PEATLAND DISASTER RISK REDUCTION BASED ON ECOSYSTEM MANAGEMENT IN PALANGKARAYA CENTRAL KALIMANTAN OF INDONESIA

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ABSTRACT

Peatland fire and drought which happened annually have become serious ecosystem disaster in Indonesia; especially in the Central Kalimantan. A model of peatland ecosystem management to decrease disaster risk is being developed in a 3.5 hectares plot in Kalampangan Village, Palangkaraya District, since 2016. The research consisted of estimation of carbon stock in the post-fire forest, natural forest and farming area; the post-fire peatland management by agronomic, agroforestry and conservation methods; and a simple methods of peat water treatment. Result of the first research are trees and litter total biomass (170.5 and 7 ton ha-1), trees and litter carbon stock (64.3 and 3.1 ha-1) in the natural forest much more higher than that of in the post-fire forest and in the farming area. Dissolved organic carbon through the water and soil respiration from soil ecosystem were also observed; physical and chemical characteristic of plot indicated peat thickness (2.7-4 m), pH (4.4 pH) and water table (35-46 cm). Some species of vegetable, food crops, forestry and conservation plants were tested in this plot; A simple methods of peat water treatment by manual and mechanical mixing were able to improve water quality to meet clean water standard.

Keywords: ecosystem management, disaster risk reduction, peatland, carbon and water.

INTRODUCTION

Peatlands are a national asset of Indonesia and the world, because they have function of production through the provision of food, ecological function as habitat of biodiversity, regulatory function as a store of carbon and water reserves, and cultural functions. Therefore the existence of sustainable peatland is very important. Tropical peatland has importance value for food production, climate regulation, water balance, biodiversity richness, soil protection and erosion control, and habitate of endemic species. Indonesia has 69 percent from the peat deposit in the South East.

Peat fires that occur repeatedly have serious impacts on ecologically and economically. Land degradation include physical, chemical and biological. Peatland destruction caused by fires is a very crucial problem. Land and forest fires in Indonesia during the dry season in 1982-1983 and 1997-1998 was the worst incident in the history of forest fires simultaneously with the occurrence of El Nino. Forest fire smoke often until reaching neighboring countries, such as Malaysia, Singapore and Brunei Darussalam. Peatland degradation also results in declining of production function, economy and lead to poverty.

Forest and land fires affect economic, social and ecological losses. The World Bank estimates that fires in Indonesia by 2015 cost at least Rp 221 trillion (16.1 US dollars) or equivalent to 1.9 percent of GDP by 2015. Most peatlands are found in Sumatra, Kalimantan and Papua. Burning areas include Sumatra South, Central Kalimantan, South Kalimantan, Kalimantan West, East Kalimantan, Riau, Jambi, and Papua. The drainage and conversion of peatlands for plantations contributes to the increased smoke haze intensity of fires. GFED (Global Fire Emissions Database version 4, GFED4) estimates that by 2015, forest fires in Indonesia contribute around 1,750 million metric tons of carbon dioxide (MtCO2e) equivalent to global emissions by 2015. The agricultural and forestry sectors have suffered losses and damages estimated at Rp 120 trillion (8.8 billion US dollars) by 2015. The cost of living environment is quite large - 26 percent of the total - and includes loss of biodiversity (using the government's defined value of biodiversity per hectare), as well as the loss of ecosystem services. The high levels of smog during September and October resulted in a loss of Rp 5.1 trillion (US $ 372 million) for the transportation sector.

The smoke haze has also contributed to the deaths of 19 people and more than 500,000 cases of acute respiratory infections. The smog also forced school closures to 34 days, resulting in a loss of Rp 540 billion (US $ 34 million). Restoration of peatlands is an important part of Indonesia's coping efforts fire and smog (Glauber*et al*., 2016).

The Central Kalimantan Province was the most affected area by the 1997/1998 and and forest fires in Indonesia. The fire occured mostly in tropical peat and peatland ecosystems in the region. This is mainly cause peatlands comprised of organic matters either already decomposed or still continue to decompose which are prone to fire hazard especially during persistent drought. Peatland ecosystem in Central Kalimantan are estimated to occupy almost 2.5 milion hectares with various types of vegetation. Peat swam forests are of paramount important due to their inherent and unic characteristics that reflect their natural resources functions. Once these ecosystem are affected by extensive fires, it will not be easy and requires a very long time to recover or even lost forever. The occurence of tropical peatland fire depend on the availability of fuel or vegetation type, rainfall and water level. This fire is categorised as a unique fire, due to its small ignition, spread slowly and with relatively long time period. The underground fire can reach the depth up to 100 – 150 cm, and usually very difficult to be distinguished (Usup, *et al.* 2000).

Peatland fire and drought which happened annually have become serious ecosystem disaster in Indonesia. Fires in tropical peatlands every year, around 4 percent of global man-made greenhouse gas emissions come from Indonesian peatlands, i.e. 1.3 Gt from burning, 0.5 Gt from ongoing degradation of peatlands (*Hooijer et al., 2006*).

Hoscilo *et al*. (2017) reported impact of the fires in the Central Kalimantan, that peat swamp forest has been mainly converted into unused land covered by homogenous, lower growing plant communities dominated by ferns and sedges with very few trees, where the peat is exposed to additional degradation by oxidation. Fire frequency and interval have noticeably increased over the last decade. Once burned fragments have become more susceptible to future fires (~50% of total burned area over period 1997-2005 was burnt two times). The fire fuel load has shifted from mainly peat swamp forest towards nonwoody vegetation (in both cases the peat soil is included in burning process). There are still locations with evidence of secondary vegetation regrowth towards forest – but these will be lost with further fires.

Locations subject to two intensive fires are dominated by homogenous, lower growing plant communities dominated by ferns and sedges with very few trees. These locations have a much lower potential, if any, for regeneration of forest vegetation, even over a long time period.

In relation to reducing the disaster risk, this study intends to draft and implement a model of peatland ecosystems conservation after fires. This is because a healthy ecosystem will increase the resilience of communities facing disaster. This study includes three aspects, namely the assessment of carbon stocks in forests and lands between unburned and burned, peatland conservation models through the cultivation of monoculture farming, agroforestry and environmental conservation; and purification of water to get clean water for local communities.

Peatland ecosystem conservation is very needed to restore eco-environment after fire. Sudmeier-Rieux *et al.* (2013) mentioned ecosystems contribute to reducing the risk of disasters in multiple and varied ways. Well-managed ecosystems can reduce the impact of many natural hazards, such as fire, drought and flooding. Environmental degradation is reducing the capacity of ecosystems to meet the needs of people for food and other products, and to protect them from hazards. The term "sustainable ecosystems" or healthy ecosystems, implies that ecosystems are largely intact and functioning, and that resource use, or demand for ecosystem services, does not exceed supply in consideration of future generations. Peat swam is a unique ecosystem, so environment aspect must be understood before reclamation and multidiciplinary approach is needed to manage it. Andriesse (1988), tropical wetlands with organic soil should be managed differently from those in the temperate regions, because the plants from which the peat is formed are different. In the tropics, trees are frequently involved as opposed to sedges and sphagnum moss in temperate regions. The large wood content of tropical organic soils requires special management, particularly during initial reclamation.

Water is the second most important substances for living after air (oxygen). However many people living in the peatland area, mostly in the suburband area hardly fulfill their clean water. In the peatland area, surface and shallow groundwater are peat water which is not suitable for domestic water consumption due to low pH, red to brownish colour and high organic content. To improve water availability for the community some laboratory experiments were done and successfully find out simple methode to remove colour and organic content from peat water, and also increasing the pH into normal value.

Base on the laboratory experiences, small and simple peat water processing unit is introduced in Kalampangan and Danau Tundai vilages in Palangkaraya. This simple unit and method is developed using as much as possible local material available. Some field experiments show that the unit successfuly increase the pH into neutral value, remove almost totally the colour and organic content of Palangkaraya peat water.

Problem concerning ecosystem degradation can be defined: drought and peat fires have an impact on the loss of biodiversity of endemic species in peat areas, affecting carbon stocks and trigger release. Drought and fires also directly impact crop failure and reduced food security as well as the loss of the role and function of ecosystems. Another issue that arises is the limited availability of clean water.

Our research aim to develop sustainable concept and model of peatland ecosystem after fire, based on eco-environmental study for disaster resilience. The research was consisted of estimation of carbon stock in the post-fire forest, natural forest and farming area, and dissolved organic carbon through the water and soil respiration from soil ecosystem; to compose concept and develop model the post-fire peatland management by agronomic, agroforestry and conservation methods; and a simple methods of peat water treatment.

MATERIAL AND METHODS

The research was conducted in the Sebangau Sub District, the Palangka Raya City District, Central Kalimantan Province, Indonesia in 2016 and 2017. This location is on peat-inland areas and including part of the ex location of the Indonesia mega rice development project, in Indonesia, 1995 which left many environmental degradation problem.

Estimation of carbon stored and observation of soil respiration

Research of the stored carbon estimationwas carried out in the former Kalampangan burnt forest, natural forest in Sebangau, forested land/agricultural and plantation/agriculture (rubber and corn). The whole location is made sub-plot and the entire trees species was observed and analyzed to obtain the Important Value (Mueller-Dombois and Ellenberg, 1974). To get the value of the biomass, observation variable was analyzed using allometric equation (Katterings *et al*., 2001).

Litter production was also observed. Measurements of carbon stored from the trees and litter is done using C-N Analyzer in the Ecology Laboratory, Research Center for Biology, the Indonesan Institute of Sciences. Soil respiration measurements was carried out in the post-burn forests, Kalampangan, natural forests in Sebangau peat, soil conservation/garden Kalampangan. Measurements were made at five points in each plot with control parameters and samples. CO_2 absorption results from soil respiration is known of the chemical analysis using titration method of 0.1 N HCl.

Post-fire ecosystem conservation model

A model of peatland ecosystem management is being developed in a 3.5 hectares plot in Kalampangan Village, Sebangau Sub District, Palangka Raya City District, Central Kalimantan Province, Indonesia, since 2016 until 2017 was still in progress. Research activities include the cultivation of monoculture farming, agroforestry and environmental conservation.

Kalampangan village, located at an altitude point of 14 to18 meter above sea level. Most of the area is flat topography, the slope is 0 to 20 percent. The villagers are ex society Indonesian government's transmigration program, the 1980's. Majority of livelihood as a vegetable farmer (Kalampangan Village Profile Data, 2014). According to the field observation, it was found that there are many non transmigrant residents who live in this village. It also adds to the community's jobs not only farmers, but also traders and other businesses. The rural areas are in the depth peaty soil that less ideal for setlement, agricultural and plantation. The most of the land outside the settlement is critical and abandoned lands.

Method of peatland ecosystem management

Stage of activities included environmental conditions and community surveys, determine the location of research plots, cultivating implementation, monitoring and evaluation of activities, further development based on research results. Environmental survey aims to find out the condition of the soil, climate, vegetation, the thickness of the peat and peat water level. Social survey aims to determine the location of the research is based on the representation of land to the village land, and the land use permit from the local community. The environmental research method included measurement of peats thickness, measuring the depth of water level, the recording of the existing vegetation, soil sampling in the field and analyzed in the laboratory, Bogor.

Social survey was conducted by interviewing farmers, village leaders and the local expert.Implementation of the cultivation is done by dividing the plot into three parts, the sub plot area of 1 hectare monoculture cultivation, agro-forestry sub area of 1 hectare plot and sub-plot of 1.5 hectares of conservation land. The selection of plants that suitable for cultivated in the peat soils, soil fertility improvement using manure, mineral and dolomite.Monoculture crops which have the shallow roots system species were included seledri (*Avium graveolence*), bawang prei, peppers (*Capsicum annuum*), eggplant (*Solanum melongena*), tomatoes (*Solanum lycopersicum*), beans, leek, corn (*Zea mays*); and also relatively resistance to flooding and acid soil, such as pineapple (*Ananas comosus*). Perenial species for the main component of agroforestry were included lengkeng(*Dimocarpus longan*),durian (*Durio zibethinus*), mangga (*Mangifera indica*), rambutan (*Nephelium Lappaceum*) dan petai (*Parkia speciosa)*. They were mixed with pineapple (*Annas comusus*) as the annual species. Species for environment conservationwas included gaharu (*Aquilaria malaccensis*), galam (*Melaleuica cajuputi*), jelutung (*Dyerapolyphylla*), ramin (*Gonystylusbancanus*), pulai rawa (*Alstonia pneumatophora*), balangiran (*Shorea balangiran*).Sustainable peatland management methods for agriculture and conservation, in principle, refer to some literature, i.e. Andriesse (1988), Ambak & Melling (2000), Najiyati*et al.* (2005), Wibisono*et al.* (2005), Ritzema & Jaya (2006), Limin (2006), Notohadiprawiro (2007),Noorand Heyde (2007), Wösten*et al.*(2008), Rieley& Page (2008), Agus&Subiksa (2008), Noor (2010), Nurida *et al.* (2011); for selection of trees species for Agroforestry refer to Tata and Susmianto (2011).

Peat water treatment

To help community in coping with the availability of clean water problem a simple methods of peat water treatment was developed using coagulation and flocculation process.

The research was conducted in the Kalampangan and Danau Tundai Village, Palangkaraya City, Central Kalimantan. This process was firstly exercise in the laboratory (Soherman and Sumawijaya, 2013). Base on this laboratory experiment then a simple method was developed using as much as possible local material and as simple as posible technological technic. This process can be carried out using mecahinal or manual technic. To introduce the methode to the community, a one day focussed group discussion and training was carried out in Kalampangan Village, Palangka Raya, Central Kalimantan in June 2016. Water purification research refers to the government regulations of the Republic of Indonesia (Anonymous, 2010; Anonymous, 2001).

While the purification methods refers to some previous study (Fitria & Suprihanto, 2007; Syarfi, Herman S. 2007; Yusnimar et al., 2010; Suherman & Sumawijaya, 2013).

RESULT AND DISCUSSION

1. Ecological study

1.1. Estimation of carbon stock

Result of the first research are trees and litter total biomass (170.5 and 7 ton ha^{-1} respectively), trees and litter carbon stock (64.3 and 3.1 ha^{-1} respectively) in the natural forest much more higher than that of in the post-fire forest and in the farming area.

In the post-fire forests, Kalampangan

The forest area is under succession after fires, it is seen very rarely found trees with stands of tall and large diameter (more than 10 cm), also on this land peat thickness reaches up to 5 m. Common species was found, i.e. tumih (*Combretocarpus rotundatus*) and gerunggang (*Cratoxylum arborescens*), both types continue to bring shoot from the remnant of burnt tree trunks. The total biomass of stands up to 3.5 tons per hectare, with biomass for *C. rotundatus* and *C. arborescens* reached 68.9% and 27.4% of the total biomass, respectively.

Observations around the forest Kalampangan (Darusman, 2007), showed that the biomass above ground is greater up to 250 tonnes per hectare. Production of litter on the surface soil showed that the leaf component (60%) contribute large compared to other components, trunk (31.5%) and branches (24.1%) of total litter. Total litter reached 3.3 tons per hectare. Carbon stored in the stand has the same pattern with biomass stands up to 1.33 tons per hectare, with the tumih contribute up to 67.7% of total carbon. While C stored in the litter fall of 1.6 tonnes per hectare.

In natural forests, Sebangau

The forest area is still in a well preserved, this is because public access away and separated by a river downstream, as well as the number of trees to stand tall and large diameter (more than 10cm), even there are trees with diameter> 30 cm is *Xylopia Elliptica*. The 61 total number of species is found, and peat thickness reaches about 3 m. Based on the Importance Value Index (IVI), the dominant species were gerunggang (*C. glaucum*) and tumih (*C. rotundatus*), and followed by *Shorea balangeran, Litsea coriacea, Xylopia Elliptica* and *Nephelium cuspidatum.* The total biomass of stands reached 170.5 tons per hectare, with biomass for *C. glaucum* and *C. Rotundatus* reached 25.3% and 12.6% of the total biomass, respectively; then it was followed by other tree species. Total litter reached 6.8 tons per hectare. Carbon stored of the stand reached 64.3 tonnes per hectare, while the carbon is stored in the ~~l~~itter fall reached 3.1 tons per hectare.

In the forested land/agriculture, Kalampangan

The plot is an area of farmer groups who develop some forest trees and several vegetables. A number of ~~a~~ third of the site is retained as young secondary forest. It was found that tumih (*C. Rotundatus*) dominates more than 30% of the total standing timber, followed by *Ploinarium alternifolium, Cratoxylum arborescens* and *Acaciamangium*, respectively, of the 11 species of trees. The total biomass of stands reached 10.7 tonnes per hectare, and total litter reached 6.8 tons per hectare. Carbon stored in the stands at the site of these observations reached 4.25 tons per hectare, with tumih (*C. Rotundatus*) as the greatest carbon content which reached 3.28 tons ha^{-1}, and the rest is other species. While the carbon is stored through litter fall reached 2.6 tons ha^{-1}.

In a rubber plantation, Kalampangan

In the rubber plantation with plants about 10 years of age, that was neglected because no continuous production of latex produced by rubber trees. Biomass stand on this land reached 14.8 tonnes per hectare, with more than 76% was rubber and the remaining biomass is Nephelium biomass. Meanwhile, for the corn crop that was planted with a plant spacing of 30 x 60 cm^2, and it was harvested every 3 months has a biomass of 12.3 tonnes per hectare. Carbon stored in the trees stands at the site reached 5.15 tons per hectare, while the corn on agricultural land reached 5.34 tonnes per hectare. Carbon stored of the litter fall, under rubber plantation was 2.3 tons ha^{-1}.

1.2. Disolved organic carbon

Dissolved organic carbon (DOC) leaching and soil respiration in three location, the highest was in the natural peat forest in Sebangau (56,88 ± 34 in mgL^{-1}), followed by a garden in Kalampangan (34,76 ± 26 in mgL^{-1}) and in the post-fire forest (21, 63 ± 32 in mgL^{-1}). The highest soil respiration was in the post-fire followed by plantation and natural forests in Sebangau.

The highest soil respiration occurs in the peat forest after fire due to high decomposition of carbon which is the impact of forest fires (Sundari *et al*., 2012), whereas the low concentration of DOC in the forest after fire due to the peats have already become the charcoal so carbon released to the atmosphere through respiration was more than dissolved carbon through the soil (Sundari *et al*., 2014).

Soil nutrients

Soil nutrient in the peat forest after fires Kalampangan was very small compared to the Sebangau natural peat forest conservation and land/garden Kalampangan. From the statistical test the entire value of nutrients in the peat forest after fires Kalampangan was very significant than that of in the natural peat forests and peat lands Sebangau / garden Kalampangan, except for potassium (K) nutrient was not significantly different from other.

2. **Conservation ecosystem model**

2.1. Environment and vegetation survey

The Kalampangan Village is an inland-peat area, which is flanked on the north is Kahajan River and in the South is Sebangau River. Kahajan River flowing from Southwest (City of Palangkaraya) to the Southeast (Banjarmasin) (Figure 1).

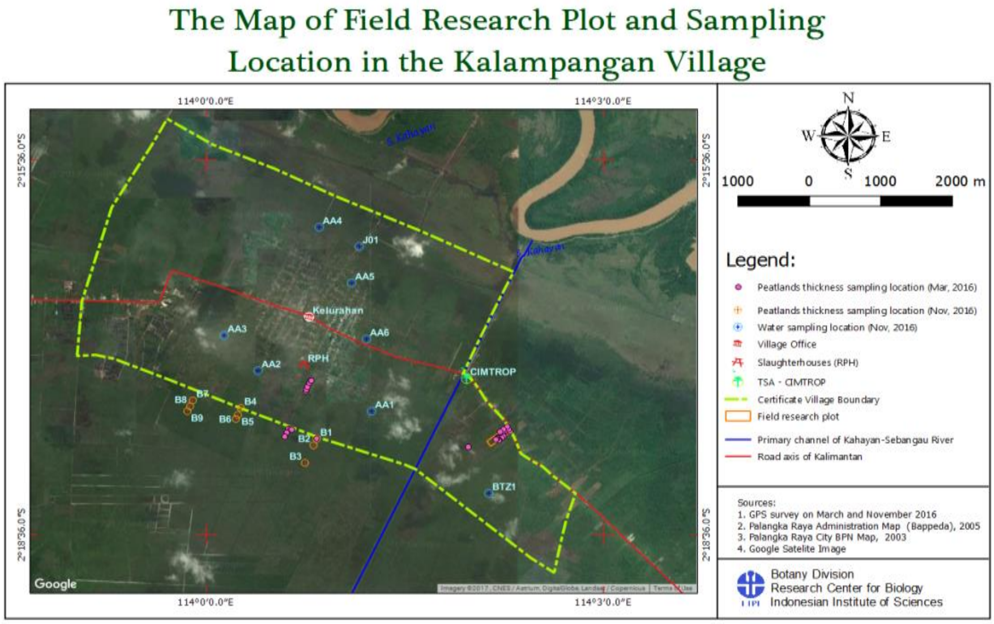

Figure 1. Field research plot, in Kalampangan Village, Sebangau Sub District, Palangkaraya, Central Kalimantan, Indonesia

The village is inhabited by ex government's transmigration program, in the 1980s, which occupies a land area as seen in the big-box map (it was called the land has been certified). Most of the village area (i.e. the lands that have been certified) is composed by the peaty depth soil (in 2-3 m peat thickness depth) to very deep peaty soil (3-4 m peat thickness depth). This peatlands area are connected to the very-very deep peatland (greater than 10 m) that called peat dom. Land inside in the Kalampangan village is used for housing, yards or gardens near the house. While the outer ring road of the village is abandoned and burnt areas which is not used for farming. The distance of this area from the village is about 1.5 to 2 km.

Survey of candidate field plot in the Kalampangan Village on March 2016, was observed based on criterias, i.e. vegetation cover, peatlands thickness, accessibility, ownership, permission to use. Based on this survey we selected the field plot sesearch with the the total area of 3.5 ha (100 mx 350 m), the peat thickness from 3.7 to 4.1 m, within easy reach, received permission from the owner of the land can be used for the field research location. Native species was found in the location is *Acacia mangium* (Acacia), *Acacia* sp. (Akasia), *Cratoxylon arborencens, Combretocarpus rotundatus, Nephrolepis bisserata, Stenochlaena palustris, Dicranopteris linearis*. We assumed that the location of field research has represented the village area.

Soil fertility

From the soil analysis before implementation of agro-monoculture (cultivation of horticultural and food crops), agro forestry and eco-conservation had the texture of clay soil with a pH (acidity) and calcium (Ca), were very low. On the other hand organic carbon (C), Nitrogen (N), ratio C / N, phosphate (P2O5) are very high. The content of aluminum (Al) is small so that the ground potential low toxic. The content of potassium (K) and sodium (Na). Soil conditions illustrated the land condition before treatment and activity was not taken place.

Climate

Based on ten year recorded rainfall data in 2006-2015, the annual rainfall pattern in Palangka Raya, indicated that the monthly rainfall was range betwen 100 mm to 450 mm. Rainfall of 200 mm up to 450 mm by month were taken place during 8 months. While rainfall of 100 mm to less than 200 mm were taken place during 4 months. Total annual rainfall ranges from 2,592 to 4,508 mm with an average of 3135 mm by year. Wet conditions was taken place throughout the year, with daily temperatures ranging from 200 to 350 degrees, with an average of 27.50. This resulted in the average daily evaporation of 1.6 mm by day or 50 mm by month. The air temperature is very hot, at noon; but the peat water easily available around the land. The climate condition with the high rainfall and no dry season (months with rainfall less than 60 mm per month) and specific climate throughout the year formed a unic peatlands ecosystem.

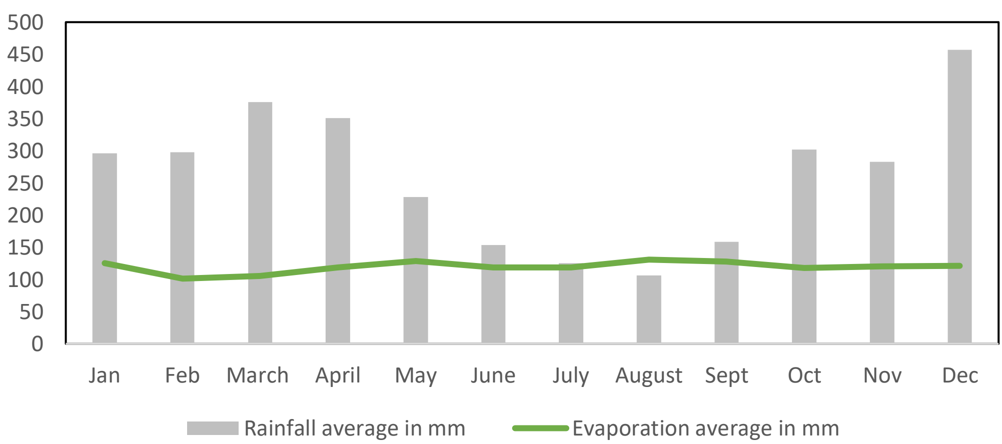

Figure 2. Monthly rainfall and evaporation in January to December, 2006 to 2015. (Source: Meteorology and Geophysics Agency, Palangka Raya, Indonesia)

Petland thickness and water level

Results of measurements indicated the water levels of 10 points, in the 350 m along the plot, period of April 1, 2016 to July 28, 2016 were the water level ranges between 35 cm and 46 cm, whereas the peat thickness ranged were between 270 cm and 410 cm from the peat surface (Figure 3). Peat water level conditions were in accordance with Government Regulation, which states that the peatlands need to be wetted with water depth of approximately 40 cm, so that the humidity is maintained and can reduce the risk of fire. The problem is how to select crops and perennial species that suitable to cultivate in the shallow water table peatland? How the morphological characteristic of plant to adapt with this condition?

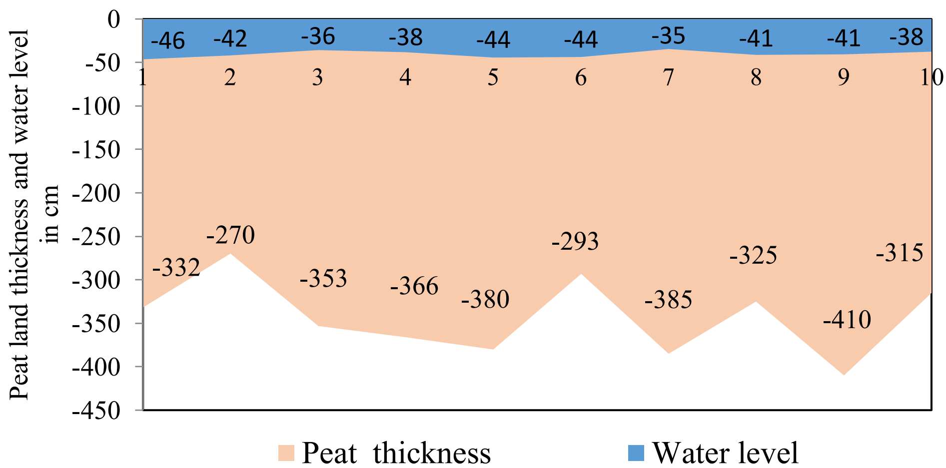

Figure 3. The water level (TMA) and the thickness of peat (TMG) in the research plot, Kalampangan, Palangkaraya, Indonesia (April-July 2016)

Research plot is a 3.5 ha (100m x 350m) of land area, which is surrounded by the oil palm plantations in the west and south, rubber plantations in the east, and the highway from Palangka Raya to Banjar Masin. On the side of the road there is a tertiary channel connected to the primary channel of mega rice project (MRP) , and the dam site of CIMTROP. Water level of plot is relatively stable, unless when the big rain the overflowed water from Kahayan river and the primary channel inundation of the land area. During the research, the major flood inundated the partially research plots area occurred in July and November 2016.

Carbon stock underground peatland

From the measurement data of peat thickness, bulk density, percent carbon content can be calculated below ground carbon stocks, using methods of Wahyunto *et. al.* (2004). From the analysis of peat thickness volume (447 253 m3), bulk density (1.02 g / cc) and the percentage of carbon (36.3%). So, the carbon stocks in peat below the ground can be determined as Volume * bulk density* carbon content, i.e. 447,253 * 1.02 * 36.3 = 165,600 ton for 3.5 ha^{-1} or 47,314 $tonha^{-1}$.

2.2. Conservation ecosystem model

The measurement results on the peat depth research plot area of 3.5 in the longitudinal direction of the point 0 north to a point 350 m south, tend to be deeper (270-410 cm). Research plots were divided into three main blocks, namely Block I of 1 ha is used for agro-monoculture cultivation; Block II (middle) of 1 ha is used for the agro-forestry cultivation (intercropping annuals and perennials); and Block III (rear) of 1.5 ha of land used for environment conservation as in Figure 4.

Agro-monoculture

In 2016, it has been tested a variety of crops and horticulture, namely*Allium ampeloprasum atau Allium porru, Capsicum annuum, Ananas comosus, Ipomoea reptana, Solanum lycopersicum, Solanum melongena dan Zea mays.* The test resulted that pineapple is potential to be developed further, due relatively resistent to inundation and acid soil. Sweet corn also potential to be developed as a food crop, and leek for vegetable crops, due to the relatively high economic value.

Agroforestry

Corn and pineapples were also used as components of agroforestry. Some perennial species as the main components of agroforestry were tested, since April 2016, i.e. longan (*longan Dimocarpus*), durian (*Durio zibethinus*), mango (*Mangifera indica*), rambutan (*Nepheliumlappaceum*) and petai (*Parkiaspeciosa*). Plant growth indicated that the average of plant height, at the age of 5 months (September 2016) was about 60 cm. Apparently Petai (*Parkiaspeciosa*) had a plant height of 70 cm, it was the best growth compare to other species.

Environment conservation

Some local species for environment conservation were tested in April 2016, i.e. agarwood (*Aquilariamalaccensis*), Galam (*Melaleuicacajuputi*), jelutung (*Dyerapolyphylla*), ramin (*Gonystylusbancanus*), pulai swamp (*Alstonia pneumatophora*), Balangiran (*Shorea balangeran*). The growth of plant height at 5 months (September 2016), was Galam (90 cm), Pulai (50 cm) , Ramin (70 cm), Shorea balangeran (80 cm), pantung (15 cm), and agarwood (90 cm).

3. **Water purification**

Clean water is one of the many problems faced by community living in the peatland area of Indonesia. This problems become severe when fire and drought occured. Colour, low pH, and high organic content are parameters which are not match to the clean standard.

A simple methods of peat water treatment by manual and mechanical mixing were able to improve water quality to meet clean water standard. This simple methode and technology have been introduced to the local people of Kalampangan and Danau Tundai Village, Palangkaraya City, Central Kalimantan. This simple methode is also being improved to make it more complienced to need and condition of local condition.

The experiment has successfully treated peat water. The indicator of this success is the loss of red-brown peat water color and the peat water pH ranging from 3 to 5 to be close to 7. There are even some results indicating the pH of processed peat water is 7.

As the purpose of this activity is to apply the method of processing peat water into clean water then the work is done by two mechanisms of mixing that is by manual and motor drive. Processing with manual mixing is done by using two different raw water sources with two repetitions done each. The first source is in the village of Kalampangan and the second source in the village of Lake Tundai. The volume of water is 100 liters. To understand the change of water quality between original peat water and the purified water were tested in the laboratory analysis.

From this result it can be concluded that the mixing process by using mixing motor gives better result. The pH, colour and organic content values are closer to the raw values than the results obtained in the treatment with manual stirring, especially for color parameters.

In the process of manual mixing, from 4 repetitions a number of 3 experiments resulted the processed water with a color value still above the threshold (10 mg / L, KMnO4) of 10.46 to 11.24 mg / L KMnO4. However, both processes (manual mixing and motor use) can improve the quality of peat water and successfully remove the peat water color. Similarly, pH and organic content close to the standard of clean water quality.

CONCLUSION

The research about ecosystem management to reduce disaster risk of peatland fire and drought can be concluded, that (1) estimation of the stored carbon from the three locations found that the highest carbon release occurs in post-fire forest, followed by conservation land / garden and natural forest. The species of *Combretocarpus rotundatus* has the highest carbon stock. The release of dissolved organic carbon (DOC) and soil respiration of the three locations, the highest is in the natural peat forest in Sebangau, followed by a garden in Kalampangan and in the post-fire forest respectively; (2) Concept and model of peatland ecosystem management using land area of 40 percent for conservation, 30 percent for agroforestry and 30 percent for monoculture cultivation, are being tested. This concept will give quick yield from the cash crops while the farmers looking for yield from perennial trees species. The seasonal crop such as seledri and onion which has shallow root system, annual crop of pineapple which relatively resistent to acid soil are suitable for agro-and agroforestry component. While *Shorea balangeran* has the best growth rate than the other local species which were tested; (3) Water purification by manual and motor drive were able to remove the peat water colour up to 99.22%, and the content of organic matter reaches 98.15%. The pH value changed from 3.92 up to 6.8 - 7.2. The value of color intensity and the content of organic substances has reached the drinking water requirements. This peat water purification procedure is expected to be easily absorbed and applied by the local people where clean water is difficult to meet. In addition, we hope that this procedure can be adopted on a large scale by government or private company.

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