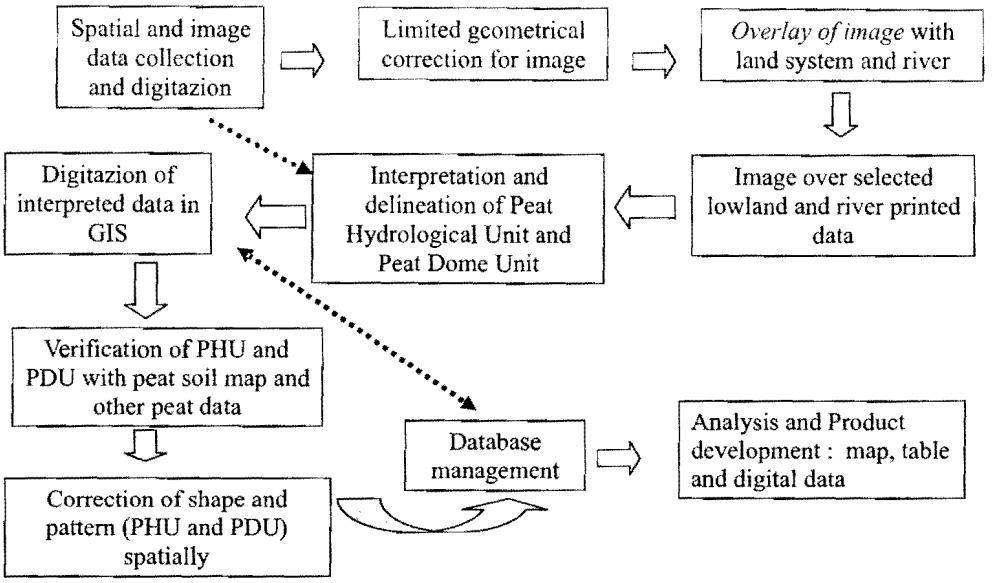

Figure 1. Development process for peat hydrological unit and peat dome unit interpretation and mapping

RESULTS AND DISCUSSION

Peat Hydrological Unit and Peat Dome Unit

The PHU and PDU have been mapped in the whole region of Indonesia (Figure 2). These peat hydrologycal units were dominated in 3 (three) islands such as Kalimantan, Sumatra, and Papua (Table 1). Some limited peat areas were found also in Sulawesi and Java. General pictures show that peat hydrological unit dominantly in coastal area, and some on central island such as in Kalimantan and Papua. From its physical environmental properties, then some further different characteristicts of hydrological unit and its dome that will be elaborated in the next section.

Based on Table 1, the highest area of PHU is located in Kalimantan, following Sumatra and Papua. The PHU areas in Java and Sulawesi were relatively small. The similar exhibition is found for PDU. However, the total number of PHU and PDU reflects with different picture. Th highest number of PHU and PDU is found in Sumatra. The second highest number of PHU is found in Sulawesi. This data indicate that the PHU in Sulawesi has small in sizes compare to other places. In Java, there is no indication of PDU.

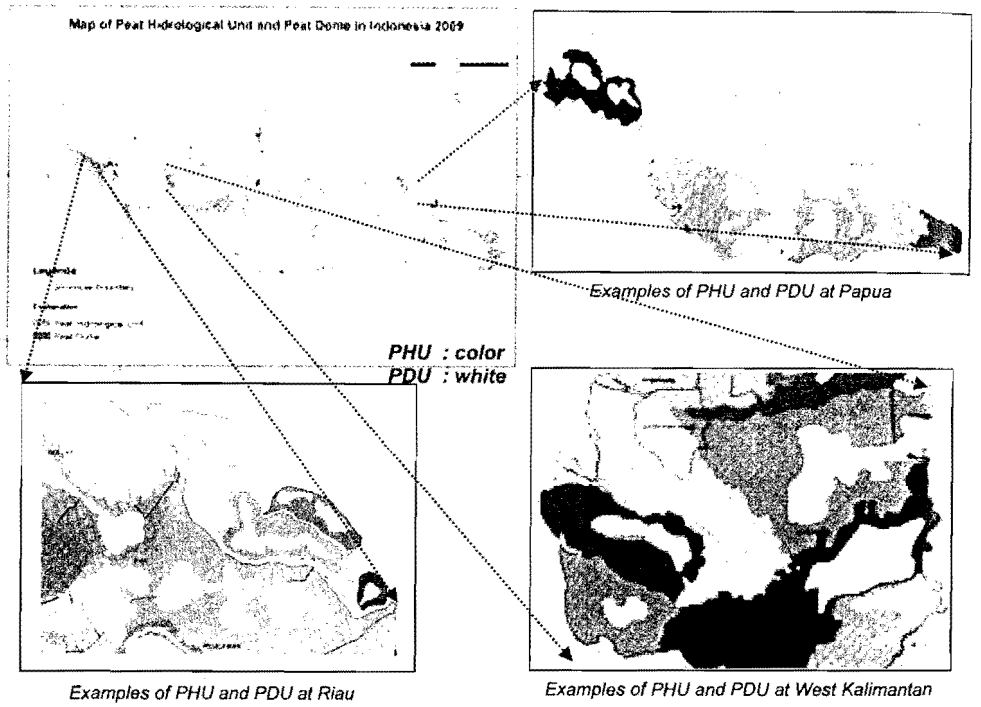

Figure 2. PHU and PDU distribution in Indonesia and some more detail examples of these polygons in Riau, West Kalimantan and Papua

Tabel 1. Area and percentage of Peat hydrological unit (PHU) and Peat dome unit (PDU) in main islands of Indonesia

No	Main island	PDU (Ha)	PDU number	PHU (Ha)	PHU number	% PDU
1	Kalimantan	2,991,650	98	10,179,696	104	29.39
2	Sumatera	2,701,527	116	10,622,143	144	25.43
3	Papua	1,253,714	66	10,173,070	88	12.32
4	Java	-	-	88,112	77	-
5	Sulawesi	62,585	19	621,618	126	10.07
	Total (Indonesia)	7,009,476	299	31,684,.640	539	22.12

Discussion

Characteristic of PHU and PDU

a. Variation of properties of PHU and PDU in Indonesia

PHU and PDU in Sumatra can be differentiated easily in remote sensing, and influenced by volcanic quarter sediment Dominant of these areas are located in the Western Coastal area, such as in Riau, South Sumatra, Lampung, Jambi and North Sumatra, following in small areas in the Western coastal area such as in Bengkulu and North Sumatra. Almost all PHU contains a particular PDU.

Similar to Sumatra, majority of PHU and PDU in Kalimantan can be differentiated easily in remote sensing, but they were influenced by tertiary sediment The dominant of PHU's are distributed in Central Kalimantan, followed by West Kalimantan, East Kalimantan and South Kalimantan. In Kalimantan, the size of PHU areas are relatively large especially in East and West Kalimantan.

The PHU and PDU in Papua, Sulawesi and Java were more difficult to identify in remote sensing compared to identify them in Sumatra and Kalimantan. PHU and PDU in Papua were hardly differentiated in remote sensing, although its size were relatively large; many of peat areas were located non-swampy area, as it locates in the central of Papua.

In contrast to PHU and PDU in Sulawesi that were hardly to be differentiated in remote sensing, due to they had small sizes of units. The peat areas in Sulawesi distribute sparesly in limited places on coastal areas. The smallest peat areas are found in Java. PHU and PDU in Java have left only in particular places such as swale (former lagoon) or lake, but in general their have been disappeared.

b. Part of PDU were difficult to be identified

As can be seen PHU in the previous maps, some PHU contain no PDU. PHU in non tidal swampy area usually may be without PDU, meanwhile PHU in tidal swampy areas sometime may have PDU. The boundary of PDU cannot be identified in image due to its key identifier in image has been disappeared such as the smooth of vegetation cover or the water content has been similar to its surrounding, as its natural properties have been destroyed.

However, PDU in Papua especially in the Southern area, cannot be identified as a distinct unit that might be related to unfinished process of peat dome development, as complexity of river drainage in these areas.

Size and boundary of PHU and PDU

a. Relative size for delimitation

The boundary of PHU can be delineated relatively, as the observation based on general appearances of lowland on images, supported by land system of RePPProT and peat soil map of Wetland International (WI). In general the size of PHU is larger than the size of soil peat map provided by WI. The reason related to area of PHU does not always peat soil area, but some contains non-peat areas, especially in natural levee or creavasse splay deposit area. The

natural process produced more sedimentation from river in these areas, not allowed development of peat soil.

Meanwhile size and boundary of PDU was more relatively delineated, as the purpose of delineation of PDU is to develop protected area, approximately minimum 30 percent of PHU. Some polygons of PDU could be delineated larger than its current size in a map, but its sizes were deducted. This decision related to importance area for cultivation.

b. PDU areas in PHU should be created with minimum standard

It is necessary to maintain minimum size of PDU in PHU, to guarantee local system safety in lowland areas. In general it is to risk to keep dependence only in upper land area.

Delimitation of PHU and PDU polygon

At least there are three aspects need to be concern, for PHU and PDU in this paper, are: unit created still in general form, based on image interpretation and available data, and locally still need to be revised.

Boundary of PHU and PDU need to revised locally both its content and boundary. The contents of unit mapping were properties description of the areas. A few transects for fact observation are required, and finally used for new boundary and supporting data for its explanation.

Technical issue and field data

a. Different quality of image used

The images used in the study had different quality either time of data capture, coverage by cloud, broken lines, and different brightness of color. The good image was very helpful in identifying object characteristics. But for image coverage by lines then some difficulties in identifying was harder to recognize object. For area covered by cloud and shadow, then the unit and boundaries were relied completely on available land system and peat soil map.

b. Some locations need field verification

The available supporting data and Landsat data used were categorized as less detail data, that in term mapping, the data were better used for mapping at scale of 1:25,000. In this case, there some possibilities that data might not sufficient for detail information, which can be applied for all results. Beside that, particularly unit of mapping in Papua, should be given priority attention as its supporting available data has less accurate, and its appearances on images majority covered by cloud particularly for peat on central part areas of the island.

CONCLUSIONS AND RECOMMENDATION

Conclusions

Character of peat land areas in Indonesia are different regarding different size and boundary of hydrological peat and peat dome unit. Some hydrological peat units have no peat dome unit.

The boundaries of hydrological units were generated based on general peat spatial character on images and available data, which implication that small area of unit might contain non peat data. Furthermore, the peat dome units were delineated with approximately 30 percent of peat hydrological unit, located in central areas.

Recommendation

As peat hydrological and peat dome units were generated based on the Landsat images, which had less detail information, and supported by available data, then some units sizes might be needed for further revised using more detail of local data or using detail and recent image. However, as general initial data, these data might be also used for preliminary source for decision for protection areas particularly for water reserve area.

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