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UDC/ODC 630*375.1

Wesman Endom1and Satria Astana

PERFORMANCES OF TWO PROTOTYPES OF LOG EXTRACTION TECHNIQUES USING THE SKYLINE SYSTEM

(KINERJA DUA PROTOTIPE TEKNIK PENGELUARAN KAYU DENGAN MENGGUNAKAN SISTEM KABEL LAYANG)

Kegiatan pengeluaran kayu untuk dibawa dari areal tebangan ke pinggir jalan angkutan bukan pekerjaan mudah. Kegiatan ini menghadapi berbagai kendala terutama kondisi biofisik misalnya lereng yang curam, naik turun lereng, menyebrangi lembah dan sungai, jalan yang licin dan kayu yang berbobot berat serta aksesibilitas yang rendah. Untuk mengantisipasi kendala tersebut, telah dilakukan rekayasa alat sistem kabel layang berupa Expo -2000 Generasi-1, bermesin bensin 6 HP (G-1) dan Expo-2000 Generasi-3, bermesin diesel 12 HP (G-3). Uji coba telah dilakukan di Cimeong dan Rancaparang untuk mesin (G-1) pada tahun 2011 dan untuk mesin (G-3) di Cibatu Cianjur serta di Cibaliung Banten pada tahun 2013. Uji coba ini dilakukan untuk mengetahui kinerja kedua mesin dalam pengeluaran kayu yang mengarah ke atas bukit serta membandingkan keduanya dalam hal produktivitas dan biaya. Data yang dikumpulkan antara lain waktu kerja, volume kayu yang dikeluarkan, jarak angkut, dan penggunaan bahan bakar. Data dianalisis untuk memperoleh nilai rata-rata produktivitas dan biaya operasi pengeluaran kayu tersebut. Hasil penelitian ini menunjukkan bahwa prototipe G-3 dengan jarak uji coba antara 130-430 m dengan posisi kayu horizontal bisa mengeluarkan kayu 1,72 m^3/jam, sedangkan prototipe G-1 dengan posisi kayu vertikal pada jarak sekitar 50-320 m, hanya bisa mencapai ± 0,85 m^3/jam. Ini berarti prototipe Expo-2000 G-3 lebih efektif digunakan untuk mengeluarkan kayu di medan curam.

Kata kunci: Kabel layang, pengeluaran kayu, muatan, horizontal, vertikal, efisiensi

UDC/ODC 630*891

Dwi Astiani, Burhanuddin, Lisa M. Curran, Mujiman and Ruspita Salim

EFFECTS OF DRAINAGE DITCHES ON WATER TABLE LEVEL, SOIL CONDITIONS AND TREE GROWTH OF DEGRADED PEATLAND FORESTS IN WEST KALIMANTAN

(DAMPAK PARIT DRAINASE TERHADAP TINGGI MUKA AIR, KONDISI TANAH DAN PERTUMBUHAN POHON DI HUTAN GAMBUT KALIMANTAN BARAT)

Saat ini, hutan gambut tropis berada di bawah tekanan yang cukup besar. Karena meningkatnya deforestasi dan degradasi hutan. Di Kalimantan, deforestasi dan degradasi hutan gambut terutama didorong oleh adanya industri penebangan, perluasan kegiatan pertanian terutama dari konversi hutan untuk lahan pertanian dan perkebunan kelapa sawit. Dengan pembangunan parit drainase intensif, hal ini dapat meningkatkan resiko kebakaran hutan. Drainase parit yang tidak dikelola dengan baik akan mengubah tinggi muka air di daerah sekitar drainase termasuk daerah di sekitar hutan gambut. Penelitian ini mempelajari pengaruh drainase terhadap perubahan air muka gambut. Pengukuran muka air dilakukan sebelum dan sesudah lahan gambut dikeringkan pada tahun 2007/2009 dan 2012/2015 di Kubu Raya, Kalimantan Barat. Hasil penelitian menunjukkan bahwa parit drainase pada lanskap lahan gambut menurunkan tinggi muka air lebih dari 3 kali, dari ~ 11,7 cm SE = 1,5, n = 5) menjadi ~ 37,3 cm (SE = 2.1 cm, n = 26). Dampak tinggi muka air lebih buruk pada bulan kering (Juli-Agustus). Menurunnya tinggi muka air gambut mengubah iklim mikro tanah, terutama suhu dan kadar air gambut. Hasil penelitian menunjukkan bahwa perubahan penggunaan lahan di gambut bersamaan dengan pembangunan drainase akan mempengaruhi tinggi muka air gambut secara beragam. Pada jarak kurang dari 500 m dari drainase, tinggi muka air cenderung meningkat menuju ke arah drainase. Oleh karena itu, restorasi ekosistem hutan gambut harus dimulai dengan mengelola hidrologi lansekap.

Kata kunci: Hutan gambut terdegradasi, parit drainase, restorasi ekosistem, iklim mikro tanah, gambut tropis

UDC/ODC 630*89

Wahyudi

NON-TIMBER FOREST PRODUCT (NTFP) COMMODITIES HARVESTED AND MARKETED BY LOCAL PEOPLE AT THE LOCAL MARKETS IN MANOKWARI – WEST PAPUA

(KOMODITAS HASIL HUTAN BUKAN KAYU YANG DIPERDAGANGKAN OLEH PENDUDUK LOKAL DI PASAR TRADISIONAL MANOKWARI- PAPUA BARAT)

Hutan tropis Papua memiliki keanekaragaman komoditas hasil hutan bukan kayu yang tinggi dan mampu memenuhi berbagai kebutuhan hidup masyarakat hutan. Komoditas tersebut cenderung diabaikan dan belum dikelola dengan baik dibandingkan hasil hutan kayu, meskipun kenyataannya hasil hutan ikutan ini berperan penting bagi keberlangsungan hidup masyarakat hutan. Penelitian ini melaporkan tentang keanekaragaman komoditas hasil hutan bukan kayu yang diperdagangkan di pasar tradisional di kota Manokwari Papua Barat. Data dikumpulkan melalui wawancara terhadap 20 responden terpilih dan kunjungan lapangan, dan diolah dengan analisis statistik sederhana. Hasil penelitian menunjukkan bahwa 29 jenis komoditas diperjualbelikan di pasar lokal Manokwari, dikelompokkan ke dalam sayuran (9 jenis), bahan pangan/makanan (4 jenis), buah-buahan (7 jenis), tanaman herbal (4), alat kerajinan/tools (3 produk), dan bahan adiktif (2 komoditas). Perdagangan komoditas ini mampu memberikan pekerjaan alternatif dan penghasilan tambahan bagi masyarakat hutan, khususnya ibu rumah tangga serta memenuhi kebutuhan konsumen akan produk-produk alami segar dan bernilai nutrisi tinggi. Pisang adalah komoditas paling popular, dikonsumsi sebagai buah-buahan atau produk olahannya. Aci sagu (Metroxylon sago) adalah satu satunya komoditas berasal dari luar Manokwari, seperti Wondama, Biak, Jayapura dan Serui. Permintaan aci sagu mencapai puncaknya pada perayaan Natal dan Tahun Baru, dimana tradisi keluarga berkumpul dan merayakan kebersamaan dengan menyajikan papeda. Mayoritas, komoditas tersebut adalah hasil memanen atau memetik, dan belum adanya usaha untuk menanam atau membudidayakannnya. Untuk terus dapat memenuhi kebutuhan konsumen akan produk segar dan bernutrisi, dan memberikan alternatif pekerjaan, serta penghasilan tambahan kepada masyarakat hutan, maka pemerintah daerah, lembaga swadaya masyarakat, kalangan akademisi, dan pemangku kepentingan lainnya perlu bersinergi meningkatkan nilai tambah dan keberlanjutan produksi dari komoditas ini.

Kata kunci: Hasil hutan bukan kayu, perdagangan, pasar tradisional, Papua Barat

UDC/ODC 630*116.1

Budi Hadi Narendra, Harris Herman Siringoringo and Chairil Anwar Siregar

GIS BASED FLOOD HAZARD AND VULNERABILITY MAPPING: A CASE STUDY OF TIDAL AND RIVER FLOODS IN DOWNSTREAM OF CIASEM WATERSHED, SUBANG-WEST JAVA

(PEMETAAN KERAWANAN DAN KERENTANAN BANJIR MENGGUNAKAN SIG: STUDI KASUS BANJIR ROB DAN BANJIR SUNGAI DI HILIR DAS CIASEM, SUBANG-JAWA BARAT)

Kejadian banjir di hilir DAS Ciasem diyakini terjadi akibat degradasi DAS dan tutupan mangrove. Tulisan ini mempelajari kerawanan dan kerentanan yang disebabkan banjir rob dan sungai, terutama pada daerah bervegetasi dan daerah terbangun sebagai elemen utama risiko. Pengamatan difokuskan pada hilir DAS Ciasem, terletak di Desa Muara, Kecamatan Blanakan, di pesisir utara Kabupaten Subang. Kerawanan banjir rob dipetakan menggunakan proses iterasi pada software ILWIS 3.4, sedangkan kerawanan banjir sungai dibuat dengan mempertimbangkan elevasi, kemiringan dan karakteristik sungai menggunakan perangkat hidrologi (HEC-geoRAS dan HEC-RAS) pada software ArcGIS 10 Peta kerawanan tersebut digunakan untuk menentukan elemen risiko yang mencakup daerah bervegetasi dan daerah terbangun. Hasilnya menunjukkan banjir rob mulai terjadi di daerah bagian barat yang didominasi tambak sebagai elemen risiko utama. Ketika permukaan air laut naik 90 cm, permukiman mengalami genangan akibat banjir rob. Sungai Ciasem mulai meluap ketika debit aliran melebihi 160 m^3 $detik^{-1}$ dan menggenangi sawah, tambak, dan pemukiman. Penelitian ini menunjukkan bahwa tambak dan sawah memiliki tingkat kerentanan tinggi terhadap kejadian banjir, sedangkan pada permukiman dan jalan tergantung pada material konstruksinya. Resiko bencana banjir seharusnya dapat dikurangi dengan melanjutkan kegiatan rehabilitasi lahan, merestorasi mangrove dan menerapkan aturan pemerintah dalam pengelolaan dan pembangunan.

Kata kunci: Peta kerentanan, banjir rob, sungai, DAS Ciasem, GIS

UDC/ODC 630*892.52

Faiqotul Falah and Noorcahyati Hadiwibowo

SPECIES IDENTIFICATION OF TRADITIONAL MEDICINE PLANTS FOR WOMEN'S HEALTH IN EAST KALIMANTAN: LESSON LEARNED FROM LOCAL WISDOM

(IDENTIFIKASI JENIS TUMBUHAN OBAT UNTUK KESEHATAN PEREMPUAN DI KALIMANTAN TIMUR: PEMBELAJARAN DARI KEARIFAN LOKAL)

Masyarakat tradisional di Kalimantan Timur telah menggunakan tum. Masyarakat tradisional di Kalimantan Timur telah menggunakan tumbuhan obat tradisional sejak beratus tahun lalu. Tulisan ini bertujuan mengidentifikasi jenis-jenis tumbuhan obat tradisional yang dimanfaatkan untuk kesehatan perempuan oleh tiga suku di Kalimantan Timur, yaitu: suku Dayak Benuaq (sekitar Hutan Lindung Gunung Beratus), Dayak Bahau (Hutan Wehea), dan Kutai (sekitar Taman Nasional Kutai). Identifikasi jenis tumbuhan obat penting dilakukan sebagai dasar upaya budidaya dan pengembangan teknologi pemanfaatannya. Pengumpulan data dilakukan dengan cara: 1) melakukan wawancara dengan 5 (lima) bidan tradisional dan pengguna tanaman obat tradisional di desa-desa tersebut ; 2) mengumpulkan spesimen tumbuhan obat di habitat alaminya; 3) melakukan analisis kualitatif terhadap hasil wawancara; 4) melakukan identifikasi botani spesimen tumbuhan obat di Herbarium Wanariset Samboja; dan 5) Studi pustaka untuk memperoleh informasi tentang penggunaan jenis-jenis tumbuhan obat tersebut oleh masyarakat tradisional di daerah lain. Penelitian ini telah mengidentifikasi dan mendokumentasikan 44 jenis tumbuhan obat dari 30 famili yang digunakan oleh masyarakat tradisional untuk kosmetika, kebidanan, dan kesehatan reproduksi perempuan. Bagian tumbuhan yang digunakan sebagai obat adalah daun, akar, batang, kulit batang, buah, bunga, dan biji. Pengolahan dilakukan dengan metode sederhana. Paling sedikit ada 27 jenis yang juga digunakan oleh masyarakat di tempat lain untuk khasiat yang sama maupun berbeda, dan senyawa kimia aktif 25 jenis telah diketahui. Penggunaan tumbuhan obat tradisional lebih murah, lebih tersedia, dan mudah diakses. Namun kualitas tumbuhan obat tersebut tidak bisa dijamin dan dosisnya tidak terstandar. Oleh karena itu tumbuhan obat tersebut perlu dibudidayakan untuk memastikan kualitas dan kuantitasnya, dan untuk mencegah kepunahan jenis.

Kata kunci : Tumbuhan obat tradisional, identifikasi jenis, Kalimantan Timur, suku, kesehatan perempuan

UDC/ODC 630*61

Hunggul Y.S.H. Nugroho,Anne van der Veen, Andrew Skidmore and Yousif A. Hussin

THEORETICAL FRAMEWORK FOR SPATIAL PLANNING AND FOREST MANAGEMENT IN INDONESIA: SECURING THE BASIC RIGHTS FOR ADAT PEOPLE

(KERANGKA TEORI UNTUK PERENCANAAN TATA RUANG DAN PENGELOLAAN HUTAN DI INDONESIA: PERLINDUNGAN HAK DASAR MASYARAKAT ADAT)

Minimnya transparansi, akuntabilitas dan partisipasi dalam perumusan kebijakan dan implementasi yang hanya didasarkan pada pertimbangan ekonomi, mengakibatkan kegagalan tercapainya tujuan pengelolaan hutan lestari (PHL). Seiring dengan keengganan para pembuat kebijakan dan keterbatasan kapasitas pemangku kepentingan, kurangnya basis data yang akurat telah terbukti menjadi kendala dalam pemilihan rencana pengelolaan yang tepat. Masalah pengelolaan hutan ini menjadi lebih rumit ketika berkorelasi dengan kepentingan ekonomi, kepentingan kelompok tertentu, dan persoalan hak-hak dasar masyarakat adat yang tinggal di dalam dan sekitar hutan. Kerusakan hutan tidak akan berhenti tanpa menjamin hak masyarakat adat atas lahan dan teritorialnya. Untuk mengatasi masalah ini, konsep tata kelola yang berkeadilan dipromosikan sebagai alternatif pengganti dari pola administrasi tradisional. Dalam tulisan ini, kami mengusulkan kerangka teoritis untuk pengembangan kebijakan untuk mencapai SFM dengan tetap menghormati hak-hak rakyat Adat. Tata kelola adaptif, manajemen adaptif, dan pembelajaran partisipatif merupakan pendekatan strategis dalam reformasi tata kelola untuk mencapai pengelolaan hutan lestari dengan tetap melindungi hak-hak adat dan penggunaan lahan secara tradisional masyarakat yang bergantung pada hutan.

Kata Kunci: Pengelolaan hutan, tata kelola adaptif, perencanaan tata ruang, Indonesia, adat

PERFORMANCES OF TWO PROTOTYPES OF LOG EXTRACTION TECHNIQUES USING THE SKYLINE SYSTEM

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PERFORMANCES OF TWO PROTOTYPES OF LOG EXTRACTION TECHNIQUES USING THE SKYLINE SYSTEM. Timber extraction from felling area to road side is not an easy job. This activity facing a number of difficulties particularly due to geo-biophysical conditions, such as steep terrain, up and/or down-hill, valley or river-to be crossed, slippery road and also the size of the timber and low accessibility. To anticipate those obstacles two engineering designs of the skyline system had been tried, the so called Expo-2000 Generation-1, using gasoline engine of 6 HP (G-1), and Expo-2000 Generation-3 using diesel engine of 12 HP (G-3). G-1 model has been tested in Cimeong and Rancaparang in 2011. G-3 model has been examined in Cibatu Canjur and Cibaliung Banten in 2013. This paper evaluates the modification of skyline system for steep terrain and to compare the performance between two modified skyline systems, in term of productivity and cost. The data collected included working time, log volume extracted, log extraction distance and fuel used. Data were analyzed to get the average productivity and cost of operation. Results show that prototype G-3 with logs in horizontal position at a distance of 130-430 m, can extract logs averaging 1.72 m^3/hr, while prototype G-1 and logs in vertical position at a distance of about 50-320 m, could only extract logs averaging ± 0.85 m^3/hr at a cost of about Rp 156,351/$m^{3.}$ It suggests that prototype Expo-2000 G-3 is more effective for log extraction logs in steep terrain.

Keywords: Skyline, log extraction, horizontal load, efficiency, steep terrain

KINERJA DUA PROTOTIPE TEKNIK PENGELUARAN KAYU DENGAN MENGGUNAKAN SISTEM KABEL LAYANG. Kegiatan pengeluaran kayu untuk dibawa dari areal tebangan ke pinggir jalan angkutan bukan pekerjaan mudah. Kegiatan ini menghadapi berbagai kendala terutama kondisi biofisik misalnya lereng yang curam, naik turun lereng, menyebrangi lembah dan sungai, jalan yang licin dan kayu yang berbobot berat serta aksesibilitas yang rendah. Untuk mengantisipasi kendala tersebut, telah dilakukan rekayasa alat sistem kabel layang berupa Expo -2000 Generasi-1, bermesin bensin 6 HP (G-1) dan Expo -2000 Generasi-3, bermesin diesel 12 HP (G-3). Uji coba telah dilakukan di Cimeong dan Rancaparang untuk mesin (G-1) pada tahun 2011 dan untuk mesin (G-3) di Cibatu Cianjur serta di Cibaliung Banten pada tahun 2013. Uji coba ini dilakukan untuk mengetahui kinerja kedua mesin dalam pengeluaran kayu yang mengarah ke atas bukit serta membandingkan keduanya dalam hal produktivitas dan biaya. Data yang dikumpulkan antara lain waktu kerja, volume kayu yang dikeluarkan, jarak angkut, dan penggunaan bahan bakar. Data dianalisa untuk memperoleh nilai rata-rata produktivitas dan biaya operasi pengeluaran kayu tersebut. Hasil penelitian ini menunjukkan bahwa prototipe G-3 dengan jarak uji coba antara 130-430 m dengan posisi kayu horizontal bisa mengeluarkan kayu 1,72 m^3/jam, sedangkan prototipe G-1 dengan posisi kayu vertikal pada jarak sekitar 50-320 m, hanya bisa mencapai ± 0,85 m^3/jam. Ini berarti prototipe Expo-2000 G-3 lebih efektif digunakan untuk mengeluarkan kayu di medan curam.

Kata kunci: Kabel layang, pengeluaran kayu, muatan, horizontal, vertikal, efisiensi

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I. INTRODUCTION

Timber extraction from felling area to road side is not an easy job. The problem is because this activity will face a number of difficulties in geo-biophysical conditions, such as steep terrain, up and/or down-hill, valley or river-to be crossed, slippery road, size of timber, low accessibility and so on. The traditional method of log extraction until now still exists, but it is not effective especially at steep terrain areas (Olund, 2001).

Although reliable data are scarce, logging is clearly more costly on steep terrain. The Reduced Impact Logging (RIL) guidelines typically set limits on the slopes that can be accessed by ground-based yarding equipment. Such limits for skid trails range from 17º slope limit suggested by Dykstra and Heinrich (1996) and 15º for major skid trails and 25º for minor skid trails suggested in the Code of Practice for Forest Harvesting in the Asia Pacific (APFC 1999), to 35º slope limit used by the Forest Department of Sabah, Malaysia (Pinard, Putz, Tay, & Sullivan, 1995). It is therefore on steep terrain that other alternative method of log extraction is required.

Various machines of skyline or ground skidding types have been applied for log extraction. These systems are separated based on type of machines, capacity, setting up the method and their operations, carriage models, and other complements. Those machines are categorized as heavy vehicles because according to definition, heavy equipment is the vehicle which is using motor power > 5kW, include trucks with Gross Vehicle Weight (GVW) > 20 ton. Those machines are mostly big sized, heavy, powerful and sophisticated. Those machines among others is the TTY-70 for skyline and skidder tractor for ground skidding.

Those machines besides being sophisticated, are also expensive, costly in operation and maintenance, needs operators with high skills, and many complementary equipments which are all heavy. It is therefore, in order to have a more appropriate technology, meaning that the machine should not be too big, it should be simple, lighter, not too expensive and techniqally easy to operate for log extraction. The technology of skyline might be feasible to be applied whether in advanced or developing countries (Lloyd, 2007). In the skyline technology, the technique of log extraction can be operated either in vertical or horizontal position.

This paper evaluates the modification of skyline system in steep terrain and to compare the performance between two modified skyline systems, in term of productivity and cost.

II. MATERIAL AND METHOD

A. Material and Location

The prototypes are known as Expo-2000 Generation-1 (G-1) and Generation-3 (G-3). The location for studying the modified machine G-1 was at Cimeong and Rancaparang Cianjur, and for G-3 at Cibatu Cianjur and Cibaliung Banten. The prototype G-1 was powered by a benzene engine of 6 HP while the G-3 was powered by solar engine of 12 HP. The logs were hauled afterward the carriage by rigging ropes. The carriage for G-1 hauling the logs had both vertical and horizontal head, but for G-3 extraction was only done with horizontal head. The slopy terrains at Cimeong and Rancaparang are similar, i.e. about 40-60%, and at Cibatu is about 60% and at Cibaliung Banten is about 30%. The distance of log extraction at Cimeong was 200 m, at Rancaparang was about 350 m, and at Cibatu was about 160 m and at Cibaliung was about 430 m. The species extracted at all experiments was teak with a length of 2-3.5 m and about 15-40 cm diameter.

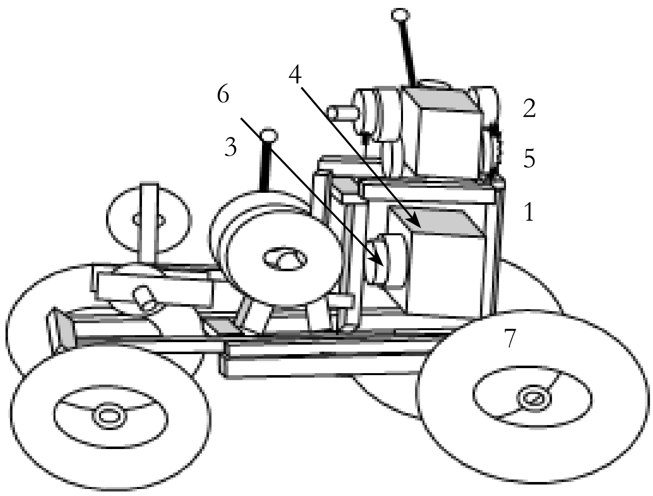
To facilitate the experiment some preparation activities were carried out: (a) choosing the location of the study area purposefully in which there was still forest harvesting activity with steep-very steep terrain; (b) finding some trees to be used as tail tree and spar tree; (c) cleaning 2-3 wide path along the cable line; (d) fixing the site area for loading and unloading of logs (log extraction distance was not more than 450 m); (e) rigging of cable line and do checking and re-checking before real operation begun; (f) provide manpower to operate skyline; (g) observe and note each log extraction process and (h) measure distance and fuel consumed before and after operation each day.

The construction of prototype machine Expo-2000 G-1 and G-3 and their components as seen on Figures 1 and 2.

B. Model of Carriage

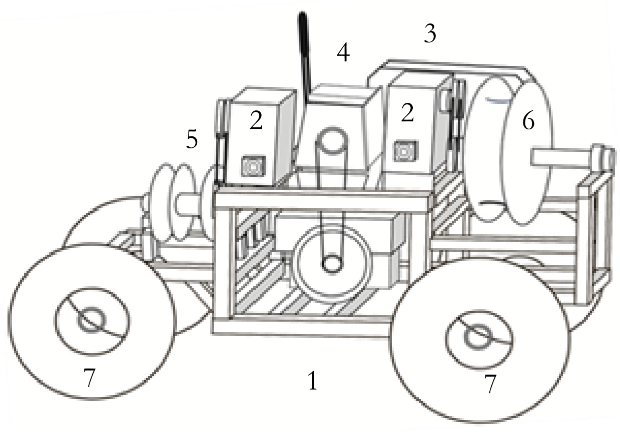
1. Carriage of logs in vertical position

Figure 3 shows one sophisticated carriage for log extraction using vertical position techniques (a) and two prototype carriages that were made locally (b, c). The skyline carriage hauls logs using the rised head position. On the left side the carriage hauls big size logs (weight up to > 0.5 ton). It is laborious to take and set-up the rigging ropes which could be very heavy. On the



Main specification:
1. Machine power
2. Handle for power-on machine
3. Stick for moving of drum
4. Reducer 1: 100
5. Gear box marine 1: 2.5
6. Endless drum
7. Tractor tire

Figure 1. Former prototype modified (G-1/6HP/gasoline)



Main specification:
1. Diesel ME 195 13 PK with 2000 rpm
2. Reducer 1 : 100 (2 pieces)
3. Excentric gear and chain of type 60 B (2 pieces)
4. Gear box marinewith 1 : 2 reducer of 2200 rpm
5. Drum of diameter 35 cm
6. Drum of endless diameter 70 cm
7. Wheel agriculture tractor

Figure 2. Latest prototype modified (G-3/12HP/diesel)

a b c

Figure 3. The modern and sophisticated carriage (a) the simple carriage (b and c) that was made locally. All extraction were carried out by vertical or rised head operation

a b c

Figure 4. Log extraction by horizontal head position using variation of carriages

centre picture, the weight of the carriage was about 35 kg while on the right side it was about 6 kg. However, both carriages are simple but strong enough to haul logs. The weakness of the rised head extraction is that logs may often go encircling and this typical occurrence of the transport may affect the rope, and slowly could reduce the power of the rope. So, the rope will be damaged sooner or later and would be very dangerous that should be avoided. However, in this system, the carriage is very powerful it could lift up logs even at the bottom of the valley (Endom, 2013, 2014).

An example of skyline that use rised head system was intended to be tried in natural production forest at PT. Sumalindo, East Kalimantan, using the Thunderbird TTY-70. Unfortunately, the sophisticated machine could not be used automatically anywhere because of too many things have to be prepared especially in low access areas.

2. Carriage of logs in horizontal position

At this operation logs are extracted by horizontal head as seen in Figure 4.

Here it can be seen that the process of log extraction was made as simple as possible by three types of carriages. In Figure 4a, the carriage is the so called tighten carriage. The log is hanging on two carriages and hauled using endless cable that is tightened at the carriage. Logs are extracted from the site to the location at a certain hill. In Figure 4b, log was extracted by hanging on two cables that lifts-up and lifts down using one tackle. The carriage is in the form of a thick box which is pulled by a 6 mm small cable that is connected to the drum on the machine. Logs from the felling site were brought to the road side. In Figure 4c the carriage became simpler, it is only built by two pieces of square pipes that is connected to the wheel by iron that hung on the main cable. At the two edges of this instrument is the set-up tackle that is used for lifting up and down of the logs to be extracted. By endless cable one or more logs can then be extracted from the felling site to a certain log yard. By using the tackle instrument which even can be used for skidding logs on the ground, if it is too short then we can add another rope for about 10-15 m distances. Therefore we can extract on a line which is 30 m in width.

C. Design of the Study

The design scheme of the study is shown in Figure 5.

D. Data Collection

Data collection was done in 2011 for study of (G-1) and in 2013 for study of (G-3) by observations and notes of all information related to the study, i.e. productivity of log extraction (diameter, length, number of logs, time consumed for loading, travelling, unloading, breaks and others) and also cost of operation.

E. Data Processing

Calculation of log volume was done using the empirical model of Brereton formula (Direktorat Jenderal Pengusahaan Hutan, 1993) as follows:

$$VL = 1/4\pi \left\{ \frac{1/2\left(D_p + D_u\right)}{100} \right\}^2 \times p \quad ....(1)$$

where: VL = volume of log (m^3); D_p = top diameter (cm); D_u = down diameter (cm); P = length (m); π = constant (3.14)

Productivity of machine was calculated using the formula as follows (Mulyadi, 2002):

$$P = \frac{V}{W} \quad ....(2)$$

where: P = productivity (m^3/hr); V = volume of log (m^3); W = time performance (hour)

Working hour of skyline operation was calculated as follows:

Extraction time = fixed time + variable time

where: fixed time = chocker time + release, variable time = travel time of extraction + empty travelling

To calculate the costs, the formula of Mujetahid (2010) was used:

1. Fixed cost of extraction

a) Depreciation was calculated by formula:

$$D = \frac{M - R}{N \times t} \quad ....(3)$$

where: D = depreciation (Rp/hr;
M = machine investment (Rp); R = Cost of residue 10% (Rp); N = life time of machine (yr); and t = yearly working hour of machine (hr/yr)

b) Interest rate was calculated by the formula:

$$B = \frac{\left[\frac{(M-R)(N+1)}{2}\right] + R \times 0,0p}{N \times t} \quad ......(4)$$

where: B = interest cost (Rp/hr; 0,0p j = interest rate /year (18%)

c) Tax

Tax amount is 5% of machine investment and was calculated by formula:

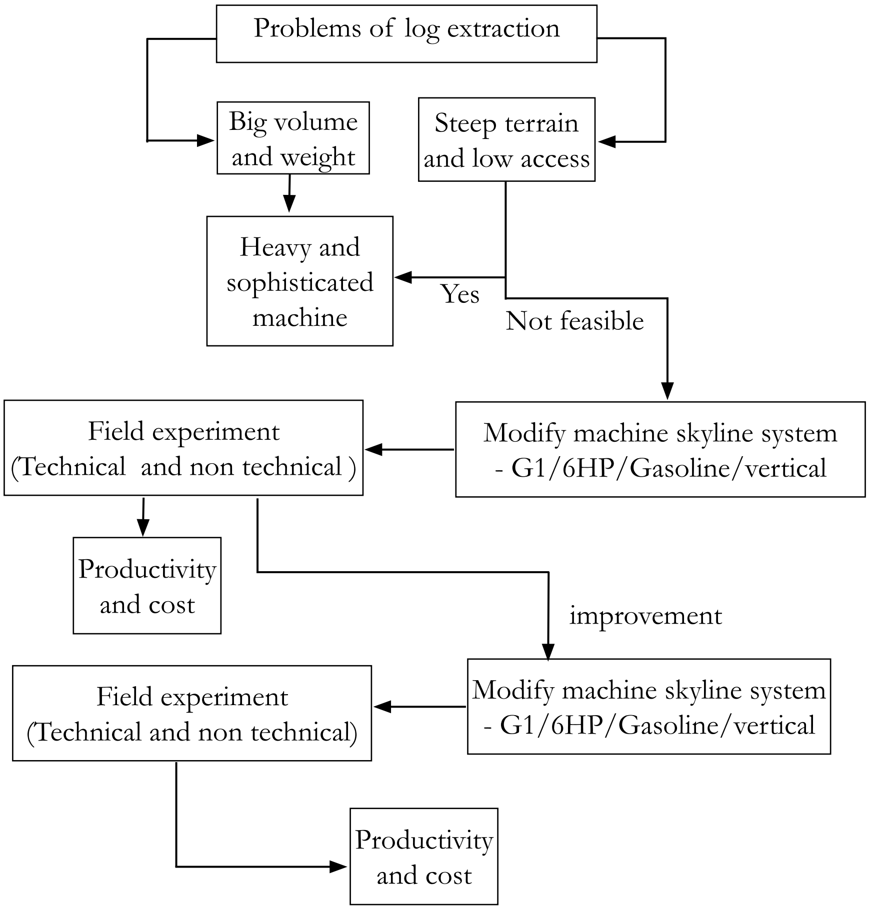


Figure 5. The schematic procedure of the study

$$P_j = \frac{\left[\frac{(M-R)(N+1)}{2}\right] + R \times 0.5}{t} \quad ...(5)$$

where P_j = tax (Rp/hr)

d) Insurance cost

Insurance cost was calculated as 5% of machine investment by formula:

$$A_{sj} = \frac{\left[\frac{(M-R)(N+1)}{2N}\right] \times 0.5}{t} \quad ....(6)$$

where A_{sj} = insurance (Rp/hr)

The amount of fixed cost (*BT*) in unit (Rp/hr) was calculated by formula:

$$BT = D + B + P_j + A_S \quad ....(7)$$

2. Variable cost of exraction

a) Maintenance of machine (P_{lb})

Maintenance cost of machine was calculated based on residual value of 10% of the investment divided by working hours per year in unit of Rp/hr.

Reparation (P_{rb})

Repairing the machine is aimed to fix the machine that had several small problems so the machine unit could be used again. Cost of repairing was calculated by dividing the cost of spare parts by working hours and the value was in unit of Rp/hr. Cost of reparation was based on direct observations in the field.

b) Fuel (B_{bk})

Cost of fuel was based on direct field observations by calculating the amount of fuel used (liter) during log extraction. Cost of fuel was calculated by formula:

$$B_{bk}(\text{Rp/hr}) = \frac{\text{Fuel used (liter) x price (Rp/liter)}}{\text{Working hours (hr)}} \quad ....(8)$$

c) Oil (P_{lo})

Cost of oil was based on direct field observations by calculating the amount oil used (liter) during log extraction. Cost of oil was calculated by formula:

$$\text{Oil (Rp/hr)} = \frac{\text{oil used (liter) x price (Rp/liter)}}{\text{Working hours (hr)}} \quad ....(9)$$

Sum of variable costs was calculated by formula:

$$BV = P_{lb} + P_{rb} + B_{bk} + P_{lo} \quad ....(10)$$

3. Cost of machine operation (B_{opr}) was calculated by formula:

$$B_{opr} = BT + BV \quad ....(11)$$

4. Salary of workers (U_p)

   Salary of workers was calculated based on working hours (Rp/hr) or (Rp/m^3)

5. Cost of business (B_{usb}) was calculated by formula:

$$B_{usb} = B_{opr} + U_p \quad ....(12)$$

6. Cost of log production (B_{prod}) was calculated by formula

$$B_{prod} = \frac{B_{usb}}{P_{tp}} \quad ....(13)$$

where: B_{prod} = Cost of log production (Rp/m^3); B_{usb} = cost of business of extraction (Rp/hr); P_{tp} = Productivity of log extraction (m^3/hr)

III. RESULT AND DISCUSSION

The experiment of both prototype machines had been done, and the result of the study is described as follows.

A. Performances of Two Prototype Machines for Log Extraction

In general, performance of the two prototype machines in log extraction operation is shown in Table 1-3. Unfortunately the G3/12HP/Diesel/vertical did not yet worked properly, then data on its effectiveness and efficiency are limited. However, from the physical machine construction it could be assumed that the productivity perhaps is higher than for G3/12HP/Diesel/horizontal, because the process of loading and unloading could be done faster, but the safety aspect is lower than for the horizontal loading and unloading process.

It can be seen clearly that for the time being the productivity of the latest prototype (G-3/12HP/Diesel) achieved 1.72m^3/hr with a coefficient of variation of about 23.9%. The former prototype (G-1/6HP/gasoline) achieved 0.63 m^3/hr with a coefficient of variation of 35.1%. G-1 has half the power of G-3. Perhaps if G-1 has a similar power as G-3, the productivity could be estimated to increase to about 1.2 m^3/hr. However, it cannot be directly calculated like that because the construction unit of machine G-1 is different from G-3. The G-1 machine unit is completed only with smaller and a single chain (type B50), while G-3 with bigger and double chains (type B60). The G-1 productivity may not reach that of G-3. Besides that G-1 construction uses only one drum while G-3 are set-up with two drums which can be operated separately or jointly.

In the previous study, the prototypes were also assessed by using some calculations for cost analysis. The result of the calculation for both prototypes is given in Table 4.

Table 4 showing that the process of extraction of logs can be done either in vertical or horizontal head position. However, because the engine power is different as well as the size of logs, distance and slopes, therefore the productivity of G-3 is much bigger than that of G-1. As regards fuel consumption, there is no much difference between both machines. It means that the prototype machine of G-3 would be useful for extracting logs especially at location where conventional method cannot work well.

Table 1. Result of G1/6HP/gasoline/vertical

No	Pulling and putting down the logs at log-yard					Productivity (m^3/hr)
	Length (m)	Diameter (cm)	Distance (m)	Time (min)	Volume (m^3)	
Mean	2.12	21.00	50-350	6.54	0.080	0.6363
Sd	0.233	4.031	-	1.297	0.034	0.3184
CV (%)	1.221	2.1328	-	2.204	5.013	5.5599

Table 2. Result of G3/12HP/Diesel/horizontal

No	Pulling and putting down the logs at log-yard					Productivity (m^3/hr)
	Length (m)	Diameter (cm)	Distance (m)	Time (min)	Volume (m^3)	
Mean	3.93	37.8	250.8	8.7	0.18	1.72
Sd	6.55	0.36	90.3	1.7	2.9	0.52
CV (%)	7.76	16.9	36.02	3.01	33.3	35.09

Table 3. Result of G1/6HP/gasoline/horizontal

No	Pulling and putting down logs at log-yard					Productivity (m^3/hr)
	Length (m)	Diameter (cm)	Distance (m)	Time (min)	Volume (m^3)	
Mean	2.430	27.667	350	19.433	0.046	0.523
Sd	0.879	6.218	0	3.520	0.022	0.280
CV (%)	36	22	0	18	48	53

The cost of log extraction for G-3 was about Rp 80,346.45/m^3 while for G-1 it was about Rp 156,351/m^3. Compared to conventional method at this typical location, skyline method was cheaper than that of blandong (local worker), cost of blandong was about ± Rp 200,000 - Rp 300,000/m^3. On the other hand, the skyline method is more ergonomic because it is able to avoid heavy physical load and reduces the risk during the operation process, as shown in Figure 6.

In Figure (6a), the worker is trying hand-pulling the rope to go uphill with small diameter log of pine on his shoulder, in Figure (6b) some workers are trying to push the log to be rolled uphill and someone at hilltop helping them using the rope, and in Figure (6c) some workers were trying to lift-up the log to the carriage that already hung at the cable line at certain height (25 m). These pictures are telling us how difficult it was extracting a piece of log on a sloping terrain, although the distance to move the log was not far, about 5-8 m. It proves that the problem of the terrain is very significant, as well as the productivity of the manual method that could be relatively low and full of risk.

To anticipate this weakness, perhaps the skyline technology which is made in a simple construction can help very much. Figure 7 shows the prototype that could be appropriate and a

Table 4. Productivity of prototype Modified Expo-2000 G-1 and G-3

Items	Engineering design of Expo skyline machine	
	Modified Expo 2000 G-1 (vertical head operation)	Modified Expo 2000 G-3 (horizontal head operation)
Completion assessories	No excentric gear, one reducer, one media for double pulley, one drum	Two excentric gear, two drums and two reducers
Control of machine operation	Easy just move forward or backward the panel on the box marine	Easy just to control theexcentric gear panel and then move the panel forward or backward onthe box marine
Engine power	6 HP	12 HP
Speed	70 m/minute	70-120 m/min
Operation	One way operation	Two ways operation
Performance	< 0.63 m^3/hr	1.72 m^3/hr
Fuel consumption	< 1 benzene litre /hr	1 -1.5 litre solar/hr
Extraction distance	50-350 m	130-430 m
Cost of operation	Rp 102,986/hr	Rp138,587,39/hr
	Rp 156,351/m^3	Rp 80,346,45/m^3

good prospect to be used for log extraction on sloping terrain, and could be used not only for removing wood but also other materials such as agriculture products. The slope at the study area was about 60% and the distance about 135 m. Here, it can be seen clearly that the operation of hauling logs could be worked out easily, calmly and safely. This could solve local problems technically and economically in remote areas that is common anywhere in this country; the skyline method could be used significantly in anticipation of field challenges. The minimum wood volume that should be extracted in order to pay back return on investment, can be seen in the calculation below.

$$\text{Cost or investment} = \text{Volume} \times \left(\frac{\text{Cost of log extraction}}{\text{Productivity of extraction}}\right) \quad ....(14)$$

$$Rp\ 72.500.000 = V\left(m^3\right)\left(\frac{Rp\ 138,587,39/hr}{1.72\ m^3/hr}\right)$$

$$V\left(m^3\right) = \times \frac{\text{Rp } 72,500,000 \times 1.72 m^3/hr}{\text{Rp } 138,587.39/hr}$$

$$= 899.79\ m^3 \sim 900\ m^3$$


a


b


c

Figure 6. Manual uphill extraction of logs with hand held rope (a), three workers rolling log uphill and helped by pulling the rope uphill (b), and pulling lift-up logs to skyline carriage (c)

This simple calculation gets the result that after effective working extraction of a minimum of 900 m^3 or after the machine has operated 524 hours, the investment can get profit. If working hours per day are 6 hours, the profit will be earned after 88 days or in about 3 months. As a comparison study the cost is given below for another type of machine, the so called Koller K 300, for log extraction by skyline.

One study of Koller K300 cable system at Salalet Hill used the machine with an engine of 50 HP. It had been operated for log extraction at distances of 100, 200 and 250 m, and each operation needed in average 6.24, 8.05 and 10 minutes. The variation of productivity was 6.6 m^3/hr (100 m), 5.5 m^3/hr (200 m) and 4.9 m^3/hr (250 m). The average extraction for each trip was two logs and the cost was about \$4.2 per m^3 or Rp 40,000/m^3 (Senturk, Ozturk, & Demir, 2007). In present value it is corresponding to Rp 150,354 which is relatively higher than the cost of production by prototype Expo-2000 Generation-3. In case of the productivity, Koller K.300 was somewhat higher than prototype Expo-2000 of Gen-3 because the power was also 4 times larger. In Perum Perhutani Unit III of West Java, in 2000 there had been an experiment using the yarder machine of IWAFUJI 115. The productivity was in average 33.33 m^3/hr (Basari, 2002). It is also easy to understand if the production was relatively higher, because the engine used was much bigger of IWAFUJI 115 which had a power of 200 HP.

Today there are many different technologies of skyline such as TTY 70, Koller K 800, Trailer Mounted Undercarriage (TRLM), Self Propelled Crawler Mounted Undercarriage (SPCM), Self Propelled Rubber Mounted Undercarriage (SPRM) TTY 70, Koller 300, Trailer Mounted Undercarriage (TRLM), Self Propelled Crawler Mounted Undercarriage (SPCM), Self Propelled Rubber Mounted Under carriage (SPRM). Those machines may be used in either developing or advanced country (Lloyd, 2007) and with big power engine, which are able to extract big logs. For example, the TTY 70 has capability to remove logs of a volume of >12 m^3 or a weight of about 10-15 ton. Another research which used small machine power was carried out by Escobar and García (2013). The model machine and its operation is shown in Figure 8.

In conclusion, Escobar and García (2013) mentioned that this system may be used technically for logging of small logs in forest harvesting operations. The advantage is that all profile types are environmentally friendly, require low investment and technically simple. However, the productivity is still low (6 ton/day for distances of 500-750 m, 8 ton/day for distances of 250-500 m and 9 ton/day for distances of 100-250 m), and labour use and cost is therefore high. Cost of operations are Col\$ 26, 18 and 14 for distances of 750-500 m, 250-500 m and 100-250 m, respectively. On the other hand, Spinelli, Maganotti & Visser (2015) mentioned that in general, cable logging is more complex and expensive than ground-based logging, which places steep terrain forestry generally at disadvantage in terms of pure harvesting cost. However, modern cable yarding technology can reduce this gap, and productivity models can assist users in refining their work techniques, so as to maximize the productive potential of their machines. In his experiment the machine was studied while harvesting selective patch cuts (gap cutting) in similar even-aged Norway Spruce stands, extracting logs between 3-6 metres long. The productivity ranged between 8.5 and 10 m^3/hour, including all delays, but excluding set-up and dismantle time.

Another study by Acuna, Skinnell, Mitchell, and Evanson (2010) mentioned that in good clear felling conditions in steep terrain a tracked self levelling feller buncher can achieve a high rate of productivity. Bunching the trees increased the productivity of the swing yarder by 25% and 19% cost reduction. Mechanized felling improves safety and value recovery.

The information above does mean that extracting logs by skyline machine is powerful and useful that should be applied at extreme

Figure 7. Field situation at operation of log extraction at Cibatu, Cianjur

Figure 8. Machine unit version 6.1

Remarks: transmission are pulleys and bands, dimensions 100x75x30 cm, 4 possible separate parts, net weight 50 kg, diesel engine power 6.5 HP (4.85 kW + 35 kg weight).

Source: Escobar and García (2013).

conditions. However, in operation of skyline there are high range variations with coeficient variation ranging from 31 to 79% (Pyles, Womack & Laursen, 1994). According to Lloyd (2007), compared with skidding tractor, the cost of operation and maintenance of skyline crane system was lower and the life time was longer. Actual extraction cost/m^3 varies very significantly depending on field conditions.

B. Comparison of the Manual and Skyline System

Safitri (2000) mentioned that on the average the size of logs which could be able to be shouldered in the manual system is the log with small diameter, i.e. top diameter of 21 cm and down diameter of 19.91 cm and length of 1.5 m, with a distance of about 32 m and the maximum distance would be 48 m. The limit of this manual method is decided by the weight of logs, weakness of workers and terrain conditions.

Figure 9. Logs extracted using simple hoist made by small pulleys and nylon string loading -unloading.
Source: Escobar and García (2013).

The two problems faced in applying the skyline technology are: choosing appropriate machine and skilled operators to operate the job. First about the machine, the constraint was how to find an appropriate machine rather than only sophisticated ones which have big engine power, because it cannot be directly used due to low accessibility conditions. The suitable forest road is rarely found especially in remote areas, the road constructions are usually dreadful. Therefore, the machine should be relatively small, have good flexibility to field condition, not too expensive but it could be built domestically and efficiently. Second, operators should have skill in technical rigging of ropes and capable of switching rope if once the rope is broken. Furthermore, it needs some instruments for setting the rope well, and the team should also be capable on deciding the right location for setting the ropes. Those jobs are not easy to execute, therefore control of operation is also important (Biller & Johnson, 1988).

Figure 10 shows the sophisticated and the simple machines, one as a locally made product prototype machine. It shows that operation of machine Expo-2000 of G-3 could be much simpler than TTY 70. It requires only handling panel of gear connection of the machine to the drum for hauling logs and backward in the air of the felling areas, and handling the panel for going forward or backward of the carriage. From this simple operation it could be concluded that it would be better and important to start building local industries for machines, including skyline that could be useful for helping regional and local development, especially for sloping areas. To support this conducive climate, the initial innovative approach should be continued and enlarged with wider scope of discipline involved (Endom, Soenarno, & Idris, 2014)

Seeing that topographic condition is the main factor that limits forest harvesting including skyline in which a convex slope, rough/not flat terrain and direction of the slope are not similar, those situations may also cause new problems. It is therefore the identification of field areas should be done well to choose which lane should be selected (Greulich, Hanley, McNeel, & Baumgartner, 1996). That is why based on this experience, foresters should be able to identify well existing conditions for defining what technique and equipment should be used for that logging operation.

a

b

Figure 10. Sophisticated skyline machine of TTY 70 (a) and a simple prototype G-3 (b)

IV. CONCLUSION

The prototypes of modified Expo-2000 G-1 and G-3 using skyline system for log extraction operation had been assembled by a team of the Forest Products Research Center, Bogor. The first prototype was tested with vertical removal position and the second one with horizontal removal position. The prototype of G-3 show edit is more appropriate to be applied in Indonesia with a productivity of about 1-3 m^3/hr and on the average 1.72 m^3/hr. The cost of log extraction reached about Rp 80.348/m^3.

Referring to many Indonesian areas that have low accessibility for log extraction, a suitable machine for supporting operation could be made in a simple construction with medium power engine. Moreover, the operator and the team must have high skill for operating the skyline to enable it to work well. It is therefore promotion and education of this discipline that should be eagerly done.

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EFFECTS OF DRAINAGE DITCHES ON WATER TABLE LEVEL, SOIL CONDITIONS AND TREE GROWTH OF DEGRADED PEATLAND FORESTS IN WEST KALIMANTAN

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EFFECTS OF DRAINAGE DITCHES ON WATER TABLE LEVEL, SOIL CONDITIONS AND TREE GROWTH OF DEGRADED PEATLAND FORESTS IN WEST KALIMANTAN. Currently, tropical peatland forests are under considerable pressure because of increasing deforestation and degradation of forests. In Kalimantan, degradation and deforestation of peatland forests are driven primarily by industrial logging, expansion of agricultural activities through primarily conversion of forests to agricultural land and oil palm plantations. By the establishment of intensive drainage, it can induce wildfires in peatland. Unmanaged drainage ditches will alter water table levels within the site adjacent to the drainage including to surrounding peatland forest. Water table assessments were conducted before and after peatland drainage on 2007/2009 and 2012/2015 in Kubu Raya, West Kalimantan. This paper studies the effect of drainage ditches into the peat land water table. Results show the establishment of drainage ditches on this peatland landscape lowered the water table by more than 3 times from ~11.7 cm (SE = 1.5, n = 5) to ~37.3 cm (SE = 2.1 cm, n = 26). The effect on the water table was in drier months of July-August. Lowering the water table level altered worst the soil micro climate, peat temperature and peat water content. The results indicate the land use changes in peatland with the establishment of drainage affects peatland water table currently. In the area of less than 500 m from the drainage, the water level tends to lower toward the drainage feature. Therefore, recovery of peatland forests should be initiated by managing the landscape hydrology (i.e. water table) to restore the ecosystem and to protect the remaining peat swamp forest.

Keywords: Degraded peatland forest, drainage ditches, ecosystem restoration, soil micro climate, tropical peatland.

DAMPAK PARIT DRAINASE TERHADAP TINGGI MUKA AIR, KONDISI TANAH DAN PERTUMBUHAN POHON DI HUTAN GAMBUT KALIMANTAN BARAT. Saat ini, hutan gambut tropis berada di bawah tekanan yang cukup besar karena meningkatnya deforestasi dan degradasi hutan. Di Kalimantan, deforestasi dan degradasi hutan gambut terutama didorong oleh adanya industri penebangan, perluasan kegiatan pertanian terutama dari konversi hutan untuk lahan pertanian dan perkebunan kelapa sawit. Dengan pembangunan parit drainase intensif, hal ini dapat meningkatkan resiko kebakaran hutan. Drainase parit yang tidak dikelola dengan baik akan mengubah tinggi muka air di daerah sekitar drainase termasuk daerah di sekitar hutan gambut. Penelitian ini mempelajari pengaruh drainase terhadap perubahan air muka gambut. Pengukuran muka air dilakukan sebelum dan sesudah lahan gambut dikeringkan pada tahun 2007/2009 dan 2012/2015 di Kubu Raya, Kalimantan Barat. Hasil penelitian menunjukkan bahwa parit drainase pada lansekap lahan gambut menurunkan tinggi muka air lebih dari 3 kali, dari ~ 11,7 cm (SE = 1,5; n = 5) menjadi ~ 37,3 cm (SE = 2,1 cm; n = 26). Dampak tinggi muka air lebih buruk pada bulan kering (Juli-Agustus). Menurunnya tinggi muka air gambut mengubah iklim mikro tanah, terutama suhu dan kadar air gambut. Hasil penelitian menunjukkan bahwa perubahan penggunaan lahan di gambut bersamaan dengan pembangunan drainase akan mempengaruhi tinggi muka air gambut secara beragam. Pada jarak kurang dari 500 m dari drainase, tinggi muka

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air cenderung meningkat menuju ke arah drainase. Oleh karena itu, restorasi ekosistem hutan gambut harus dimulai dengan mengelola hidrologi lansekap.

Kata kunci: Hutan gambut terdegradasi, parit drainase, restorasi ekosistem, iklim mikro tanah, gambut tropis

I. INTRODUCTION

Tropical forests are under considerable pressure because of the raise of deforestation and degradation of intact forests (Hansen et al., 2001; Achard et al., 2002; Field, Werf, & Shen, 2009). The deforestation rates of intact forests in South-East Asian tropical peatlands – concentrated in Sumatra and Kalimantan, Indonesia – has been reported as 3.4% y^{-1} from 1990 to 2010 (Miettinen, Shi, & Liew, 2011), which exceeds the deforestation rates reported for other tropical forests such as in Central America and the Caribbean (1.2% y^{-1}) and South America (0.5% y^{-1}) (Achard et al., 2002; Hergoualc'h & Verchot, 2011). Currently, only 29% of the primary peatland forests of South-East Asia remain (Miettinen, Shi, & Liew, 2016). Tropical peatland accounts for 25% of deforestation from 2000 to 2005 in South-East Asia (Hooijer, Silvius, Wösten, & Page, 2006).

Large areas of tropical peatland forests have been logged for wood products to supply local, regional and global demand (Curran et al., 1999) and developed for either small-scale farming (e.g. sago, corn, pineapple, and vegetables) or large-scale agricultural plantations (e.g. oil palm) involving extensive drainage of peatlands, particularly in Indonesia (Achten & Verchot, 2011; Carlson et al., 2012, Carlson et al., 2013). These peatlands have also incurred synergistic exposure to drought and wildfires (Langner, Miettinen, & Siegert, 2007; Page, Hoscilo, & Tansey, 2008; Langner & Siegert, 2008). As a result of both natural and anthropogenic changes, deforested and drained tropical peatlands have become potential significant source of greenhouse gas (GHG) emissions globally as lowering the peatland water table leads to a significant increase of CO_2 emissions (Astiani, Mujiman, Salim, Hatta, & Firwanta, 2015; Astiani, 2016) as well as changes in peat soil characteristics. Deforestation and forest degradation of forest biomass and soil carbon have become truly global issues because of their contributions to global climate change (Werf et al., 2009; Eva et al., 2010). Werf et al. (2010) estimated that in 2005 deforestation accounted for about 20 - 29% of the total anthropogenic GHG emissions, primarily carbondioxide (CO_2).

In Indonesia, about 60% of the current emissions come from deforestation, degradation and peatland conversion (Someshwar, Boer, & Conrad, 2009). However, among carbon components, emissions and their corresponding environment factors from land-use and land-cover change are perhaps the most uncertain components of the global carbon cycle, with enormous implications for estimating the current carbon budget and for modelling scenarios of climate change over the next 10-50 years (Ramankutty et al., 2007; Carlson et al., 2012, Carlson et al., 2013). Because peatlands sequester relatively high carbon stocks – especially below ground – these forests may play an important role in moderating atmospheric CO_2 concentrations. However, forest degradation, land cover changes, and altered drainage, combined with changes in temperature and precipitation, are transforming peatland forests into major carbon sources rather than stores/sinks (Carlson et al., 2012, Carlson et al., 2013). Moreover, degradation of forest coverage is often a complex process with some degree of ecological recovery and a strong interaction with climatic fluctuations (Jones & Schmitz, 2009). Therefore, large uncertainties in land-based carbon stocks and fluxes exist and, in particular, from drained and degraded forested peatlands. Assessment of CO_2 respiration of

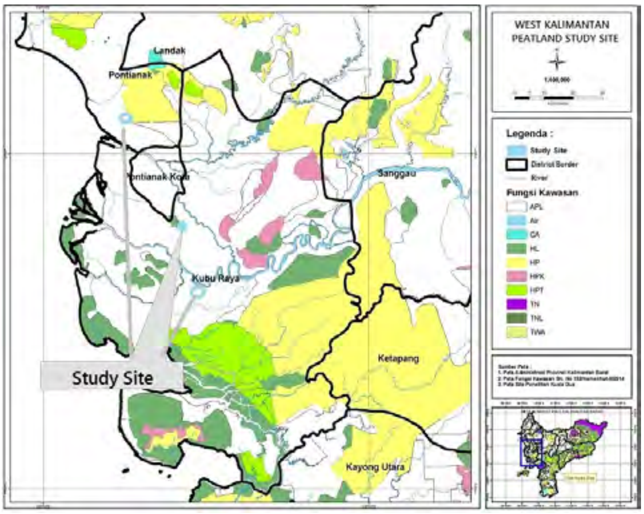


Figure 1. Study site of water level assessment

peat across a range of annual crops grown on peatland found a high CO_2 respiration from agricultural land uses on peat ranging from 83.8 to 139.9 ton ha^{-1} y^{-1} (Astiani, Hatta, & Fifian, 2015) and in drained, degraded peatland forest ~76 ton ha^{-1} y^{-1} (Astiani, 2014). However, the interactive effects of climate, water table, soil and site characteristics and forest conditions and dynamics are poorly understood. This paper studies the effect of drainage ditches on peatland water table, soil characteristics, and growth of degraded peatland forests in Kubu Raya District, West Kalimantan.

II. MATERIAL AND METHOD

2.1 Study Site

The study was conducted in a formerly logged peatland forest in an ombrotrophic, coastal peatland in Kubu Raya District, West Kalimantan, Indonesia. The plot is located at 0013’ S and 109026’ E, ca~ 4 m a.s.l. Mean annual rainfall is 3200 mm ± 530 mm (based on rainfall data on 2000-2014, recorded from West Kalimantan Supadio Station) with zero months per year with an average of less than 100 mm rainfall, even during the onset of the El Niño Southern Oscillation (ENSO). Average ambient temperature is 26.5±0.5°C, with minimum and maximum temperatures of 22.6 - 32.2°C. The study location is depicted in Figure 1.

This site of peatland forest was selected based on intensive survey and satellite image searching (Landsat ETM+, 30 m resolution) that showed unfragmented forest blocks representing degraded peatland forest in the area. Throughout the 12 ha area, peat depth was measured with a Russian Peat Corer (Aquatic Research Instrument) coupled with Garmin eTrek GPS readings, then peat depth distributions were mapped. At this focal site, peat depth ranged from 2.6 to 5.4 m. By applying a georeferencing technique, the peat depth area generated in ArcGIS was then clustered into three peat depth classes together with corresponding areas within the total measured area (<3.5 m ~ 6.5 ha; 3.5 – 4.5 m ~ 4.25 ha; and >4.5 m ~ 1.5 ha).

In 2009, the local government established canals/drainage ditches (3 m width x 2 m depth) for small scale agriculture and plantation development along the edges of the East and West sides of the peatland forest of our focal study site within a distance of approximately 300 m and 200 m parallel to both edges of the studied forest landscape. Water in the canals was not regulated by dams to maintain the water table (Figure 2). The water was drained into the lower part of the peatland landscape especially when there was no rain to the landscape. Therefore, tree growth before and after canal construction at the same site

(a) (b)

Figure 2. Peatland water table before (a) and post (b) canal establishment at the same landscape

could be compared. Observation over this peatland landscape concluded that there was no water level management following canal establishment.

2.2 Peatland Forest Floristic Condition and Tree Measurement

From previous studies, measurements have been conduced on the forest tree population within the forest block (Astiani, 2014; Astiani, Mujiman, et al., 2015; Astiani, Hatta, et al., 2015). This area was selectively logged (non-mechanized) in 2002-2004. Inventory estimated 12 trees per ha (> 30 cm dbh) were either removed or lost during felling over the site. Villagers interviewed near this area reported that vegetation coverage is mostly *Shorea* spp. (Dipterocarpaceae) and *Gonystylus* sp. (Thymeleaceae) for local construction. In 2007, Dipterocarpaceae comprised 7% of the understory (< 10cm dbh) and 3% of the canopy trees (≥10 cm dbh) (Astiani, 2014).

Mean stem density and tree basal area (> 10 cm dbh) yielded ~458 trees ha^{-1} and 9.73 m^2ha^{-1} and included at least 100 tree species within 31 families, whereas seedling (diameter <5 cm) and sapling (5-10 cm dbh) inventories recorded 25,390 ± 1433 seedlings ha^{-1} and 1113 ± 44.8 saplings ha^{-1}. The prominent species were *Litsea gracilipes* (Lauraceae), *Pometia pinnata* (Sapindaceae), *Litsea resinosa* (Lauraceae), *Tetramerista glabra* (Tetrameristaceae), *Elaeocarpus griffithii* (Elaeocarpaceae), *Litsea nidularis* (Lauraceae), *Shorea uliginosa* (Dipterocarpaceae) and *Neonauclea excelsa* (Rubiaceae). The forest vegetation registered for this study is important, because the aboveground vegetation could affect micro climate and hydrology balance within the forest under storey as well as belowground site characteristics.

Peatland forest condition within the study area is classified into low, mid and high degraded forest classes using projection results of the forest coverage percentages measured with Forest Densiometer. The forest coverage measurements were then cross checked with Leaf Area Index (LAI) measurements using Licor 2100 LAI measurement tool.

Across the study area, tree stems >10 cm dbh were mapped, tagged, identified to species or at least genus and monitored for diameter growth 3 years before and 3 years post canal establishment and compared. Stems (<10 cm dbh) were measured with a calliper and given a permanent red paint mark at the point of measurement. All stems >10 cm dbh were fitted with field-made steel dendrometer bands (Paoli, Curran, & Slik, 2008). Dendrometer bands were placed at 1.3 m above ground or 20 cm above buttresses and other bole irregularities. The red paint was renewed every six months to prevent visual loss if dendrometer bands were rotted or lost. Each tree was measured annually, and tree increment was calculated as the difference between diameter and estimated biomass at the end of each interval.

Transforming diameter increment into accurate biomass increment estimates requires application of an appropriate allometric equation (Clark et al., 2001). There are several available allometric equations for estimating biomass in tropical forest such as Kato, Tadak, and Ogawa (1978), Brown (1997) and Chave et al. (2005). In this study method stated by Paoli and Curran (2007) was applied to estimate aboveground biomass using the moist forest equation of Chave et al. (2005) who also incorporates specific wood densities. Chave et al.'s equation was derived from a larger data set than used by Brown (1997), and estimates aboveground biomass as a function of both diameter and wood specific density. Aboveground net tree biomass was defined as the cumulative growth of all trees that survived through each sampling interval (5-10; 10-20; and > 20 cm dbh; (Clark et al., 2001; Paoli & Curran, 2007). Moreover, new recruits from the 5-10 cm dbh class that grew into the >10cm dbh class was included.

2.3 Monitoring of Water Table Levels

The effect of the establishment of drainage ditches on lowering water table levels was measured within the forest before and after the establishment of the drainage ditches near the peatland in 2009, and repeated during 2012-2015. Since 2007, nine piezometers have been located across permanent plots where NPP, soil emission, carbon and other related topics were studied. The results of these studies have been published previously by Astiani (2014). Before drainage established water levels were monitored and observed monthly and more focus on dry and rainy months, while post drainage establishment, water table levels were monitored more intensively (weekly) over the years. The average of monthly water table within the forest and mean distribution of water table across the landscape among the drainage sites were accumulated.

2.4 Peat/Soil Environment Conditions

Along with other focus of the study on soil/peat CO_2 emissions using a Licor 8100 Automatics Soil CO_2 Respiration Measurement bi-weekly and it was averaged for monthly condition. Several site conditions at the same site before and after the drainage establishment such as soil surface temperature, content of soil surface water, and soil bulk density within 0-20 cm depth, for both conditions of water table levels. The first soil condition measurements were assessed concurrently with other observation on peat soil CO_2 emissions (Astiani, 2014) for both conditions of water table levels in 2008 and 2011 consecutively.

2.5 Data Analysis

Throughout this paper, data are presented as means and standard errors (SE) unless otherwise noted. Trees within a plot were grouped into three size classes (i.e., 5-10, 10-20, >20 cm dbh) and growth of all stems within a size class were summed. Comparisons among the 3 years before and 3 years post canal-establishment on water table levels, soil characteristics, and tree measurements were examined with simple T test if growth, productivity, and tree mortality and all those variables differed significantly across the two conditions. All analyses were performed using Sigmaplot version 11.2.

III. RESULT AND DISCUSSION

3.1 Influence of Drainage Ditches on Peatland Water Table Levels

The establishment of drainage ditches lowered the water table across the overall peatland landscape. The results of measurements demonstrate that water table level depths have significantly lowered after the establishment of the drainage ditches adjacent to the ombrotrophic peatland forest. T test results demonstrate that both situations, before and after ditches were significantly different ($t = -9.991$, $df = 2$, $P = <0.001$) (Figure 3). The results of the overall yearly monthly assessments shows that mean of water level depth before the

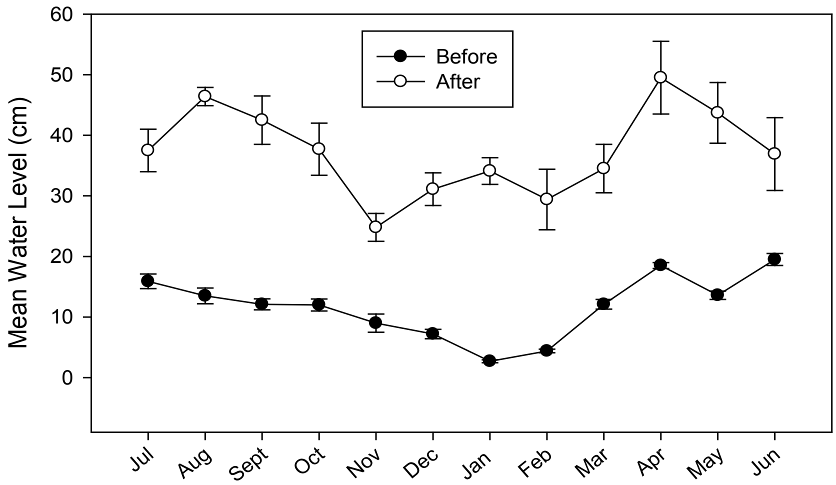


Figure 3. Distribution of mean water table level on peatland before and after the establishment of drainage ditches/canals

establishment of the drainage ditches was 11.7 ± 1.5 cm, while after the canal construction it was 37.3 ± 2.1 cm. Even though the shift of water table was varied at each point of assessment, the canal lowered the landscape mean water table by ~25 cm.

Figure 3 demonstrates that post drainage establishment, mean monthly water table level of the peatland landscape fluctuated more and significantly increased according to the the distance of water level below the peatland surface. Lower water table consequently impacted on the other conditions or characteristics of the peatland site as stated by Mitsch and Gosselink (1993), peatland hydrology has an influence on peatland chemical and biotic characteristics and processes as well as influencing land formation through their interaction with vegetation, nutrient dynamics, and carbon fluxes (Waddington & Roulet, 1997). Hydrological changes will also alter the rate of gas diffusion and carbon flows (Holden, 2005).

3.2 Peat Characteristics Before and After Establishment of the Canals

Some soil conditions were observed before and post establishment of the ditches. Results indicated that there was significant difference in soil surface temperature. The mean monthly distribution of soil temperature is presented in Figure 4a. Results of a T test indicated that the temperature before the presence of the canal was relatively lower than post canal ($t = -3.78$; $df = 47$; $P = <0.001$). Results show that peat temperature was consistently higher during post canal establishment. Higher differences were observed especially in dry and rainy months of July - August and December - January whereby in dry months, the temperature post canal could reach 37-38°C, while before it was 3-4°C lower. Moreover, in rainy months post canal temperature was consistently higher than before. Overall monthly means were 29.9 °C and 31.8°C before and after the drainage establishment. There was also significant difference in the peat surface water content ($t = 21.23$; $df = 52$; $P = <0,001$). Peat surface (0-20 cm) water content was significantly higher before the presence of the ditches (94.6% ± 0.8 vs 77.7% ± 0.2). The mean monthly distribution of water content is depicted in Figure 4b.

It was also observed that when water table lowered (Figure 5a), the water content also decreased ($p = <0.001$). Meanwhile since the peatland landscape is solely rainfed the water table was mainly influenced by the precipitation (Figure 5b.).

Here the presence of soil water with higher water level close to peat surface could mitigate

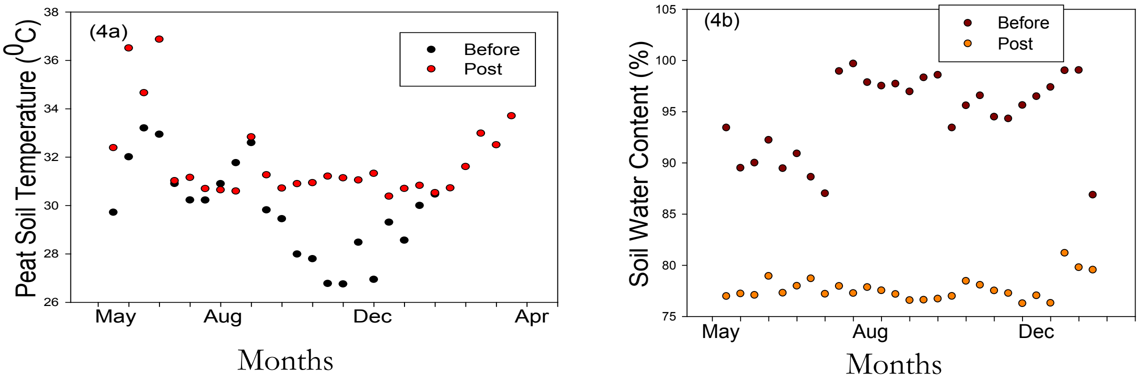


Figure 4. Mean soil temperature on forest floor before and post establishment of canals (4a); Mean monthly soil water content before and post establishment of drainage ditches (4b)

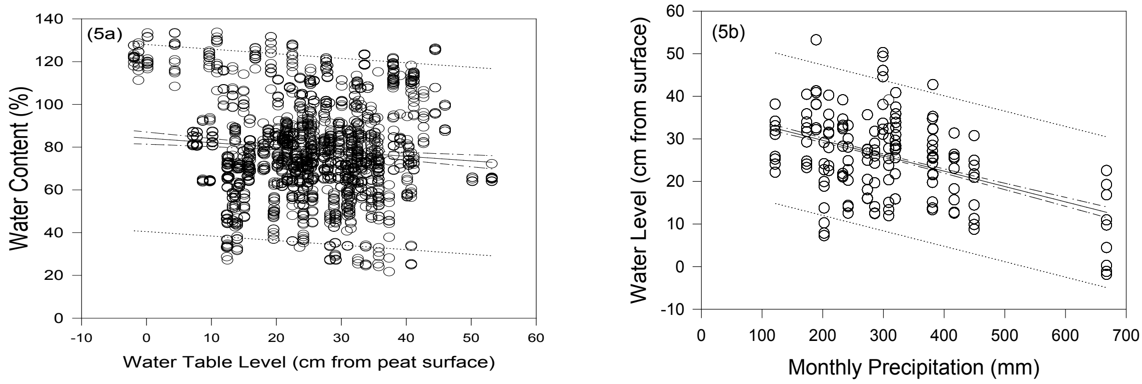


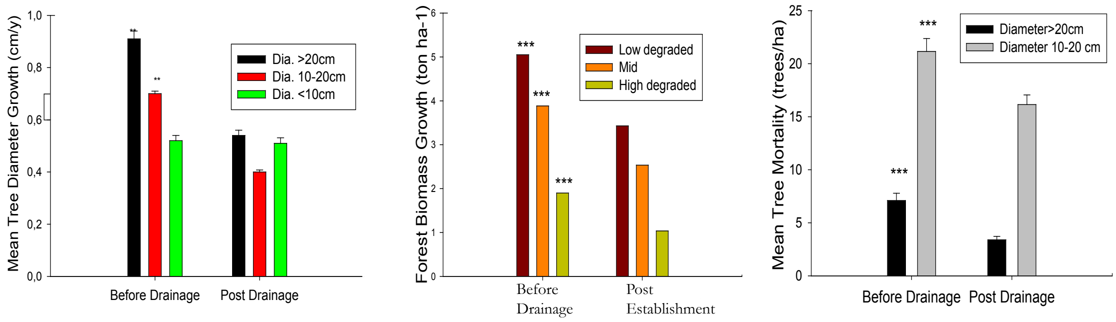
Figure 5. Linear regression between peatland water level and peatland 15 cm-surface water content (a); (5b) Linear regression between monthly precipitation and peatland water table (b)

soil temperature escalation. Figures 4a and 4b, show constant water content reduction which could be one of the factors that leads to the rise of soil temperature.

3.3 Effects of Canal/Drainage Ditches on Forest Dynamics

Comparison of diameter growth and tree biomass per hectare of trees with diameter >10cm demonstrated that lowering water table levels due to drainage ditches has significantly affected mean diameter growth and total biomass per hectare in this degraded peatland (~42% decrease in tree diameter >20 cm and diameter 10-20 cm, p = <0.001). However, for smaller trees (diameter < 10 cm) there is no significant difference in their annual growth rates (Figure 6a) and trees seem to grow better in its new condition after the changing of water table levels. Although this degraded peatland forest varies in its biomass stock, tree growth and mortality, lowering water table levels constantly decreased the tree growth at different levels of forest degradation (Figure 6b). However, an interesting result is shown in lowering the water table level significantly and reducing the mortality of trees (Figures 6c).

Associated demographic shifts in this study area included increased tree growth and recruitment of small trees, increases in aboveground biomass, lowering mortality of smaller trees, yet increased large tree mortality. The changes of biomass, growth, and mortality of trees could reflect a distribution of responses



(a) (b) (c)

Figure 6. The average of tree diameter growth (cm per tree) of tree diameter >20 cm and 10-20 cm before and post drainage (a); biomass growth at some levels of degradation (b) (***=significantly different at p = <0.001); Mean annual tree mortality per ha before and post drainage (c)

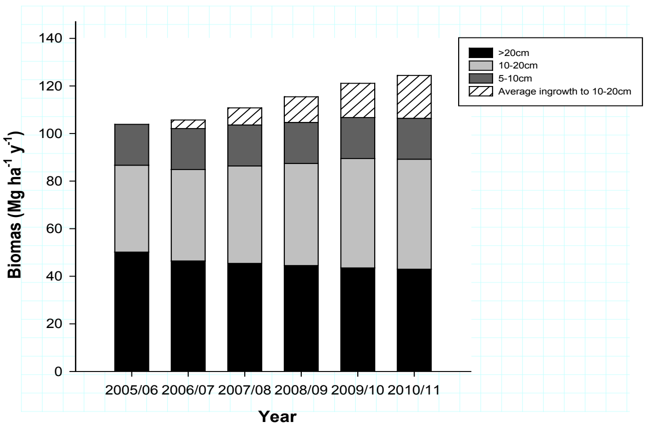


Figure 7. Biomass growth per ha in degraded peatland forest 2005-2011
Source: Astiani (2014)

to resource availability and site condition dynamics (Feeley et al., 2007) and diversity shifting (Astiani, 2016). Our previous study demonstrated that reduced rainfall in peatlands lowered the water table (R= -0.44) from the peat surface (Astiani, 2014) which has been demonstrated to have positive effects on Net Primary Production in some northern peatlands (Laiho & Laine, 1997; Minkkinen, Korhonen, Savolainen, & Laine, 2002; Laiho, Vasander, Penttilä, & Laine, 2003).

Even though lowering of the water table level due to the establishment of drainage ditches reduced the biomass growth of the trees, when we calculated cumulatively within the six years of assessments (before and post canal presence) it showed that a significant additional growth occurred, whereby stand basal area of trees increased by 27%. More detailed analysis indicated that the biomass of larger trees decreased by about ~ 14%, but growth of smaller and younger trees increased by ~ 76%. Previous analysis showed that the overall forest biomass increased by ~24% (Figure 7), therefore, the results indicated that drainage establishment has affected this secondary, degraded peatland forest by tending to reduce the growth of larger trees, yet had no impact on the growth of smaller trees while also reducing their mortality level.

These results demonstrate the impacts of the establishment of drainage ditches on hydrology and forest dynamics of degraded peatland forest. Peatland forest should be maintained in a landscape based on management to enhance their sustainability and natural resource functions. Partial management of this ecosystem could interfere with the peatland forest's multi roles not only in supporting sustainable wood and food production, but also its important contribution in mitigating GHG emissions.

Hydrological restoration is urgently needed to take care of the affected forests in order to rehabilitate the ecological functions of these peatland forests and to support their sustainability. Future research is needed to understand the most suitable peatland water table for peatland forest and other land covers to support peatland restoration and conservation.

IV. CONCLUSION

Establishment of drainage ditches/canals in the opened/agricultural peatland landscape decreased peatland water table levels in the area. However, it had significant effect on stand growth in nearby peatland forests within the same landscape, even though the peatland forests themselves were not changed to other land uses.

Decreasing water table levels in the forest reduced tree growth rate individually especially for larger trees (diameter>20 cm) yet concurrently reduced their rate of tree mortality. These results imply that management of degraded peatland forests has to focus more on attention to forest land cover and land use changes (e.g. to small and large scale agriculture, plantation, or other purposes) in the peatland surrounding the forest, especially their effects on the alteration of the hydrological conditions which influence tree growth and mortality within the forest ecosystem. A well-managed water level (e.g. maintained by overflow dams) is urgently needed for the affected forests in order to restore the ecological functions of the forest and to support forest growth, health, and sustainability.

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NON-TIMBER FOREST PRODUCT (NTFP) COMMODITIES HARVESTED AND MARKETED BY LOCAL PEOPLE AT THE LOCAL MARKETS IN MANOKWARI – WEST PAPUA

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NON-TIMBER FOREST PRODUCT (NTFP) COMMODITIES HARVESTED AND MARKETED BY LOCAL PEOPLE AT THE LOCAL MARKETS IN MANOKWARI – WEST PAPUA. The biodiversity richness of tropical forests in Papua provides substantial livelihood necessities for most forest people. This includes Non-Timber Forest Products (NTFPs), under-valued, neglected, or minor forest commodities that play a key role for the entire livelihood of the forest people. This paper highlights the diversity of NTFP marketed by the local people of Papua at traditional markets in Manokwari, West Papua. Data were collected from twenty respondents selected randomly from two local markets at Manokwari and field visits to surrounding (primary or secondary) forests, and analyzed using simple statistical analysis. The result indicates that 29 NTFPs commodities were on the market, and grouped into vegetables (9), food (4), fruit (7), medicinal herbs (4), tools (3) and addictive material (2). These commodities give alternative incomes, create unskilled jobs to the female-forest dwellers at Manokwari, and provide daily fresh vegetables and nutritious products for local customers. The marketed NTFPs are harvested from surrounding primary or secondary forest areas of Manokwari. Banana is the most favorable commodity in high demand either serving as food or fruit. Sago (*Metroxylon* spp.) is the only commodity supplied from other areas out of Manokwari, mainly from Wondama, Biak, Jayapura, and Serui. Annual events of Christmas and New Year create the highest demand for sago processed to papeda, that represent cultural or heritage food for most of the Papuanese family gatherings. Cultivation of these NTFPs has to be seriously considered for sustainable harvest due to the current extensive harvesting from the nature which will deplete the resources if no intensive cultivation carried out. To sustain availability of fresh daily needs, and provide alternative income to local people, local government, forest institutions, universities, non government organizations, and motivators need to work together to gain added value and secure sustainable supply of those NTFPs.

Keywords: Non-Timber Forest Product, local market, trade, West Papua

KOMODITAS HASIL HUTAN BUKAN KAYU YANG DIPERDAGANGKAN OLEH PENDUDUK LOKAL DI PASAR TRADISIONAL MANOKWARI- PAPUA BARAT. Hutan tropis Papua memiliki keanekaragaman komoditas hasil hutan bukan kayu yang tinggi dan mampu memenuhi berbagai kebutuhan hidup masyarakat hutan. Komoditas tersebut cenderung diabaikan dan belum dikelola dengan baik dibandingkan hasil hutan kayu, meskipun kenyataannya hasil hutan ikutan ini berperan penting bagi keberlangsungan hidup masyarakat hutan. Penelitian ini melaporkan tentang keanekaragaman komoditas hasil hutan bukan kayu yang diperdagangkan di pasar tradisional di kota Manokwari Papua Barat. Data dikumpulkan melalui wawancara terhadap 20 responden terpilih dan kunjungan lapangan, dan diolah dengan analisis statistik sederhana. Hasil penelitian menunjukkan bahwa 29 jenis komoditas diperjualbelikan di pasar lokal Manokwari, dikelompokkan ke dalam sayuran (9 jenis), bahan pangan/makanan (4 jenis), buah-buahan (7 jenis), tanaman herbal (4), alat kerajinan (3 produk), dan bahan adiktif (2 komoditas). Perdagangan komoditas ini mampu memberikan pekerjaan alternatif dan penghasilan tambahan bagi masyarakat hutan, khususnya ibu rumah tangga serta memenuhi kebutuhan konsumen akan produk-produk alami segar dan bernilai nutrisi tinggi. Pisang adalah komoditas paling popular, dikonsumsi sebagai buah-buahan atau produk olahannya. Aci sagu (Metroxylon sago) adalah satu satu komoditas berasal dari luar Manokwari, seperti dari Wondama, Biak, Jayapura dan Serui. Permintaan aci sagu mencapai

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puncaknya pada perayaan Natal dan Tahun Baru, dimana tradisi keluarga berkumpul dan merayakan kebersamaan dengan menyajikan papeda. Mayoritas, komoditas tersebut adalah hasil memanen atau memetik, dan belum adanya usaha untuk menanam atau membudidayakannnya. Untuk terus dapat memenuhi kebutuhan konsumen akan produk segar dan bernutrisi, dan memberikan alternatif pekerjaan, serta penghasilan tambahan kepada masyarakat hutan, maka pemerintah daerah, lembaga swadaya masyarakat, kalangan akademisi, dan pemangku kepentingan lainnya perlu bersinergi meningkatkan nilai tambah dan keberlanjutan produksi dari komoditas ini.

Kata kunci: Hasil hutan bukan kayu, perdagangan, pasar tradisional, Papua Barat

I. INTRODUCTION

Tropical forests have been widely acknowledged for their richness in biodiversity, social-economic roles and supporting livelihood of the forest people (Sarmah & Arunachalam, 2011), balancing global climate and carbon cycling of the universe, as well as being the source of main economic revenues for most rural people living in developing countries. Long term interactions and heavy dependence of indigenous peoples on forest resources have been widely recognized for the improvement of their livelihoods (Andel & Reinders, 2010). Tropical forests provide two main products a) timber, the main or major product, and b) non-timber forest products (NTFPs), the minor or even inferior products. Even though these two forest products are renewable or sustainable products their differences and similarities are very obvious or contradictory (Wahyudi, 2013).

With respect to their economic contributions, timber production is measurable but not NTFPs. More importantly, their ecological, social, and biological values, as well as economic values are contradictory to one another. Timber harvesting or production requires intensive capital investments, resulting in environmental damages, as well as disturbances to the remaining forest ecosystem. On the other hand, the impacts on the environment of harvesting NTFP and the remaining forest ecosystem are much less than those of timber forest products (Arnold & Perez, 2001). More importantly, the ecological, social, biological and economic values of NTFPs are tremendous and immeasurable. It seems that the net values of NTFPs are bigger than those of timber (Rositawati & Effendi, 2013; Wahyudi, 2013).

Papua Island consists of Papua and West Papua provinces. It has evergreen forest called Papuasia tropical forest with an area of 41.5 million ha. The Papuasia tropical forest is one of the mega-biodiversity hot spots left on the Earth and becomes the last World Heritage, on which the future of medicinal treatment, illness, and drug development are relying (Wahyudi, 2012). Papuasia tropical forest produces high-value, beautifully decorative timbers, such as merbau (*Intsia* spp.), matoa (*Pometia* spp.), dao (*Dracontomelum edule*), and others. The NTFPs, which have already been acknowledged and used widely for medicinal purposes, are red fruit (*Pandanus conneideus* L.), mahkota dewa (*Phaleria macrocarpa* (Scheff) Boerl), sarang semut (*Myrmecodia tuberosa*), and kantong semar (*Nepenthes alata*).

Papua Island is inhabited with various ethnics, including indigenous people speaking 307 languages and consisting of 300 ethnic groups (Language Centre of Papua and West Papua, 2013). They live mostly close to the surrounding tropical forests, and frequently called "forest people" (Wahyudi, 2012) or "forest dwellers" (Arnold & Perez, 2001). These indigenous people depend heavily on these forests for variety of reasons, like food, vegetables, fruits, fresh fish and meat, as well as instant and attractive additional income (Pohle & Reindhardt, 2004). Harvesting forest commodities of NTFPs are relatively easy work to be carried out with no high-skills and special tools are needed. For most indigenous people, forest harvesting is also one of their alternative jobs, in combination with other activities such as fishing, hunting and shifting cultivation.

Food and Agriculture Organization (FAO) (1998) has acknowledged that regarding their end utilization, NTFPs commodities can be grouped into five purposes, food and their derivative products, ornament of plants, wild animal and their products, non-wood construction material, and bio-organic material. Whereas, for economic, as regards usages and market analysis, NTFPs are divided into three categories, like subsistence level (for own consumption), local used-level, and commercial level. In Manokwari, West Papua, diverse NTFPs are harvested and sold at local markets, the place, where local people, forest harvesters, and local consumers make social contacts and interactions. They provide daily income and subsistence work for the indigenous women. They also become the important sources of fresh nutritious food for local communities. They are complementary to those from agriculturally cultivated food or vegetables. Diversity of NTFPs, traded at local markets in Manokwari, their roles to income generation and creating alternative works to the local people, and the NTFPs commodities with highest demands are not studied intensively yet. Therefore, this paper present the diversity of non-timber forest products harvested and marketed by the local people at two local markets in Manokwari, West Papua. The roles of NTFP commodities in the daily income of the indigenous people or alternative works, and the potential efforts contributing to the sustainability; even production and supply, as well as market chain of the favored NTFP.

II. MATERIAL AND METHOD

Research was conducted at two local markets, Sanggeng and Wosi, representing traditional and typical markets at Manokwari, West Papua. Wosi (S 00° 51`58".3, E 134° 03`58".1) is approximately 3 km away from Sanggeng (S 00° 52`04".6, E 134° 03`04".6). This research was conducted in 2013, and completed in two months period. Twenty female respondents, all indigenous people of Papua acting as both suppliers and sellers, were selected purposively according to their NTFP sold. Survey and field visits were conducted to examine the state of the forest areas, where the NTFP were mostly harvested and gathered. The collected data were tabulated and analyzed using simple statistical analysis.

III. RESULTS AND DISCUSSION

A. NTFP Commodities

The results show that 29 NTFP commodities were recorded by this research, and grouped into vegetables (31%), food (14%), fruits (24%), medical herbs (14%), tools (10%), and addictives (7%). These commodities are fewer compared to those reported by several other studies. Pohle and Reinhardt (2004) reported that 120 plant species were taken from forest and used in the Nangaritza valley, Southern Ecuador, mostly used for food (27%), medicine (16%), and construction (27%). Collin, Martins, Micthell, Teshome, and Arnason (2006) reported that 86 medicinal plants mostly forest vegetation were reported and used in East Timor, ranging from bark, root, stem, leaves, sap, fruit, flower, and wood. The diversity of NTFPs commodities harvested and sold by the local people at the two local markets in Manokwari, West Papua, are illustrated in Figure 1.

Figure 1 shows that numbers of NTFP commodities of vegetables, addictives and food sold at the two local markets, Wosi and Sanggeng, are similar to one another. Vegetables and fruits, consisting of 9 and 7 commodities, respectively, are the two dominant NTFPs, among the others. These vegetables are mostly leaves of wild plants growing in the primary or secondary forest areas. The five favorite vegetables of the customers are leaves of gnemo (*Gnetum gnemon* Linn), fern leaves (*Diplazium esculentum*), young leaves of pakis (*Cyathea contaminans*), gedi leaves (*Abelmoschus manihot*), and cassava leaves (*Manihot utilissima*). These vegetables are rich in vitamin, good sources of antioxidant (Widowati, Safitri, Rumumpuk, & Siahaan, 2005), and protein

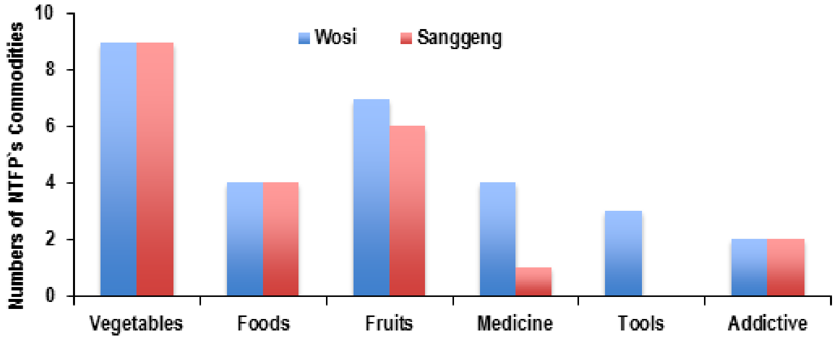


Figure 1. NTFP commodities harvested and sold at the two local markets in Manokwari

(a)

(b)

Figure 2. Fern leaves (a), and cassava leaves (b)

(Khang, Wiktorsson, & Preston, 2005). Fern and cassava leaves are shown in Figures 2a and 2b, respectively.

Local people plant cassava crop for two purposes: 1) narrow leaves for production of vegetables, and 2) broad leaves for producing tuber. It is very important to highlight that indigenous people grow plants for different purposes. For example, cassava planted for producing leaves is different than those planted for producing tuber. Similarly, *Carica papaya* planted for producing leaves or flower are different than those planted for producing fruits. From these practices, it is clear that local knowledge in growing plants for certain purposes does exist in West Papua. It is obvious that harvesting leaves frequently of cassava in big volumes will have a physiological impact on this plant to produce tuber (Khang et al., 2005). Therefore, to get maximum leaves and tubers, the local people plant two different cassavas, one for leave production and another for tuber production. These practices are also applied for *Carica papaya* (Zhou, Christoper, & Paull, 2000).

Fresh, un-cultivated, or wild mushroom and bamboo shoot were also sold at both traditional markets. The two wild mushrooms are compost and wooden mushrooms, and are available mainly during the rainy season, but bamboo shoots are available through the season. The wooden mushroom is initiated by felling suitable host trees for mushroom substrates, and compost mushroom grow naturally at any compost litter on forest floor. Mushrooms are rich in protein (Mayun, 2007) and bamboo shoot is effective as anti-cholesterol (Park & John, 2009).

All NTFP commodities are harvested from

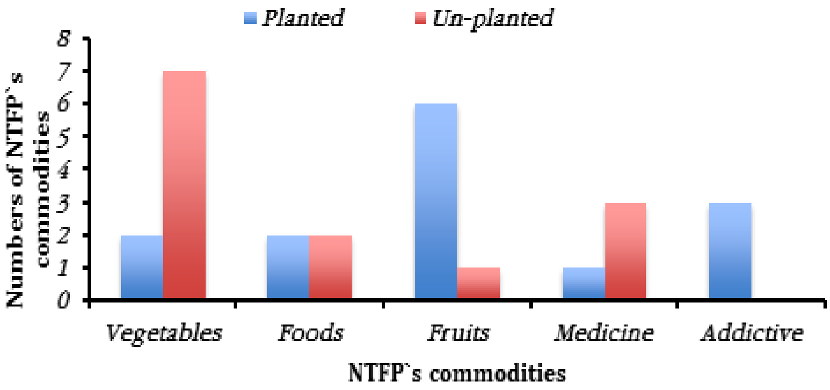


Figure 3. Planted and not planted NTFP commodities

(a)

(b)

Figure 4. Addictive commodities of pinang (a) and sirih (b)

Manokwari and its surrounding areas, but sago (*Metroxylon* sp.) is the only commodity supplied from outside, such as Wondama, Biak, Jayapura and Serui. It is probably due to the fact that those areas are locally known as producer of the best quality sago. As a traditional food, sago is recently disappearing from the traditional market. Best price and high demand of this commodity is close to December, where Christmas and New years Eve are celebrated by most local people, thus the annual time for family gathering.

B. Planted and Not Planted Commodities

To ensure the sustainability of NTFPs for the next harvesting seasons, cultivation must be carried out as these commodities are planted for earning cash (Kunio & Lahjie, 2015). However, intensive cultivation of planting, weeding, pruning, fertilizing the plants is not common practices for the local people. They mostly do only enrichment planting or replacing old plants, and leave them grow naturally. These practices are not recommended for long term use as these commodities will be extinct or absent to supply local consumption. Presumably most of the daily NTFP commodities growing in the forest have the ability to renew themselves for the next harvesting season (Arnold & Perez, 2001). Sustainable harvest of renewable NTFPs can contribute to the economic well-being of the forest people and involving them in conservation of the biodiversity (Shankar, Murali, Shaanker, Ganeshaiah, & Bawa, 1996). Therefore, levels of extraction, replantation, and enrichment planting are necessary to prevent the loss of these commodities in the future (Perez & Byron, 1999).

The number of planted and not planted NTFP commodities is shown in Figure 3.

This figure clearly indicates that vegetables are mostly harvested from wild plants, where seven of nine vegetables are not planted, ranging from gnemo (*Gnetum gnemon*), fern (*Diplazium esculentum*), pakis (*Cycas* sp.), gedi (*Abelmoschus manihot*), *Carica papaya*`s flower, bamboo shoot, and edible mushroom. These vegetables are classified as wild edible NTFPs that are commonly collected from the forests for self-subsistence, as well as for cash generating income (Sarmah & Arunachalam, 2011). The two-planted vegetables are *Cassava* sp. and *Carica* sp. for producing leaves.

Figure 3 also highlights that NTFP for daily consumption that are available through the season are mostly not planted. Due to their natural potentials, fast growing recovery, and distributed anywhere, they are harvested directly from the secondary forest. Local people usually have several locations for communal territory, where all members of the local community could harvest proportionally both for family consumption and selling for cash. On the other hand, fruits and additives (Figures 4a and b), are two commercial NTFPs for earning cash for local people, and only belonging to the owner of the land. In addition, two other planted vegetables of *Cassava* sp. and *Carica* sp. are planted on any marginal or un-attended land by local people, and only the grower could harvest.

Fruits and additives commodities are mostly planted to earn family income. Durian (*Durio zibethinus* L), rambutan (*Nephelium lappaceum* L.), and avocado (*Persea americana* Mill.) are very attractive fruit commodities to earn money for the local people. While pinang (*Areca catechu* L.) and sirih (*Piper* sp.), as shown in Figure 4a and 4b, respectively, are the two most favorite addictive commodities for the local community. These commodities are contributing to the dirtiness of public places or offices due to producing a red-resistant and sticky color. Local people ranging from children to adults mostly consume or become addicted to these commodities.

Figure 4 represents two complementary addictive commodities, namely pinang fruits with cooked lime (Figure 4a), and fruit of sirih (*Piper* spp.). When the demand of these commodities is very high, these commodities are supplied from outside Manokwari. Pinang fruits are sometimes replaced by dried gambir (*Uncaria gambir* Roxb.) fruit.

C. Harvesting Season

Harvesting season refers to the time period of harvesting, which is divided into two categories, all seasons and seasonal. All seasons mean that the commodities are available throughout the year, while seasonal refers to a definite time of harvesting. Availability of NTFPs or harvesting times, are summarized in Figure 5. It shows that NTFP commodities are mostly available throughout the season. The vegetable that is available all seasons is wild mushroom, while two fruits that are available all seasons are banana (*Musa* spp.) and markisa (*Passiflora quadrangularis* Linn.)

As these commodities are mostly available for harvesting throughout the season, it clearly shows that local people do not experience shortage to the next harvesting. The volume of harvest is quantifiable to their personal capacity and capability, availability of NTFP, as well as market demands. With these approaches, the indigenous peoples are quite reasonable in balancing the production, supply, and demand of the local markets. This means that local people always quantify their NFTP harvest based on their own carrying capacity and the income that could be earned. Complexities of walking tracks or accesses, capacity limitations as well as the next harvesting period are variables for avoiding over harvesting despite market demanding. To sustain productivity and sustainability, local people avoid over extraction or harvest of NTFP commodities (Ros-Tonen, 2000). It seems that this traditional and ancient knowledge of utilization of natural resources reflects the indigenous policy of sustainable management and utilization (Andel & Reinders, 2010; Sarmah & Arunachalam, 2011).

It is also supported by the facts that local people have more than one location

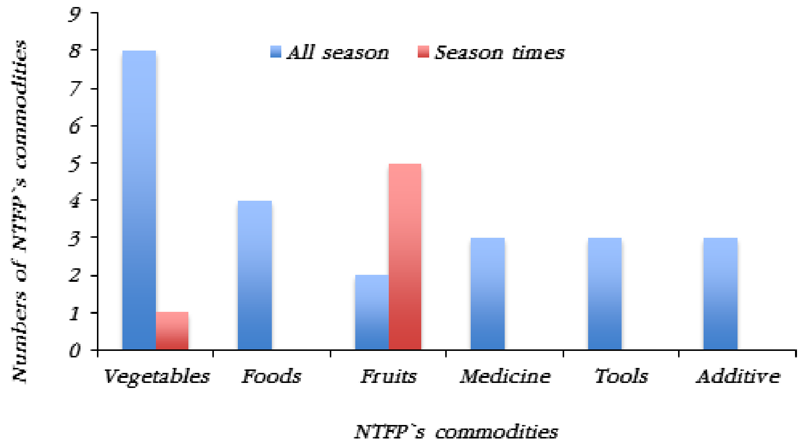


Figure 5. Harvesting seasons for NTFP commodities

for harvesting and collecting these NTFP commodities. They always harvest their commodities using a rotation scheme. Forest dwellers come to the commodities suitable for harvesting, and go to other commodities and locations for the next harvesting, and finally harvesting is back to the first commodities or harvesting cycle or rotation. This is quite reasonable as this method is easy to do, need unskilled work, small investment, low risks, and no special tools are needed. Therefore, in this case NTFP extraction is likely more familiar than other skilled works for forest dwellers.

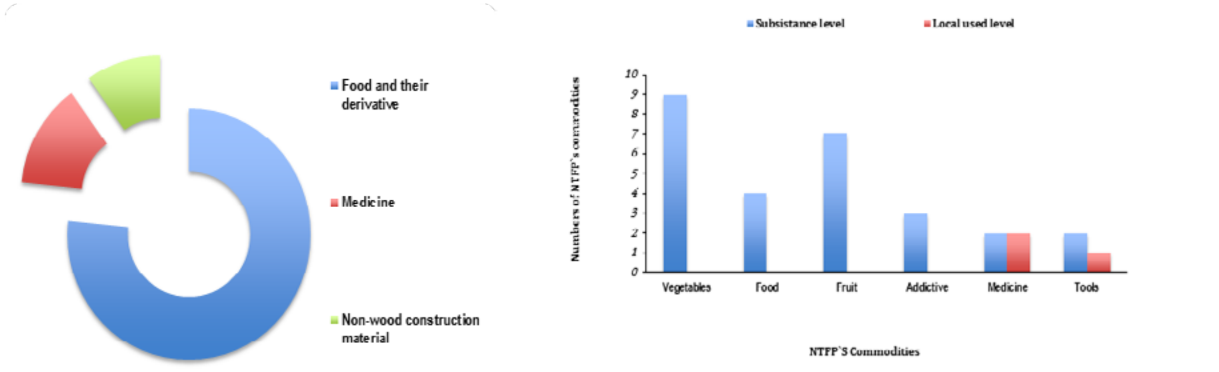
D. Food and Agriculture Organization (FAO) classification for NTFPs

FAO (1998) classified NTFPs according to their end usages into 5 (five) classes, ranging from food and their derivatives, ornamental plants, wild animal and their derivative products, bio-organic chemical, to non-wood construction material. Whereas, for economic, scale of usages, and market analysis, they can be grouped into three levels, subsistence level, local-used level, and commercial level, respectively. Accordingly, the NTFP harvested and marketed at the two local markets in Manokwari town can be summarized as shown in Figures 6a and 6b, respectively.

Figure 6a clearly illustrates that 77% of NTFP commodities sold by the local people at the two local markets in Manokwari belong to food and their derivative products. Mostly, they are fresh-green ones, which have just been harvested from the surrounding forests, then transported directly to these local markets. According to FAO (1998) classification, these NTFP commodities are dominated by subsistence commodities, and two commodities of medicine, red fruits and lawang`s root *Cinnanomum culilawan*, and tool (bamboo comb) are classified to locally used-level commodities. The NTFP commodities are in majority daily consumable goods and categorizes as subsistence level. These findings highlight that they are consumed directly after being harvested from the forest or sold in fresh condition to earn money to meet the daily expenses of the forest dwellers (FAO, 1998).

E . Local Prices and Scales or Values

The NTFP commodities marketed at the two traditional markets in Manokwari town employ a local or bargained standard or values, like bunch for vegetables, stacking of fruits or population (packet of 10 pinang, 20 sirih and a sachet of cooked limed (Figures 4a and 4b), for addictive commodities. Common scales like kilogram (kg), or gram (gr) are not used frequently. Regular price for a bunch of vegetables is Rp 5.000 (five thousand Indonesian rupiah), equal to $US 0.52 on average. During harvesting time, approximately 50 bunches of two or three different vegetables are prepared. One-cluster cooking banana, consisting of 10-15 bunches,



(a) (b)

Figure 6. Classification of NTFPs according to their end usages (a) and market analysis (b)

has a price of Rp 150,000 – 200,000, and one-pile mushroom is Rp 5,000, which is enough to make fried vegetables for two persons.

Processed medicinal plants of Red fruit raw extract and a bag of dried-raw Sarang semut were the most expensive NTFP commodities, at a price of Rp 60,000 – 75,000 for 650 ml of red fruit extract, Rp 75,000 (black) and Rp 150,000 (white) for Sarang semut, respectively. Forest dwellers could earn approximately Rp. 350,000 – 650,000 for a single trip to these two local markets, including transportation and meal cost. They could earn a net income from Rp 200,000 to Rp 500,000 on average or fluctuating from Rp 500,000 to 1,500,000 when the commodities marketed are mostly fruits and additives.

The local people involved in these NTFP commodities are old women, mostly from Biak, Wondama, Serui, Sorong, and Manokwari itself. However, those from mountainous areas are major sellers at Wosi traditional market, while those from low land areas surrounding Manokwari are at Sanggeng market. Several non-indigenous people are involved in selling addictive commodities, and two indigenous people are also selling processed medicinal plants, but they are just selling, without processing them. Indigenous people harvest their NTFP commodities from the forest areas, and grouped into vegetables, food, or fruits, using plastic bag made from recycled rice pack, and directly transported to the local market by car, urban transportation. Stacking, bunching, and dividing of commodities are done at the markets. They sell their commodities by themselves. On the other hand, half processed products of medicinal plant, like Red fruit, dried-sarang semut, and roots of Lawang, are brought from the home processed industry, and sold to the consumer by the local people.

These findings highlight that intensive training on small entrepreneurship for local people are necessary to maximize the added value of their medicinal plant commodities. Also, post harvest treatment, packaging and labeling are such efforts that could be provided to support the local people to optimizing profit from their NTFP commodities harvested from their own forest.

IV. CONCLUSION

Papuasia tropical rain forest provides substantial and never-ending support to the local people, including consumable products called Non-Timber Forest Products (NTFP). These products also provide substantial nutrition not only for the forest people but also to the local community of Manokwari. For local people, harvesting and selling NTFP commodities could provide instant income, offer alternative work, and earn money to cover their daily expenses.

It is highlighted that in the future NTFP supplied from the natural forest will decrease if intensive cultivations or re-planting are not undertaken by the local people to ensure that the supply of NTFP commodities of vegetables, fruits, foods are continuously available when needed. This is important not only to secure the income generating sources and alternative works of the indigenous people but also the demand of local communities with green, fresh and nutritious commodities with reasonable prices.

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GIS BASED FLOOD HAZARD AND VULNERABILITY MAPPING: A CASE STUDY OF TIDAL AND RIVER FLOODS IN DOWNSTREAM OF CIASEM WATERSHED, SUBANG-WEST JAVA

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GIS BASED FLOOD HAZARD AND VULNERABILITY MAPPING: A CASE STUDY OF TIDAL AND RIVER FLOODS IN DOWNSTREAM OF CIASEM WATERSHED, SUBANG-WEST JAVA. Flood events in downstream of Ciasem watershed are believed to occur due to degradation of watershed and mangrove cover. This paper studies the flood hazard and vulnerability caused by tidal and river flood, mainly on vegetation and built up areas as the main element of risk. The observation was focused at downstream of Ciasem watershed, located in MuaraVillage, Blanakan subdistrict, north coastal region of Subang District. Tidal flood hazard was mapped using iteration process in ILWIS 3.4 software while river flood hazard map was made up incorporating elevation, slope and river characteristics using hydrological tools (HEC-geo RAS and HEC-RAS) in ArcGIS 10 software. Those hazard maps were then utilized to determine element of risk covering vegetation and built up areas. Result showed that tidal inundation started to happen in the western area dominated by fish ponds as the main element of risk.When sea level rose up to 90 cm height, settlement areas were experiencing inundation by tidal flood. Ciasem River began to over flow when the river discharge exceeded 160 m^3 sec^{-1} and inundated the paddy fields, fish ponds and settlements. This study indicated that fish ponds and paddy fields having high vulnerability to the flood event while that of settlements and roads depend on the construction materials. Flood disaster risk should be reduced by continuing the land rehabilitation activity, restoring mangrove vegetation, implementing government regulations on management and establishment of aquaculture in mangrove, and carefully considering the construction of coastal protection barriers.

Keywords: Hazard map, river flood, tidal flood, vulnerability map, watershed

PEMETAAN KERAWANAN DAN KERENTANAN BANJIR MENGGUNAKAN SIG: STUDI KASUS BANJIR ROB DAN BANJIR SUNGAI DI HILIR DAS CIASEM, SUBANG-JAWA BARAT. Kejadian banjir di hilir DAS Ciasem diyakini terjadi akibat degradasi DAS dan tutupan mangrove. Tulisan ini mempelajari kerawanan dan kerentanan yang disebabkan banjir rob dan sungai, terutama pada daerah bervegetasi dan daerah terbangun sebagai elemen utama risiko. Pengamatan difokuskan pada hilir DAS Ciasem, terletak di Desa Muara, Kecamatan Blanakan, di pesisir utara Kabupaten Subang. Kerawanan banjir rob dipetakan menggunakan proses iterasi pada software ILWIS 3.4, sedangkan kerawanan banjir sungai dibuat dengan mempertimbangkan elevasi, kemiringan dan karakteristik sungai menggunakan perangkat hidrologi (HEC-geoRAS dan HEC-RAS) pada software ArcGIS 10 Peta kerawanan tersebut digunakan untuk menentukan elemen risiko yang mencakup daerah bervegetasi dan daerah terbangun. Hasilnya menunjukkan banjir rob mulai terjadi di daerah bagian barat yang didominasi tambak sebagai elemen risiko utama. Ketika permukaan air laut naik 90 cm, permukiman mengalami genangan akibat banjir rob. Sungai Ciasem mulai meluap ketika debit aliran melebihi 160 m^3 *detik*$^{-1}$ *dan menggenangi sawah, tambak, dan pemukiman. Penelitian ini menunjukkan bahwa tambak dan sawah memiliki tingkat kerentanan tinggi terhadap kejadian banjir, sedangkan pada permukiman dan jalan tergantung pada material konstruksinya. Resiko bencana banjir seharusnya dapat dikurangi dengan melanjutkan kegiatan rehabilitasi lahan, merestorasi mangrove dan menerapkan aturan pemerintah dalam pengelolaan dan pembangunan.*

Kata kunci: Peta kerentanan, banjir rob, sungai, DAS Ciasem, GIS

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I. INTRODUCTION

Coastal management should be wisely done as a part of watershed management. Weak and ineffective control of human activities in watershed management areas such as forestry, agriculture, mining, industry, or other sectors will likely decrease the quality of the environment. Water pollution, erosion, sedimentation, land subsidence, seawater intrusion, shoreline change, silting-up of river estuary, and mangrove degradation are some indicators of environmental degradation found in downstream of watershed. Various materials are contained in the surface runoff flowing from upstream to the coastal area. Some of the materials may increase agricultural soil fertility in downstream area, but on the other hand sedimentation also speed up shallowing of river estuary that trigger flood events in coastal areas (SIPLA, 2012; Valiela et al., 2014).

Based on the typology, a coastal area has high flood hazard due to low land area that can be below mean sea level, and become an area of river estuary (Mardiatno et al., 2012). River flood (discharge overland flow) or known as delivered flood is caused by surface runoff as a part of the rainfall that flowing from the land to the river system and finally reach peak discharge that cannot be contained by the river channel. River flood in downstream watershed is relatively intense compared to the middle or upper watershed because the slope gradient is relatively low. Beside of river flood, coastal area with low slope gradient is also familiar with tidal flood that mainly happens during high seawater level when areas lower than mean sea level are flooded. The tidal floods are frequently caused by deforestation of mangrove forest and the impacts of flooding can be seen as settlement submergence, house damage, and landscape deformation (Munji et al., 2013). Higher hazard will be happening when river flood and tidal flood occur in the same time.

In the disaster risk management, the risk caused by flood can be reduced or minimized by mitigation actions started with analysis and mapping the vulnerability of the elements at risk. Flood vulnerability analysis using Geographical Information System (GIS) and remote sensing combined with field validation can be done rapidly, easily, and to improve the accuracy of the map. The vulnerability assessment can be assessed with geographical, physical, social, or economic aspects. A flood vulnerability map can be utilized by stakeholders as a consideration in decision making during, before, or after flood events.

This paper studies the level of vulnerability of flooding in coastal areas with major elements at risk being cultivation and built up areas. By knowing the level of flood vulnerability, the government and the community can better anticipate handling of the flood disaster and flood victims so that losses can be minimized. In this study, flood vulnerability assessment will be limited to the geographical aspects of the physical elements of cultivated and built up areas.

II. MATERIAL AND METHOD

Materials used in this study were digital topographical map 1:25000, Quickbird satellite imagery acquired from Google Earth with 2,4 m spatial resolution. The equipments used were soil core samplers, plastic bags, soil drill, GPS, voice recorder, stationery, computer software, and field equipment. The study was located at downstream of Ciasem watershed, and was administratively situated in Muara Village, Blanakan Sub-district, north coastal region of Subang District. The northern coast of Java commonly has inter-tidal swamp formation. This downstream watershed is draining water from two main rivers namely Ciasem River and Cijengkol River. Based on the geologic map of the Pamanukan Quadrangle, Jawa 1209-6 scale 1:100000, the area is composed of river deposits (Qa) consisting of silt, sand, clay, mud, gravel, and sediment of Gempol coastal swamp (Qac) which consists of fine sand, silt, shells of mollusks, and coral. Soil in the downstream area is dominated by alluvial types (Abidin & Sutrisno, 1992).

Tidal flood hazard was mapped using

iteration (looping) technique which was operated in ILWIS 3.4 software. The iteration is a mathematical calculation repeatedly using the previous result as an input for the next calculation until the required results are achieved. Inputs used in this operation were pixel values of digtal elevation map (DEM) showing the land elevation, and data of sea water level. DEM was built from elevation points derived from topographical map at the scale of 1:25000 and detailed elevation points from design map of Ciasem River flood control infrastructure at the scale of 1:2000 (Balai Besar Wilayah Sungai (BBWS) Citarum, 2007). By adding the 29 elevation points from field measurements to the data set those elevation points were interpolated using a moving average technique to produce a digital elevation model (DEM) map. The simulations started from the coastline map as the start folder of iteration. Based on data of the rise in sea level, tidal flood inundation was simulated starting with 10 cm rise in sea water level, then by 20 cm, and continued up to the level when the sea water rise was inundating all of the study area. The resulted raster maps were exported to vector format and overlayed with land cover map to determine the area of each type of inundated land cover.

Soil characteristic plays an important role in predicting the length of inundation or the permeability of the soil. This characteristic is related to the texture of the soil and will also affect soil saturation. Clayey soil absorbs water slower than sandy or loamy soil, therefore it has slower permeability and remain saturated much longer (Sutter, 2008). In this research, soil permeability was measured through laboratory analysis of undisturbed soil samples. A total of 24 soil samples were collected using soil core sampler up to 15 cm depth. The sampling points started from the coast line up to 4.7 km inland. Disturbed soil samples for soil texture analysis were also taken at the same points. Approximately, 1 kg of soil per sample point was placed into a plastic bag and labeled.

Flood hazard areas due to river overflowing were identified by hydrological modeling based on elevation, slope, and river characteristics using hydrological tools (HEC-geo RAS and HEC-RAS) in ArcGIS 10 software (license number 445095). Data and maps of river geometry such as main channel of the river, cross sections, river banks, downstream reach that had been prepared in ArcGIS were exported to be processed in HEC-RAS tool. Cross sections of Ciasem River channel were made at 6 points of river stations (RS). Sequentially point 6 is the first point at downstream. This model used river discharge at upper part as an input, and the output will give information of the flood water characteristics such as extent, height, and current speed.

Since inundation areas and flood height map from previous flood events were not available, the flood height model was quantitatively validated. The validation was done by showing map result to the local community and assessing whether the map extent were in agreement with flood situation as stated by the respondents (Webster & Forbes, 2006). Respondents involved in this validation process were 13 households including one village officer whose job was to take care of disaster victims. Flood event information from one person was always crosschecked against other respondents. Respondent's statement on flood height could be amplified by showing flood mark on the house wall.

Based on the flood-hazard map, delineation of the elements at risk will be performed in the form of vegetation and built up areas. Land use affected by the flood was delineated by overlaying the landuse map with flood hazard map. The boundaries of vegetation and built-up areas as element at risk were studied in this research and were determined through on-screen digitization of Quickbird satellite imagery. Each type of vegetation and built-up area was assessed through field survey. The results of this assessment will be mapped into a flood vulnerability map and analysed spatially to determine the area of each vulnerability level. Vulnerability level shows the loss or damage degree of certain element at risk from occurrence of the flood.

III. RESULT AND DISCUSSION

Flood assessment showed that in the Muara Village, there are two sub villages (kampung) that are often flooded by tidal flood or river flood namely Sindang Laut 1 and Sindang Laut 2, so the physical vulnerability assessment has focused on the elements at risk in both kampungs. The land use of those kampungs was dominated by fish ponds. Settlement areas were located around Ciasem river bank together with paddy field. Details of land cover in the study area are based on high resolution satellite imagery and the result of interpretation is presented in Figure 1.

Analysis of disturbed soil samples showed that the soil in this area has a heavy texture characterized by a high content of clay. Based on the composition of sand, silt, and clay the soil was classified within the class of clay to clayey loam. Only in one soil sample dominated the sand fraction.The easeness of the water to drain into the soil was predicted by permeability measurement of the soil samples. The result of soil permeability measurement ranges from 0.3 to 5.0 cm/hour. High permeability is usually found in soils with light texture or soil that has many pores for drainage. The permeability

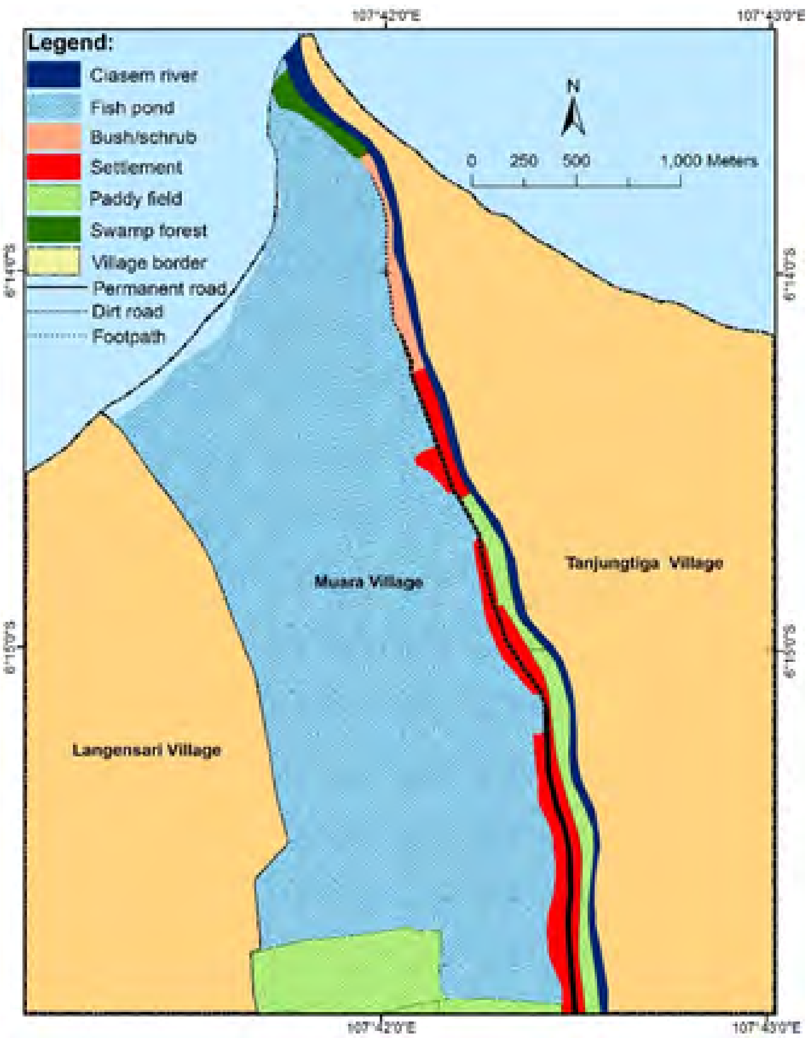

Figure 1. Landcover of Muara Village

values were interpolated to obtain a soil permeability map, and it was used to predict the duration of flood inundation.

A.Tidal Flood Hazard

Tidal flood occurred in the study area is affected by the rising of the sea water level due to daily tides, rising of sea wave height, or a combination of both. Data of the level obtained from Tanjung Priok tidal station belonging to the Geospatial Information Agency showed that the lowest sea water height was 13 cm and the highest was 112 cm. Wave height data of the West Java northern coastal area based on publication of the Meteorological, Climatological, and Geophysical Agency (BMKG) showed that wave heights were of 2 to 3 m with the maximum value reaching 6 m (Ristianto, 2011).

Simulation started with 10 cm rise in sea water level and this study showed that the 160 cm sea level rise would inundate the whole area of kampung Sindang Laut 1 and Sindang Laut 2. Some results of the inundation map generated in each scenario of sea level rise are presented in Figure 2.

Area inundated by tidal flood begun at the northern region and at the 70 cm sea level simulation, the inundation occurred in the western area. Settlements were inundated after sea level rising reached 90 cm. The area inundated by tidal flood for each land cover can be seen in Table 1.

Fish ponds were the largest area of elements at risk inundated by tidal flood. This inundation caused huge losses for the farmers due to damages to pond embankment and loss of cattles. Paddy fields were also an element that was widely affected by tidal flood. At the growing season period, sea water inundation will cause the paddy plants to die. Many farmers have converted their paddy fields into fish ponds due to tidal flood events are getting worse from year to year.

Tidal flood that occurred in the coastal area of Subang may be caused by the accumulation of several factors, such as rising of sea level, conversion of mangrove areas/coastal forests,

Table 1. Area inundated by tidal flood for each land cover

Sea water rising (cm)	Inundated area (ha)					Total
	Bush/schrub	Fish pond	Swamp forest	Settlement	Paddy field	
10	-	187.0	-	-	-	187.0
20	-	187.0	-	-	-	187.0
30	-	187.0	3.7	-	-	190.7
40	-	222.7	4.3	-	-	227.0
50	-	222.7	4.3	-	-	227.0
60	5.8	253.2	4.3	-	122.6	386.0
70	5.8	319.5	4.3	-	236.0	565.7
80	5.8	614.1	4.3	-	236.0	860.3
90	5.8	836.7	4.3	-	236.0	1082.9
100	5.8	1042.9	4.3	56.0	317.3	1426.6
110	5.8	1042.9	4.3	57.9	375.4	1486.5
120	5.8	1042.9	4.3	57.9	375.4	1486.5
130	5.8	1042.9	4.3	57.9	375.4	1486.5
140	5.8	1494.5	4.3	57.9	483.8	2046.4
150	11.7	1573.4	4.3	137.0	486.7	2213.3
160	11.7	1749.5	4.3	153.3	489.3	2408.4

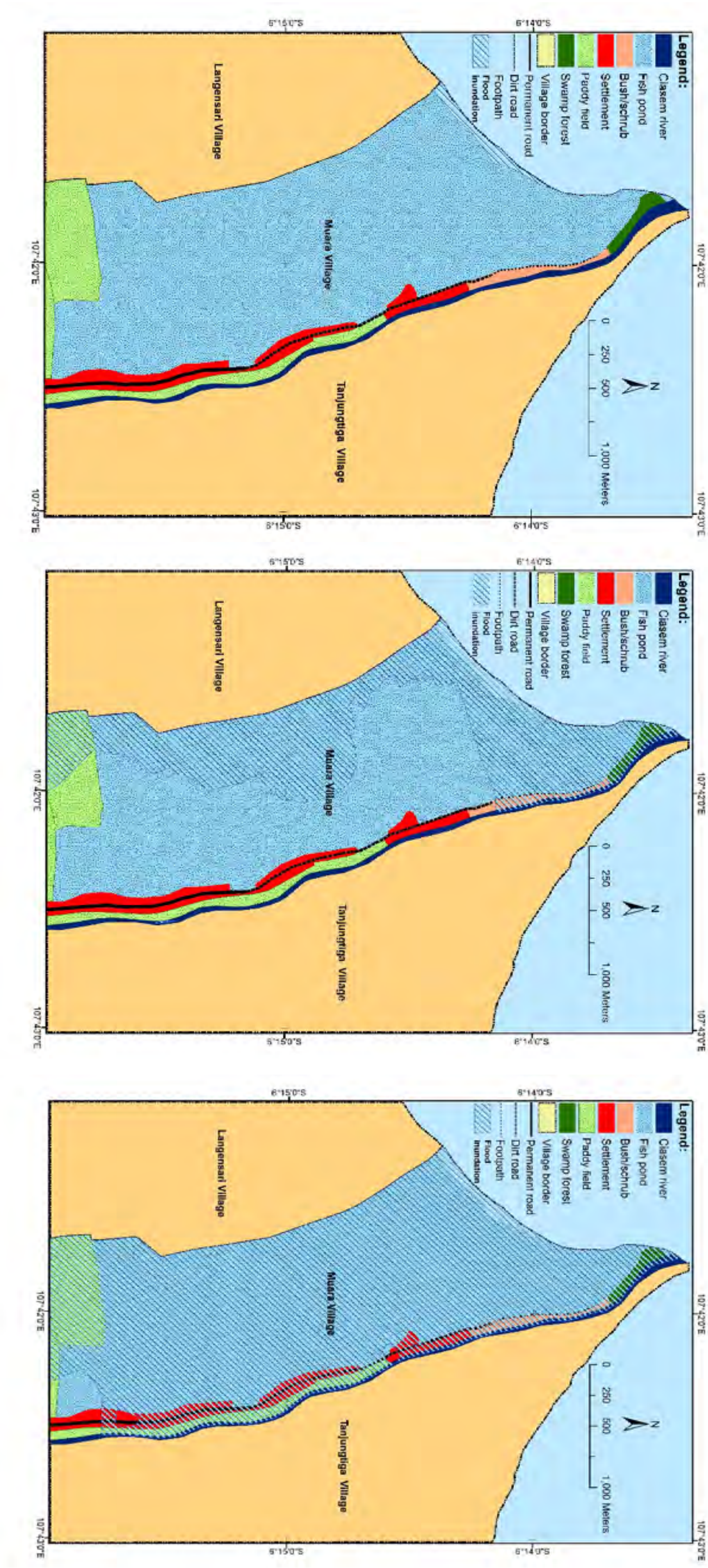

Figure 2. Some maps of tidal flood inundation for each sea-level rise

or any change in coastline due to abrasion or accretion. Sea level rising is the increase of the average sea water level from a reference point on the land as a result of increasing volume of sea water. Based on data of Topex/Poseidon, Jason 1, and Jason 2 satellites, sea level change in the period 1992 – 2012 reach up to 12.9 mm yr^{-1} with an average of 6.9 mm yr^{-1} (Hartanto et al., 2013). This increasing volume can be caused by thermal expansion of sea water due to rising temperatures and melting of glaciers and ice in polar areas (Nurmaulia, Prijatna, Darmawan, & Sarsito, 2005).

Reducing tidal flood risk can be reached by biotic method by making a green belt with mangrove plants and mangrove conversion attempt to suppress existing ones. The mangrove is proven as a biotic structure to reduce sea wave impact and coastline changes. The reduction is about two times larger than area without mangroves, and the function is also effective to protect the coastline from abrasion (Soraya, Suhara, & Taofiqurohman, 2012). By planting an 80 m wide zone of mangrove forest with 0.11 trees m^{-2} (about 1.100 trees ha^{-1}) is sufficient to reduce wave height by 80% and make the method as the most natural and cheapest way to protect coastal area (Hashim & Catherine, 2013). Beside protecting coastal area from high wave, the presence of mangrove forest also offer protection from typhoon and variety of ecological services such as absorption of pollutants and purification of water (Ibharim, Mustapha, Lihan, & Mazlan, 2015).

Abiotic method can be done with technical civil buildings such as the manufacture of the beach wall, groin (coastal protection structure built jutting relatively perpendicular to the direction of the coast), jetty (buildings placed perpendicular to the coast on either side of the mouth of the river which serves to reduce the flow of sediment silting on the beach), breakwaters or offshore breakwaters made parallel to the coast at some distances from the shoreline (Wilisandy & Saputro, 2006). However, the development and selection of the construction type should be considered carefully because the construction would often negatively affect other sides of the shoreline (Hildaliyani, 2011).

B. River Flood Hazard

Flood hazard mapping due to overflowing of river water was carried out by hydrological

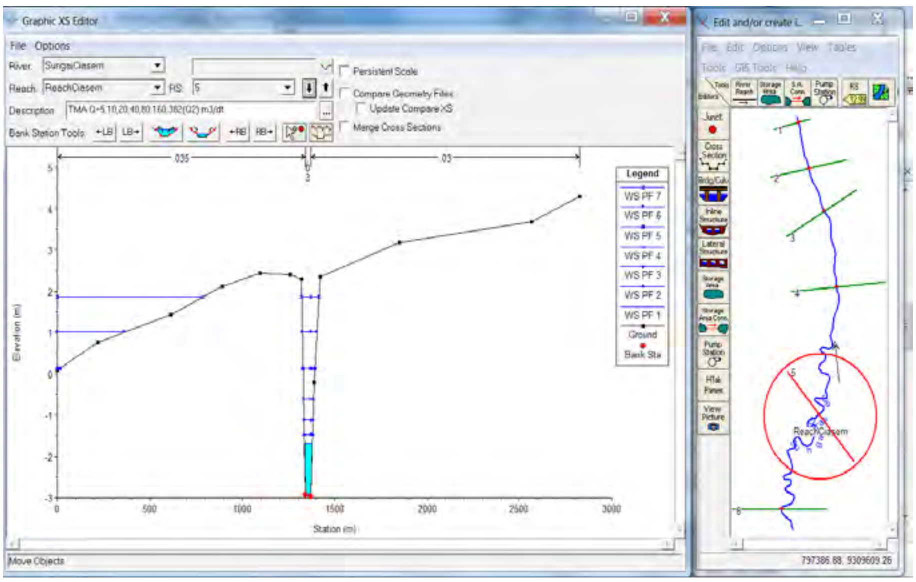

Figure 3. HecRAS output at RS 5 as a result of the first scenario

modeling. River discharge on the upstream side can be determined according to the data in the field or using plan flood discharge based on specific return period. In the first scenario, seven profiles (PF 1 - PF 7) have been tested using streamflow discharge inputs of 5, 10, 20, 40, 80, 160 and 382 m^3/s, respectively. The last profil value (382 m^3/s) was intentionally used and equals the discharge of 2 year's flood return period. HEC-RAS output showed that the river flood began to occur in the profile 6 (debit = 160 m^3/s), which occurs in the area around the river station (RS) 5 as shown in Figure 3. The affected elements at risk were paddy fields, fish ponds and settlements.

In the second scenario, six profiles (PF1 - PF6), the input used maximum flood-plan discharge in the periods of 2, 5, 10, 25, 50, and 100 year with consecutive annual discharge of 382, 464, 519, 589, 641 and 693 m^3/s (Balai Besar Wilayah Sungai (BBWS) Citarum, 2007). HEC-RAS output showed that the flood started to inundate the river banks in the RS 5 for all profiles (PF) as shown in Figure 4.

Information obtained from HEC-RAS subsequently exported to ArcGIS format to map the flood area and the inundation height as shown in Figure 5. The flood inundation map was overlayed with land cover maps, and the areas of each inundated land cover were tabulated as shown in Table 2.

The best way to mitigate river flood hazard is to avoid any permanent settlement in these locations and gradually relocate the inhabitants to safer place. If relocation leads to deadlock situation, different technical protection should be done to manage the threat to the settlements, such as development of a levee system that directs the water away from the most densely populated areas or dams further upstream to absorb peak flows (Appelquist & Balstrøm, 2014). For future planning, the Government should control flooding event by allocating a buffer zone along the coastline without human settlement. Mangrove forests should be protected to minimize sedimentation shallowing the head of the estuary as a cause of flooding (Ellegaard et al., 2014)

C. Validation

Qualitative validation revealed that most of the area inundated by tidal or river flood in the map was agreed by all respondents. They remembered that during the big flood

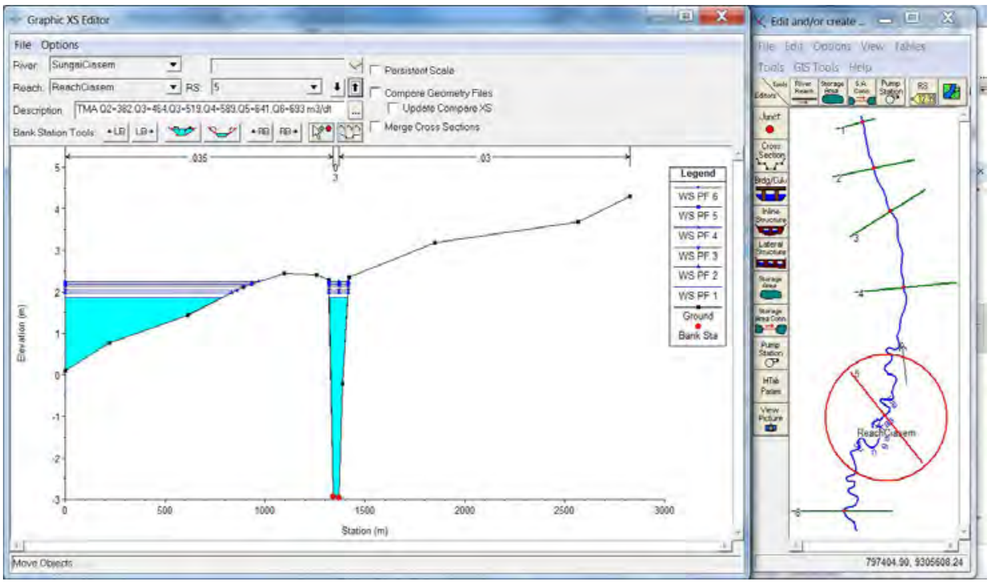

Figure 4. Inundation height on each cross section for the maximum flood-plan discharge in the periods of 2, 5, 10, 25, 50, and 100 year in river station (RS) 5

Table 2. Inundated area of each land cover type for every two years of river flood planning

Inundation height (cm)	Inundation area for each land cover (ha)					Total
	Bush/schrub	Fish pond	Swamp forest	Settlement	Paddy field	
< 40	11	815	4	45.6	369.9	1247
40 – 60	17	1039	4	45.6	369.9	1476
60 – 80	17	1262	4	45.6	369.9	1700
80 – 100	17	1622	4	97.4	390.4	2133
100 – 120	17	2359	4	155.4	443.7	2980
120 – 140	17	3255	4	246.5	564.4	4088
140 – 160	17	3324	4	292.1	730.9	4370
> 160	17	3394	4	337.7	745.9	4500

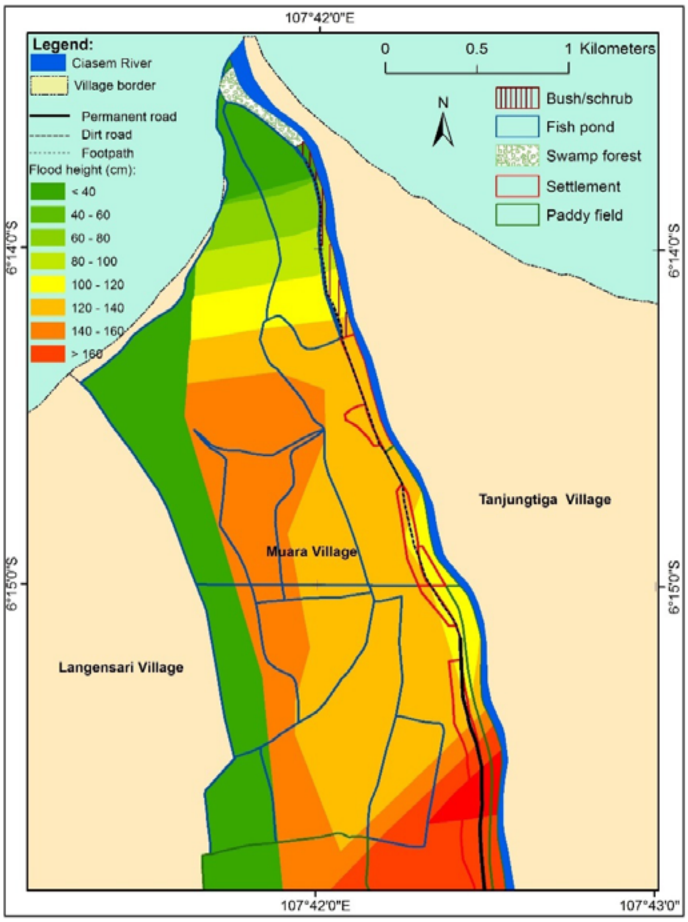

Figure 5. Inundation height caused by river flood

in December 2012, all areas were inundated in their kampung and was already noted in the map. Each respondent stated the height of the flood in their houses and on the land elevation. They also provided flood height information on the road or other public facilities, as well as duration of the inundation. During the severe flood, the inundation could stay upto two weeks, but some people experienced the inundation for only two hours.

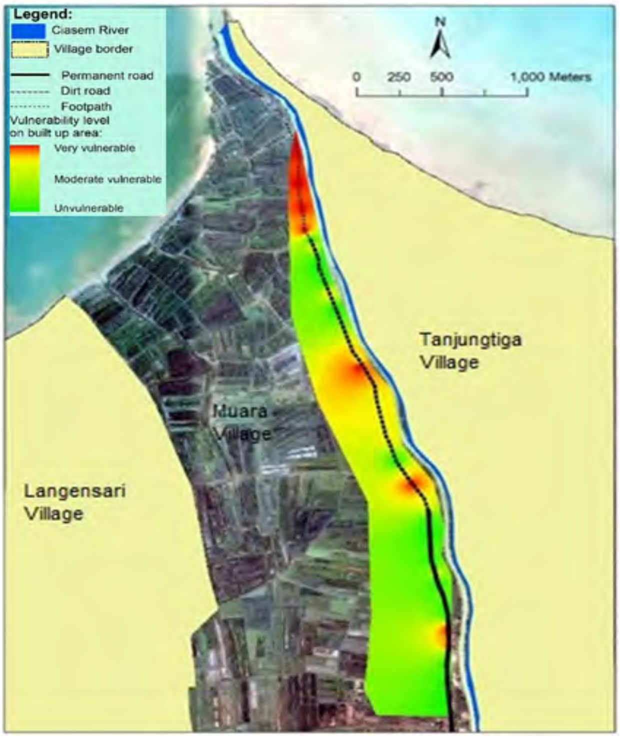

Figure 6. Level of vulnerability based on settlements and road conditions

D. Vulnerability of Elements at Risk

River and tidal inundation maps were overlayed with land cover map to get the area of each element at risk. The built up areas cover residential areas, roads, and fish ponds while vegetated areas were paddy field, bush/ shrub, and coastal forests (mangroves). Field observations found that only the settlements and roads had different levels of vulnerability to the flood inundation, while the others were not different.

Based on field observation, the vulnerability level was divided into three classes those who were nonvulnerable, quite vulnerable, and very vulnerable. Non-vulnerable settlement was categorized as a house made of permanent brick wall or a building with two floors. Quite vulnerable buildings were semi-permanent buildings with brick walls at the bottom up to one meter height and the rest was made from woven bamboo. The very vulnerable houses were constructed using woven bamboo wall and using wood or bamboo as poles. When flood comes, this type of house will be heavily damaged and very humid. Road vulnerability was distinguished by its construction. Nonvulnerable roads were made of asphalt or concrete layers. Quite vulnerable road was dirt road with compacted stone layer, and the very vulnerable road was footpath constructed using only hardened soil. The physical condition of the element at risk in the form of settlements and roads mapped using GPS and scoored with a value of 1 up to 3, representing nonvulnerable up to very vulnerable level. The scoring results were interpolated to obtain a map of the vulnerability level as shown in Figure 6.

The vulnerability map illustrates that high vulnerable areas are located in the north and partially in the middle. The northern part area will be inundated firstly during tidal flood, and it was included in the inundated area in case of river flood. On that northern part, there is a settlement cluster with houses made of woven bamboo, and the road type is only footpath. Northern and middle areas should receive more attention during flood event, not only they are vulnerable from the physical aspect, but also their socioeconomic conditions need also to be attended to.

IV. CONCLUSION

Based on the physical conditions, Kampung Sindang Laut 1 and Sindang Laut 2 are prone areas to the flood hazard either caused by river or tidal floods. The condition is exacerbated by the decline in mangrove cover and high sedimentation in the estuary of the Ciasem River. Tidal inundation started in the north and followed in the western part with the fish ponds as the main element at risk. At 90 cm sea level height, the settlement started to inundate. Ciasem river flood started to occur when river water discharge reached 160 m^3/s with paddy fields, fish ponds and settlement as the main element at risk. Paddy fields and fish ponds have the largest area of flood risk. Based on the physical condition, those two elements have the same high vulnerability to flood while settlements and roads have different vulnerabilities depending on the construction materials. Settlements and roads in the north and center parts have higher flood vulnerability than the other parts.

Flood disaster risk should be reduced by continuing the land rehabilitation activity, restoring mangrove vegetation, implementing government regulations on management and establishment of aquaculture in mangrove, and carefully considering the establishment of coastal protection construction.

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SPECIES IDENTIFICATION OF TRADITIONAL MEDICINE PLANTS FOR WOMEN'S HEALTH IN EAST KALIMANTAN: LESSON LEARNED FROM LOCAL WISDOM

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SPECIES IDENTIFICATION OF TRADITIONAL MEDICINE PLANTS FOR WOMEN'S HEALTH IN EAST KALIMANTAN: LESSON LEARNED FROM LOCAL WISDOM. Traditional communities in East Kalimantan have been using traditional medicinal plants for centuries. This paper aims to identify the plant species used for traditional medicine for women's health in three tribes in East Kalimantan: Dayak Benuaq around Gunung Beratus Protection Forest, Dayak Bahau around Wehea Forest, and Kutai tribe around Kutai National Park. Medicinal plant species identification is important for plant breeding and developing utilization technology of those species. Data were collected by: 1) interview with traditional midwives and traditional medicinal plants users in those villages; 2) collecting the medicinal plant specimens in their natural habitat; 3) qualitative analysis of the interview records; 4) botanical identification of the specimens in Herbarium Wanariset Samboja; and 5) literature review about the usage of those medicinal plants by traditional communities in other places. This research result showed 44 medicinal plant species from 30 families for cosmetics, maternal uses, and women's reproductive health. The used parts of the medicinal plants were the roots, leaves, barks, stem, and fruits. The medicinal plants were processed by simple methods. There were 27 species also used by other communities for similar or different efficacies, and the active chemical compounds of 25 species have been known. The utilization of traditional medicinal plants are cheaper, more available, and accessible. However, the quality of the medicinal plants can not be guaranteed, and the dosage was not standardized. Therefore the medicinal plants need to be cultivated to ensure the quality and quantity, and to prevent species extinction.

Keywords: Traditional medicinal plants, species identification, East Kalimantan, tribes, women health

IDENTIFIKASI JENIS TUMBUHAN OBAT UNTUK KESEHATAN PEREMPUAN DI KALIMANTAN TIMUR: PEMBELAJARAN DARI KEARIFAN LOKAL. Masyarakat tradisional di Kalimantan Timur telah menggunakan tumbuhan obat tradisional sejak beratus tahun lalu. Tulisan ini bertujuan mengidentifikasi jenis-jenis tumbuhan obat tradisional yang dimanfaatkan untuk kesehatan perempuan oleh tiga suku di Kalimantan Timur, yaitu: suku Dayak Benuaq (sekitar Hutan Lindung Gunung Beratus), Dayak Bahau (Hutan Wehea), dan Kutai (sekitar Taman Nasional Kutai). Identifikasi jenis tumbuhan obat penting dilakukan sebagai dasar upaya budidaya dan pengembangan teknologi pemanfaatannya. Pengumpulan data dilakukan dengan cara: 1) melakukan wawancara dengan 5 (lima) bidan tradisional dan pengguna tanaman obat tradisional di desa-desa tersebut; 2) mengumpulkan spesimen tumbuhan obat di habitat alaminya; 3) melakukan analisis kualitatif terhadap hasil wawancara; 4) melakukan identifikasi botani spesimen tumbuhan obat di Herbarium Wanariset Samboja; dan 5) Studi pustaka untuk memperoleh informasi tentang penggunaan jenis-jenis tumbuhan obat tersebut oleh masyarakat tradisional di daerah lain. Penelitian ini telah mengidentifikasi dan mendokumentasikan 44 jenis tumbuhan obat dari 30 famili yang digunakan oleh masyarakat tradisional untuk kosmetika, kebidanan, dan kesehatan reproduksi perempuan. Bagian tumbuhan yang digunakan sebagai obat adalah daun, akar, batang, kulit batang, buah, bunga, dan biji. Pengolahan dilakukan dengan metode sederhana.

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Paling sedikit ada 27 jenis yang juga digunakan oleh masyarakat di tempat lain untuk khasiat yang sama maupun berbeda, dan senyawa kimia aktif 25 jenis telah diketahui. Penggunaan tumbuhan obat tradisional lebih murah, lebih tersedia, dan mudah diakses. Namun kualitas tumbuhan obat tersebut tidak bisa dijamin dan dosisnya tidak terstandar. Oleh karena itu tumbuhan obat tersebut perlu dibudidayakan untuk memastikan kualitas dan kuantitasnya, dan untuk mencegah kepunahan jenis.

Kata kunci : Tumbuhan obat tradisional, identifikasi jenis, Kalimantan Timur, suku, kesehatan perempuan

I. INTRODUCTION

Traditional communities living around the forest, especially those who had difficulties to reach modern health facilities, have been utilizing traditional medicinal forest plants from time immemorial. In those olden days herbal remedies provided the only relief when modern medicines were not available (Kulip, 2003). Traditional medicine is the only feasible source of healthcare for a vast number of people living in less developed countries, especially in rural areas (Marshall, 2011). Traditional medicine is the total sum of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, used in the maintenance of health, and in the prevention, diagnosis, improvement or treatment of physical and mental illnesses. There is a significant demand for traditional and complementary medicine (TCM) both in terms of practices and practitioners worldwide. Over 100 million Europeans are currently users of traditional and complementary medicines. There are many more T&CM users in Africa, Asia, Australia and North America (World Health Organization, 2013). The Food and Agriculture Organization (FAO) reported in 2011 that an estimated 80% of the population in Africa and Asia rely largely on these plant-based drugs for their health care needs (Marshall, 2011). In the 21st century, natural products represent more than 50% of all drugs in clinical use. During the last 3 decades, up to 50% of the approved herbal medicines are either directly or indirectly taken from natural products, including plants, microorganisms, fungi and animals (Sakhya, 2016). The growing demand of herbal drugs are also driven by emphasis on a healthy living, and concerns over the side-effects of mainstream drugs (Rinaldi & Shetty, 2015). Therefore, further medical based research and cultivation efforts of the medicinal plant species is needed.

The tropical rain forests of East Kalimantan are rich in medicinal plant species. However, the medicinal plants are only known by their local names or specific characteristics. Traditional medicinal plant species identification has not yet been conducted. Species identification is important to plan further research on phytochemical contents and to conduct species cultivation in the future.

The women (as a different sex from men) have specific needs of medicine due to their biological and social conditions. Women are the main consumers of the herbal drugs, especially for the dietary supplements (Rinaldi & Shetty, 2015). The women in traditional communities around remoted forest areas are no exception for those specific need of medicine. The women in traditional communities usually use traditional medicinal plants for daily reproductive health, maternal purposes and beauty treatments. The knowledge of women's daily medicine needs has been inherited from mothers to daughters for years. A traditional community usually has one or several traditional midwives who are considered to have special knowledge in child birth, maternal, and reproductive health issues (Falah, Noorcahyati, & Sayektiningsih, 2013; Mupfimira, 2012; Okonofua, 2002; Strathy, 2000).

Knowledge about traditional medicinal plants for women's health has been handed down for generations orally, without written documentation. Moreover, in the inheriting process, the species used was only mentioned by local name, or even only by mentioning the specific characteristics of the species. The species identification of women's medicinal plants has not been studied intensively. Once the medicinal plants species have been thoroughly identified and documented, then future research on their biological and phytochemical potential may provide important information on their safety and efficacy for women worldwide, who are searching for natural treatment for their medical problems. Furthermore, the cultivation effort of the medicinal plant species should be conducted.

This paper studies species identification and utilization of women's health medicine plants in three forest traditional communities in East Kalimantan. In addition to the purpose of documenting traditional knowledge, this paper is also expected to contribute information for ethno-botanists in developing technology for the utilization of medicinal plants.

II. MATERIAL AND METHOD

A. Studi Site

The field research has been conducted from June to November, 2010. Primary data was collected in three sites: a) Tanjung Soke and Gerunggung villages, around Gunung Beratus Protection Forest (GBPF), sub district of Bongan, West Kutai Regency; b) Nehas Liah Bing village, sub district of Muara Wahau, East Kutai Regency (around Wehea Forest); and c) Menamang villages, around the Kutai National Park (KNP), sub district of Sebulu, Kutai Kartanegara Regency. The three study sites were selected because traditional communities who lived in the surroundings have the knowledge and habit of using traditional medicinal plants for health. The research subjects included: a) Dayak Benuaq tribe community in Tanjung Soke and Gerunggung villages; b) Dayak Bahau community in Nehas Liah Bing village, and c) Kutai tribe community in Menamang Kiri and Menamang Kanan villages. The literature study had been conducted in 2013, and then it had been deepened in 2017.

General condition of the research location is described in Table 1.

B. Material and Tools

The objects of this research were: 1) the traditional midwives and village women in five villages (Tanjung Soke, Gerunggung, Nehas Liah Bing, Menamang Kiri, and Menamang Kanan villages) who considered have much knowledge about medicinal plants for women's health; and 2) medicinal plants around the Gunung Beratus Protection Forest, Nehas Liah Bing village, Wehea Forest, and Menamang villages.

Materials used in this study included: 1) an interview guidance, and 2) methylated spirit for preservation of medicinal plant specimens. Tools used in data collection were recorder, camera, plastic bags, machetes, cutting scissors, label paper, and newsprint.

C. Data Collection and Analysis Methods

This research used qualitative methods of the moderate participant observation, where the researchers were involved in the day-to-day activities of the informants (like farming activities or participation in traditional meeting), but did not follow the overall activities of the informants within a day (Sugiyono, 2007). The key informants were the traditional midwives, who according to the members of the traditional community were considered most knowledgeable or could recognize women's medicinal plants. There were five key informants who were selected using purposive sampling, one traditional midwife for each village of Tanjung Soke, Gerunggung, Nehas Liah Bing, Menamang Kiri, and Menamang Kanan. In addition to the key informants, interviews were also carried out with several village women who still use traditional medicines in everyday life. Interview with the village women have been conducted in their house separately (in Tanjung Soke and Gerunggung, and Menamang), and collectively in the community service centre (*gotong royong*) in Nehas Liah Bing.

The data were collected through the four steps outlined below :

1). Structured interviews with the key

Table 1. General conditions of research location

No	Aspect of condition	Tanjung Soke and Gerunggung	Nehas Liah Bing	Menamang
1.	Name of nearest forest area	Gunung Beratus Protection Forest (19,800 ha)	Wehea Forest (38,000 ha)	Kutai National Park (198,604 ha)
2.	Geographic location of the forest area	1^{o}00’00.00” – 1^{0}05’03.24” LS 16^{0}15’51.61” - 116^{0}21’22.98” BT	01^{0} 34’ 04.3” LU 116^{0} 46’ 02.2“ BT	116^{0} 57’ 7.3” LU 0^{0}13’41.7” BT
3.	Major tribe	Dayak Benuaq	Dayak Bahau	Kutai Menamang
4.	Other tribe	Banjar	Javanese, Buginese, and other tribes of Dayak	Javanese, Banjar, Buginese
5.	Number of residents	117 (Tanjung Soke), 99 (Gerunggung)	2500 people	1089 people
6.	Major religion	Islam	Catholics	Islam
7.	Major education level	Elementary school (> 70%)	Elementary school	Elementary school (>60%)
8.	Major livelihood	Farmers	Farmers	Farmers
9.	Other livelihoods	Wood industries labors, elementary school teacher	Chainsawmen, oil palm plantation and coal mining labors, fishermen, merchants	Oil palm plantation labors
10.	Customary ritual/ ceremonies	Still carried out several Dayak ceremonies as cultural heritages	Ritual ceremony before starting the rice planting and harvest festival	Not actively carried out, only for wedding ceremonies

informants. The local name, efficacy, used part, and utilization method of each medicinal plant were recorded;

2). Field observation guided by the key informants, and collecting herbarium specimens of the medicinal plants from their natural habitat around settlements, gardens, and the forest areas. Specimens that were easily identified in the field were only recorded, not collected. Unidentified specimens were numbered, collected and brought to the Herbarium at Wanariset Samboja for further identification. Whole parts of the small plants were should be collected. From a large plants or trees, 30-40 cm long pieces of organs were collected, mostly branches with leaves, flowers and fruit. Collected plant specimens were diluted in 70% alcohol in airproof plastic bag. These specimens were later dried and pressed in the Herbarium at Wanariset Samboja, East Kalimantan.

3). Identifcation of the herbarium specimens was done in the Herbarium at Wanariset. Species identification used morphological characteristics that could be compared with known databases in the Herbarium Wanariset. Characteristics observed included general characters, the structures of stems, roots and leaves, embryology and flowers. The specimens were also deposited if have not yet been collected in the Herbarium Wanariset.

4). Literature review to get information about the usage of those medicinal plants by traditional communities in other places in the world.

III. RESULT AND DISCUSSION

People have found remedies within their habitat, and have adopted different strategies depending upon the climatic, phyto-geographic and faunal characteristics, as well as upon the peculiar culture and socio-structural typologies (Nichter, 1992 in Samuel et al., 2010). Due to their spesific biological and physical conditions and the socio-cultural demands, female human have specific needs of medication in order to maintain their health and beauties, as well as for the prevention and treatment of illnesses. For the women who live in the remote or isolated area where it is difficult to get medication or modern cosmetics, their special medicines were obtained from the plants that grew in the surrounding area, based on their ancestral knowledge passed down for decades or hundreds of years. They gained the knowledge and experience based on empirical and experimental observation of the existing plants in the vicinity, for example plant species that taste bitter allegedly is able to cure malaria, or a plant species that is able to regenerate quickly have the capability to recover the stamina (Falah et al., 2013).

A. Knowledge Inheritance System

The knowledge of utilization of traditional plants for women's health medicine passed down from mothers to daughter, usually being a secret or clandestine of a family lineage (Hariyadi, 2011; Noorcahyati, 2012; Trubus, 2010). In the Dayak community, although at the same tribe, each family can have traditional medicine knowledge which is different from their ancestors. The process of transfering medicinal plant knowledge is conducted orally, being a closed information or a secret, and not documented (Noorcahyati, 2012; Setyawati, 2010; Trubus, 2010). They stated that the knowledge of traditional medicine can only be passed on to people who have great intention and high willingness to learn (Falah et al., 2013).

In terms of delivering knowledge on utilization of medicinal plants, the results of interviews of several traditional healers indicated that they tend to be enclosed to outsiders. This is due to the consideration that traditional knowledge of medicinal plants is a heritage to be protected and kept secret. Knowledge is only delivered to certain people. Level of disclosure of information about the medicinal plants to outsiders is different at each location. For example, for the Dayak Siang people in Central Kalimantan, the act of delivering the information on medicinal plants to outsiders may be subject to a customary fine called jipen (Noorcahyati, 2012). The people of Dayak Benuaq in Tanjung Soke village required embedding nails and certain things of ritual offerings before taking specimens of medicinal plants in Gunung Beratus Protected Forest (Falah et al., 2013).

Respondents with the deepest traditional knowledge on women's health medicine were the traditional midwives who were all over 50 years age. At the present the usage of traditional medicine for women's health become abandoned and obsolette due to several factors such as the influence of modern education and lifestyle changes. The utilization of traditional plants is fading due to migration, restriction from religion, lost interest of younger generations and heavy dependence on modern medicine (Kulip, 2003). Deforestation for agricultural development and timber harvesting makes the resources scarce which also contributing to the loss of the knowledge. Currently, modern medicine is preferred by the youth because it is more practical (no need to collect ingredients, and to process and mix the potion) and is relatively easy to obtain (Falah et al., 2013). On the other hand, traditional herbal medicine has some advantages, especially for those living in remote areas : it's cheaper and affordable, the materials are available around the villages, the efficacy had been proven by older people, and is considered to have no side effects compared to the mainstream modern chemical drugs.

B. Utilization Method of Medicinal Plants

This study has gathered data of about 44 medicinal plants species from 30 families which are used for women's health in forest communities around Gunung Beratus Protection Forest, Wehea Forest, and the villages of Menamang Kiri and Menamang Kanan. Out of the total seven species were used as reproductive health medicinal plants, 30 species as postpartum and maternal medicine, and 9 species as cosmetics. The families that had used most as medicinal plants are Leguminosae (6 species), Zingiberaceae (five species), Rubiaceae (5 species), and Euphorbiaceae (5 species). Three species used as medicine for more than one efficacies are: *Callicarpa longifolia*, *Blumea balsamifera*, and *Brucea javanica*.

The types of herbs that were often used by people have different life forms such as shrubs, trees, bushes, epiphytes, lianas, roots and grass. Utilization of shrubs as an ingredient in traditional medicines is more favorable than trees because it was easily collected by women. The use of trees as medicinal plants could be a possible threats to the species extinction, because they could be extinct if people are taking them excessively (Noorhidayah & Sidiyasa, 2005). In addition, cultivation of the trees is a long time process and the growth requirements are difficult. In GBPF, people did a specific ritual before taking the plants, by driving a nail to mark the location of the medicinal plants. In terms of conservation, the ritual was performed by the community to prevent excessive removal to and avoid the scarcity of medicinal plants in the future (Falah et al., 2013).

The mostly used parts of the plants as medicine were the roots (43.18%). Other used parts were the leaves (29.54%), barks (13.63%), stem (6.82%), fruits (4.54%), and all parts (2.27%). The roots become the most used parts, because the Dayak Benuaq in Tanjung Soke used the roots from various species to make potions for maternal uses, due to special phylosophy that every plant that could naturally germinat after being uprooted has the efficacy to recover health and stamina for the mother after childbirth (Falah et al., 2013). But from the conservation perspective, the uses of roots as medicine ingredients could led to the death of the plants (Noorhidayah & Sidiyasa, 2005).

People used simple methods to process the medicinal plants, such as squeezing, soaking, boiling, shredding, and pounding. The treatment dose was determined only by habits (such as a glass of water) or size of the patient's body.

Most of the medicinal plants were found in the forest (58.33%), while the rest grow wild in the resettlement area (41.67%). This indicates that cultivation of medicinal plants has not been conducted by the community. Collecting medicinal plants from the wild often causes inconsistent quality (variations in active ingredients) depending on the area the plants grow (Sakhya, 2016). Collecting from the wild also often results in the plants being mistaken and unwanted plant material included (World Health Organization, 2013).

C. Species Identification of Medicinal Plants Used for Women's Health

The species of traditional medicines plants used for women's health could be divided into three categories, i.e: a) medicinal plants species for women's reproductive health; b) medicinal plants species for maternal purposes; and c) medicinal plants species used as cosmetics for women's beauty care. Each category of women's medicinal plants would be described in the following paragraphs.

1. Species identification of medicinal plants used for women's reproductive health

An immense number of plant species have been and continue to be used by women and traditional healers worldwide in all aspects of women's health, such as menstruation, conception, pregnancy, birth, lactation, and the menopause (Stuart, 2004 in Michel et al., 2007). Just like women and traditional healers in other traditional communities, women around Gunung Beratus Protected Forest, Wehea Forest, and Kutai National Park have used medicinal plants for maintain their reproductive health and cure reproductive organ illnesses. The species of medicinal plants used for women's reproductive health were described in Table 2.

The medicinal plants for women's reproductive health (Table 2) includes the species which are easily taken according to women physical condition, and could be found in gardens, yards, or the forest edge. The herbs were utilized to cure the regular problems of women's reproductive organs. The herbs processing was very simple and done manually, and the dosage was determined subjectively, only by habit or based on estimation of body-sized.

Almost all of the medicinal plants species in Table 2 are also used as folk medicinal plants

Table 2. The traditional medicinal plants used for women's reproductive health

No	Species/Family	Local name	Life form	Location*	Efficacy	Proceed and usage methods
1.	*Callicarpa longifolia* (Verbenaceae)	Garam payau	Little trees	1	Leucorrhoea treatment	Squeezing the leaves, boiling, then drinking the potion
2.	*Drymoglossum piloselloides* (L.) Presl. (Polypodiaceae)	Kete-kete	Epiphyt	3	Endometriosis treatment	A minimum of 3 leaves shredded, filtered, then drink once a day
3.	*Flemingia macrophylla* (Willd.) Merr. (Leguminosae)	Kayu kemudaan	Lianas (vines)	3	Maintaining feminine organ muscle in good condition	Boiling the roots then drink the potion
4.	*Macaranga winkleri* Pax & K.Hoffm (Euphorbiaceae)	Nge-laq meh biang	Trees	2	Treatment for menstrual cycle problem	Boiling the stems, drink the potion
5.	*Parameria polyneura Hook.f.* (Apocynaceae)	Manggarsih/ Serapat	Trees/ Shrubs	3	Firm vaginal muscles and strengthen the uterus	Boiling the roots, then drinking for 3 times a week
6.	*Phyllanthus urinaria* L. (Euphorbiaceae)	Niur Songo	Shrubs	3	Fertilizer	Washing then eating the fruits after menstrual period
7.	*Tinospora crispa* (Menispermaceae)	Sampai	Lianas	3	To treat abdominal pain during menstrual period Endometriosis	Washing then eating the roots sufficiently

Key* = 1. Gunung Beratus Protection Forest 2. Wehea Forest 3. Menamang for the same or different efficacies in Asia and the tropical region worldwide (see Table 5). *Parameria polyneura* is also used by the Malay people for the same efficacy. The species have commercially produced as herbal medicine for women in Indonesia and Malaysia.

Some species belonging to the same genus as the medicinal plants in Table 2 are also used by other traditional communities as herbs for women. For example, in Lao PDR, *Macaranga denticulate* (Blume) Müll. Arg. (the same genus as *Macaranga winkleri*) is also used for postpartum recovery treatment. Also in Lao PDR, *Callicarpa arborea* Roxb. (the same genus as *Callicarpa longifolia*) is used for postpartum recovery treatment, expelling lochia, postpartum abdominal pain, perineal healing, and for uterus retracting (Lamxay, de Boer, & Bjork, 2011).

2. Species identification of traditional medicinal plants used for maternal uses

The traditional midwives usually gave medicinal plants for childbirth, postpartum use to recover mothers' stamina after delivering a baby, and increasing breast milk supply (lactogogue). The species of medicinal plants used for maternal use is described in Table 3.

Delivering a baby (childbirth) is a riskfull and exhausting struggle, therefore traditional midwives tend to used easily gained plants from the surrounding gardens, yards, or forest edge, so the postpartum medicinal treatment could be done quickly and efficiently for the safety and health of the mother and the baby. Most of the species listed in Table 3 have the life forms as lianas, shrubs, bushes, or small trees which could easily be collected by women. Traditional midwives only took the bark part of the large trees. Due to the emergency treatment of the mother, the traditional midwives also used to do simple method to proceed the plants to become traditional herb medicine, such as squeezing, simple cutting, and boiling. Indegenous people around Gunung Beratus Protection Forest have special philosophy to select plants species for the postpartum recovery, i.e. every plant that could naturally be germinated after being uprooted has the efficacy to recover health and stamina for the mother after childbirth (Falah et al., 2013).

At least 22 medicinal plant species in Table 3 are also used for the same or different efficacies in other communities, such as *Eurycoma longifolia* and *Ficus deltoidea*. Those two species not only have been used as medicines for various ailments in the Malay Archipelago, but also pharmaceutically tested to have medicinal chemical compounds (see Table 5). *Eurycoma longifolia* and *Ficus deltoidea* have been distributed and formulated as capsules, tea, and tonic tea throughout Malaysia (Bunawan, Amin, Bunawan, Baharum, & Noor, 2014; Effendy, Mohammed, Muhammad, Mohammad, & Shuid, 2012). The species *Arbus precatorius* that is used to make easy and smooth the childbirth by the Kutai people in Menamang villages also used for the same efficacy in Guinea-Bissau and Ivory Coast. The same species is also used for antifertility, contraceptive, and abortifacient in several communities in Asia and Africa (see Table 5), and has pharmaceutically be proven to have some medicinal effects, i.e. abortifacient, antiestrogenic, antifertility, anti-implantation, antispermatogenic, and contraceptive and/or interceptive effects (Ross, 2003).

3. Species identification of traditional medicinal plants used for cosmetics

Women always have an instinct to care for and beautify herself, even if they live in the isolated area. Therefore the women of the forest community have knowledge of utilizing the surrounding plants as cosmetics. The knowledge had passed down from mothers to daughters for the time immemorial. The species of medicinal plants used for cosmetics is described in Table 4.

All the herbs species in Table 4 were externally used medicines, used as powder or shampoo for skin and hair care. The herbs were manually processed into powder or shampoo by refining, squeezing, or pounding the leaves, roots, or fruit. Not all the species were easily taken, such as the leaves of the *Cananga odorata*

Table 3. The species of medicinal plants used for maternal uses

No	Species	Local name	Life form	Finding location	Efficacy	Processing and usage method
1.	*Abrus precatorius* L. Gaertn.(Leguminosae)	Penisip	Shrubs	3	1	Boiling the roots of penisip, belimbing and tabat barito, then drink the potion
	Cnestis platantha Griff. (Connaraceae)	Belimbing bikut	Woody lianas			
	Ficus deltoidea Jack. (Moraceae)	Tabat Barito	Epiphyte			
2.	*Aleurites moluccana* (Euphorbiaceae)	Kemiri	Trees	3	3	The bark is heated over a fire, then be trampled
3.	*Alpinia galanga* Willd. (Zingiberaceae)	Teraran	Shrubs	1,3	2	Washing the root, soaking, boiling, then drink the potion, or shredded and rubbed into skin of stomach
4.	*Blumea balsamifera* DC. (Asteraceae)	Kutai Sembung	Shrubs	1	2	Cutting the roots of *Morinda citrifolia, Hyptis brevipes, Blumea balsamifera, and mimosa pudica* into pieces, soaking, boiling, then drinking the potion
	Hyptis brevipes Poit. (Lamiaceae)	Rumput Fatimah	Shrubs			
	Morinda citrifolia L. (Rubiaceae)	Mengkudu	Shrubs			
	Mimosa pudica (Leguminosae)	Putri malu	Bushes			
5.	*Blumea mollis* (D.Don) Merr. (Compositae)	Sembung	Shrubs	3	2	Boiling the roots, drink the potion Refining the young leaves, mix with cold powder, apply to the whole body
6.	*Bougainvillea spectabilis* (Nyctaginaceae)	Kembang Kertas	Shrubs	1	2	Cutting the roots into pieces, boiling, then drinking the potion
7.	*Brucea javanica* (L) Merr. (Simaroubaceae)	Kayu Sumpit	Trees	1	2	Cutting the stem into pieces, boil it
8.	*Caesalpinia sappan* L. (Leguminosae)	Sepang	Shrubs	3	1	Drying inside part of the bark, brew it, then drink the potion during pregnancy and before childbirth
9.	*Callicarpa longifolia* Lam. (Verbenaceae)	Garam payau	Small trees	3	2	Boiling the bark then drink the potion
					4	Shredding the leaves, pouring water, filtering, then drink the water
10.	*Carica papaya* (Caricaceae)	Pepaya	Tree shaped shrubs	3	6	Soaking the root into boiled water, then drink the potion
11.	*Durio zibethinus* (Bombacaceae)	Durian	Trees	3	2	Pounding the bark, mix with the cold powder, apply to the whole body

Table 3 (Continued)

No	Species	Local name	Life form	Finding location	Efficacy	Processing and usage method
12.	*Eurycoma longifolia* Jack (Simaroubaceae)	Tongkat ali (pasak bumi)	Small trees	3	4	Boiling the roots, drink 3 times a day (minimum for 3 days)
13.	*Gonocaryum calleryanum* (Baill.) Becc. (Icacinaceae)	Kayu mati hidup	Small trees	3	2	Boiling the roots, drink the potion
14.	*Hiptage bengalensis* (Malpighiaceae)	Temelekar	Woody lianas	1	2	Cutting the roots into pieces, boiling, then drinking the potion Cutting the bark into pieces, pound it, taking the sap, then rubbing into stomach
15.	*Lepisanthes amoena* (Hassk.) Leenh (Sapindaceae)	Bengalun	Small trees	3	2, 6	The fruits and young leaves be cooked, mixed with fish, then be eaten
16.	*Lygodium circinnatum* (Burm.) Sw. (Schizaeaceae)	Mintu	Lianas	1	2	Cutting the roots into pieces, soaking, boiling, then drinking the potion
17.	*Mitragyna speciosa* Korth. (Rubiaceae)	Kedemba	Trees	3	2	The bark smothered in hot water, then be drunk one week after childbirth
18.	*Oroxylum indicum* (L.) (Bignoniaceae)	Bentolan	Trees	1	2	Cutting the roots into pieces, soaking, boiling, then drinking the potion
19.	*Paspalum conjugatum* (Graminae)	Beriwit	Herbs / grass	3	2	Refining the young leaves, soaking, filtering, then drink the potion
20.	*Passiflora foetida* L. (Passifloraceae)	Terong kumut	Lianas	3	5	Squeezing all of parts, soaking in the water, then drink the potion
21.	*Piper betle* (Piperaceae)	Sirih/ kerakap	Lianas	3	2	Boiling the leaves, drink the potion
22.	*Rothmannia schoemanii* (Teijsm. & Binn.) Triveng. (Rubiaceae)	Bentan Basap	Trees	3	2	Boiling the roots, drink the potion 3 times a day
23.	*Sida* sp. (Malvaceae)	Bembe	Bushes	1	2	Washing the root, soaking, boiling, then drink the potion
24	*Syzygium* sp. (Myrtaceae)	Kayu Serai	Trees	3	2	Boiling the stem, drink the potion 2 or 3 times a day
25	*Tamarindus indica* L. (Leguminosae)	Asam Jawa	Trees	3	2	Squeezing the root, soaking, boiling, then drink the potion

Notes : Finding location: 1. Gunung Beratus Protection Forest 2. Wehea Forest 3. Menamang
Efficacy: 1. Easy and smoothing childbirth; 2. Health and stamina recovery after childbirth; 3. Leg swelling after childbirth; 4. Postpartum fever treatment ; 5. To stop postpartum bleeding; 6. Increasing breastmilk supply.

Table 4. The traditional medicinal plants used for cosmetics

No	Species	Local name	Life form	Finding location	Efficacy	Usage methods
1.	*Baccaurea lanceolata* (Miq.) Muell.Arg. (Euphorbiaceae)	Rambai	Trees	3	Brighten the skin tone	Yellowed leaves mixed with cold powder, then apply into face
2.	*Brucea javanica* (L) Merr. (Simaroubaceae)	Kayu Sumpit	Trees	1	Acne treatment	Pounding the leaves, apply into acnes
3.	*Blumea balsamifera* DC. (Compositae)	Wekiah guaq	Shrubs	2	Hair blackening	Burning the roots, mix it with palm oil, apply into hair
4.	*Cananga odorata* (Lamk.) Hook. F. Thomson (Annonaceae)	Kanghit	Trees	1	Soften the facial skin	Squeezing young leaves, apply into face
5.	*Morinda citrifolia* (Rubiaceae)	Mengkudu	Trees	3	Anti dandruff	Crush the ripe fruits, use the water as a shampoo
6.	*Boesenbergia pandurata* *Curcuma zanthorrhiza* *Curcuma zedoaria* *Kaempferia galanga* L. (Zingiberaceae)	Temu putih Temulawak Temu kunci Kencur	Herbs	3	Asteringent	Refining the roots/tubers of *K. galanga, C.zaedoaria, B.pandurata,* and *C. zanthorrhiza*, squeezing, use as a cold powder, apply into face
7.	*Mussaenda* sp. (Rubiaceae)	Pilanggang Bulan	Shrubs	1	Soften the facial skin	Squeezing young leaves, apply into face
8.	*Paspalum conjugatum* (Graminae)	Beriwit	Herbs / grass	3	Blackening the hair	Squeezing the leaves, use the water as a shampoo
9.	*Senna alata* (L.) Roxb. *(Leguminosae)*	Ketepeng	Little trees	3	Soften the skin	Refining young leaves and flower, use as powder, apply into face

Notes : Finding location: 1. Gunung Beratus Protection Forest 2. Wehea Forest 3. Menamang

and *Brucea javanica*, but the herbs are still used for daily treatment of the skin. At least two medicinal plants species used as cosmetics in Table 4 have been pharmaceutically tested for the similar efficacy (see Table 5). *Baccaurea lanceolata* (used in Menamang to brighten the skintone) has been pharmaceutically tested as antioxidant agent (Bakar, Ahmad, Karim, & Saib, 2014; Manullang, Daniel, & Arung, 2013). *Brucea javanica* (used for acne treatment) has been pharmaceutically tested as antibacterial agent (Sornwatana, Roytrakul, Wetprasit & Ratanapo, 2013). Other species in Table 4 are also used as medicinal plants in other communities for the similar or different efficacies.

D. Utilization of the Same Medicinal Plants Species by Other Communities

Several medicinal plant species for women's health that were used by traditional forest communities in the villages of Tanjung Soke, Gerunggung, Nehas Liah Bing, Menamang Kiri and Menamang Kanan were also used by other traditional communities, for similar or different efficacies. Based on the literature study, at least 27 species were also used by other communities for many efficacies, and the active chemical compounds of 25 species were known, as described at Table 5.

The results of the literature study described in Table 5 shows that for several medicinal plants species (such as *Arbus precatorius*, *Baccaurea lanceolata*, *Brucea javanica*, *Eurycoma longifolia*, and *Ficus deltoidia*), the traditional knowledge of medicinal plants (which is based only on empirical observations and experiences) turned out to be scientifically proven based on pharmaceutical tests. However, further studies are needed to determine the dose treatment and the active chemical composition of those species which have not been tested yet.

Compared to modern pharmaceuticals, the utilization of traditional medicinal plants in this research sites (Tanjung Soke, Gerunggung, Nehas Liah Bing, Menamang Kiri, and Menamang Kanan) are cheaper, more available, and easy to be accessed. But the utilization of those traditional medicinal plants also have several weakness as follows:

1. The quality of medicinal plants can not be guaranteed, because they were harvested from the wild, not cultivated. Traditional

Table 5. The uses of similar medicinal plants by other communities based on literature study

No	Botanical name	Utilization by other communities	Active chemical compound	References
1.	*Aleurites moluccana* (L.) Willd.	Contusion, swelling (Jambi), hair growth (Java), anti cancer	Saponin, flavanoid, poliphenol, tannin	Sangat, Zuhud, & Damayanti (2000)
2.	*Alpinia galanga* Willd.	Postpartum recovery, anaemia, high puerperal, lactagogue (Lao PDR), inhalation problem, ringworm (Jambi), rheumatism, emmenagogue, aphrodisiac, diabetes, bronchitis, antipyretic, anti-inflammatory, heart diseases, chronic enteritis, kidney disorders	Tannin, phenol, gallic acid, glycosides, monoterpenes, carbohydrates, galangin, alpinin, zerumbone, kampferide	Hariyadi & Ticktin (2012); Kaushik, Yadav, Kaushik, Sacher, & Rani (2011); Lamxay et al.(2011)
3.	*Arbus precatorius* L.Gaertn.	Aphrodisiac (Afghanistan, East Africa, Egypt, Mozambique, Nepal, Pakistan); nerve tonic (Brazil and Jamaica); snake bite remedy, treat intestinal worms, oral contraceptive, improving menstrual cycle (Central Africa); gonorrhea, stomach troubles, chest pain, antiemetic, facilitate childbirth, abortion (Guinea-Bissau, Ivory Coast), coughs and flu (Haiti, Kenya, Virgin Islands); eye diseases, abortion, emmenagogue, antifertility agent, abortifacient and prevent conception, toxic, tuberculosis, painful swellings (India, Pakistan); antimalaria and anticonvulsant (Nigeria); treat bronchitis, and hepatitis (Taiwan), anti-inflammatory (Thailand)	Among others: abruquinone, alanine, choline, anthrocyanins, aspartic acid, campesterol, chrysanthenin, cysteine, dolphin, eicosane, galactose, gallic acid, glutamine, glycine, lectin, leucine, lysine, polysaccharide, etc	Ross (2003)

Table 5 (Continued)

No	Botanical name	Utilization by other communities	Active chemical compound	References
4.	*Baccaurea lanceolata*	Antioxidant, abdomen pain (Serawak), treat water fleas (Jambi)	Phenolic, flavonoid, anthocyanin, carotenoid	Bakar et al. (2014); Hariyadi & Ticktin (2012); Kulip (2003); Manullang et al. (2013)
5.	*Blumea balsamifera* (L.) DC.	Postpartum recovery (Lao and Southeast India), perineal high, retraction of high uterus, miscarriage recovery (Lao), diarrhea, dysentery, colic, leucorrheasis, helminthic (Southeast India), nosebleed (Sabah)	Flavanoid, terpens, lactones, sineol, borneol, kamper, tannin	Dewi, Nisaa', Kabangnga', Boiga, & Rahmah (2007); Kulip (2003); Lamxay et al. (2011); Noorcahyati, Falah, & Ma'ruf (2010); Rahayu, Sunarti, Sulistiarini, & Prawiroatmodjo (2006); Rositta SMD, Rostiana, Pribadi, & Hernani (2007)
6.	*Blumea mollis* (D.Don) Merr. (Compositae)	Anti-bacterial, anti-inflammatory, hepatoproctivity, eucorrhoea (India)	Alkanes, chrysanthaenone, methanol	Devi, Namratha, Kumar, & Kumar (2011); Ratnam K. & Raju R. (2005)
7.	*Brucea javanica* (L.) Merr.	Hepatitis, diarrhea, fever (Jawa), disentery, malari, (Kutai), diabetes (Dayak Meratus), antibacterial	Saponin, tannin, poliphenol, peptide	Dewi et al. (2007); Hidayat (2005); Sangat et al. (2000); Sornwatana et al. (2013)
8.	*Caesalpinia sappan* L.	Antibacterial, anticoagulant, menorrhagia, cardiovascular, cerebrovascular diseases (China)	Homoisoflavanoid, juglone	Zhao et al. (2014)
9.	*Callicarpa longifolia* Lam.	Cure wounds (Aceh and Dayak), malari, inflammation (Aceh); diarrhea (etnis Talang Mamak); face powder (Dayak Tanjung); ulcer (Belitung), diarrhea, malari, kidney disease (Kutai)	Saponin, karbohidrat, tanin, alkaloid, steroid	Dewi et al. (2007); Hidayat (2005); Karmilasanti & Supartini (2011); Kloppenburg-Versteegh (1983); Sangat et al. (2000)
10.	*Carica papaya* L.	Appetite enhancer, malari (Jawa, Kamerun), hypertension (Sunda, Kamerun)), helminthic (Kamerun)	Flavonoid, tanin, steroid-triterpenoid, carbohydrate	Hidayat (2005); Indrawati (2002)
11.	*Cnestis platantha* Griff.	High fever ailment (Malaysia)	No reference	Samuel et al. (2010)

Table 5 (Continued)

No	Botanical name	Utilization by other communities	Active chemical compound	References
12.	*Drymoglossum piloselloides*	The leaves are used to treat rashes, whilst a decoction is used in a lotion for smallpox, and used in a poultice for headaches (Malay)	Phenol, alcohol, alkanes, alkenes, ethers, aldehyde, ketones, carboxylic acids, esters carboxylic acids	Bali, Fatimawali, & Wehantouw (2014); Giesen, Wulffraat, Zieren, & Scholten (2006)
13.	*Eurycoma longifolia* Jack	Sexual stimulant, aphrodisiac, treatment of male osteoporosis (Malaysia)	Eurycomanone, eurycomanol, eurycomalactone, alkaloid, phenolic components, tannins, triterpenes, quanissoids	Effendy et al., (2012); Samuel et al. (2010)
14.	*Flemingia macrophylla*	Anti-oxydant, analgesic, anti-inflammatory , anti-tyrosinase (China)	Flavanoid, flavanone, genistein, flemiphyllin	Shiao, Wang, Wang, & Lin (2005); B. S. Wang et al. (2012); YJ et al. (2010)
15.	*Ficus deltoidia* Jack.	Afterbirth treatment to contract uterus and vaginal muscles, treat disorder menstrual cycle, leuchorroea, wounds healing, sore of rheumatism (Malaysia); relieve headache, cold, toothache, aphrodisiac and health tonic (Indonesia); antidiabetics, anti-inflammatory, antimelanogenic, antibacterial antiphotoaging, antioxidant, antiulcerogenic	Shikimic acid, terpenoids, flavonoid, monoterpenes, aliphatic, sesquiterpenes, terpenes, triterpenes	Bunawan et al. (2014)
16.	*Hiptage benghalenzis* L. Kurz	Burning skin (India)	Saponin, tannin, flavonoid	Agharkar (1991)
17.	*Hyptis brevipes* Poit.	Headaches (Panama); diarrhea (Paraguay); protective medicine after childbirth (Malaysia and Indonesia), protection against worms for newborn infants (Java)	Methylene chloride, methanol extracts, bioactive flavonoids, triterpenoids	Rositta SMD et al. (2007); Sakr, Roshdy, & El-Seedi (2013)
18.	*Lepisanthes amoena* (Hassk). Leenh	Treatment of facial skin, antibacterial	alkaloids, terpenoids, steroids, flavonoids, saponin, carbohydrate	Kuspradini, Susanto, & Ritmaleni, Mitsunaga (2012)
19.	*Melastoma malabathricum* Linn.	Man vitality (Dayak Bahau), swollen mouth (Aceh), diarrhea	Naringenin, kaempfenol	Hussain, Abdullah, Noor, Ismail, & Ali (2008); Noorcahyati et al. (2010); Sangat et al. (2000); Sunison, Anandarajagopal, Kumari, & Mohan (2009)

Table 5 (Continued)

No	Botanical name	Utilization by other communities	Active chemical compound	References
20.	*Mimosa pudica* Linn.	Sedative, expectorant, anti inflammation, fever, helminthic, insomnia, dysentery	Tanin, mimosin, asam pipekollinat	Dalimantha (2006); Dewi et al. (2007); Rahayu et al. (2006); Saputra (2009)
21.	*Morinda citrifolia* L.	Hypertension (Sunda, Kutai), amandel (Dayak Kendayan), man vitality (Sumba); inflammatory bowel, laryngitis, hepatitis, fever, cough (Kutai), jaundice (Perak, Malaysia)	Alkaol, sterol, polysaccharide, courmarin, scopoletin, ursolic acid, linoleic acid, caproic acid, capryllic acid, alizarin, acubin, xeronin iridoid glycoside, vitamin C, A, karotena	Dalimantha (2006); Dewi et al. (2007); Samuel et al. (2010); M. Y. Wang et al. (2002)
22.	*Oroxylum indicum* (L.) Benth.ex Kurz	Fever, stomach ache (Kutai), malari, kidney ache, snake bite (Mentawai), swelling (Sabah)	Saponin, poliphenol, flavonoid	Dewi et al. (2007); Hidayat (2005); Kulip (2003)
23.	*Parameria polyneura* Hook.f.	Make the uterus shrink after childbirth (Java and Malaysia), teeth blackening	saponin, poliphenol, flavonoid, tanin	van Valkenburg (2001)
24.	*Phyllanthus urinaria* L.	Cough (Malaysia), backpain (Jambi), anticancer, antitumor, and anti angiogenic	Corilagin, gallic acid, ellagic acid	Kulip (2003); S.T., Pang, & Yang (2010)
25.	*Senna alata/Cassia alata* Linn.	Ring worm,scabies, (Indonesia, Malaysia, Thailand), himnithic, eye drops, fever, hepatitis (Kamerun), anti-implantation, abortifacient, anti-gonadotropic, anti-progesteronic	Antraquinone (rhein and aloe-emodin), chrysophanic acid, glucose, alkaloid	Gritsanapan & Magneesri (2009); Jiofack et al. (2010); Kulip (2003); Yakubu & Musa (2012)
26.	*Tamarindus indica*	Postpartum recovery, varicella, mild puerperal, neonatal high fever (Lao); abdominal pain, diarrhea and dysentery, helminthes, wound healing, malaria, constipation, inflammation, cell cytotoxicity, gonorrhea, eye diseases (India, Pakistan, Bangladesh, Africa)	copper, iron, sodium, manganese, magnesium, otassium, phosphorus, lead, and zinc	Bhadoriya, Ganeshpurkar, Narwaria, Rai, & Jain (2011); Khanzada et al. (2008); Lamxay et al. (2011)
27.	*Tinospora crispa* (L.) Hook.f.Thomson	Malaria, rheumatics, bruising, appetite enhancer, hepatitis, hemnithic, cough, calligata, diabetes	Alkaloid, saponin, tannin, flavonoid, glikosida, pikroretin, baberin, palmatin, kolumbin, jatrohize	Samuel et al. (2010); Sangat et al. (2000); Supriadi (2001); Windadri, Rahayu, Uju, & Rustiami (2006)

medicinal plants have various material qualities depending on the source of the countries and plants, due to genetic differences, environmental conditions, and the methods of harvesting, transportation and storage (Rinaldi & Shetty, 2015; Sakhya, 2016).

2. The dosage of medicinal plants was not standardized. In these research sites the treatment dose was determined only by habits (such as a glass of water) or size of the patient's body. Modern medicine demands standardized dosage based on factors such as bodyweight or disease severity. Traditional healers are more likely to give patients a unique dosage or combination of medicines that is decided during the consultation (Rinaldi & Shetty, 2015).
3. The extensive use of trees and root parts of medicinal plants can lead to the extinction of the medicinal plants species.

Therefore, to ensure the supply and quantity, the medicinal plants need to be cultivated, particularly the trees and those species where the roots are used. It is also important to do cultivation efforts of forest medicinal plant species to anticipate the scarcity due to deforestation and forest conversion. The cultivation, harvesting, and transportation methods also need to be standardized to ensure the product quality. It is also important to do further medical research to determine the proper dosage, and also to get information about the pharmatical compound of the medicinal plants.

IV. CONCLUSION

This research has identified and documented 44 medicinal plants species from 30 families which are used for women's health in forest communities around Gunung Beratus Protection Forest, Wehea Forest, and the villages of Menamang Kiri and Menamang Kanan. Out of the total 7 species were used as reproductive health medicinal plants, 30 species as postpartum and maternal medicine, and 9 species as cosmetics. At least there were 27 species which were also used by other communities for similar or other efficacies, and the active chemical compounds of 25 species have been known.

Compared to modern pharmaceuticals, the utilization of traditional medicinal plants are cheaper, more available, and easy to be accessed. But those medicinal plants were grown wild, and have not yet been cultivated by the community, so the quality of medicinal plants can not be guaranteed and the dosage of medicinal plants was not standardized. The extensive use of trees and roots part of medicinal plants can lead to the extinction of the medicinal plant species. Therefore, they need to be cultivated to ensure their quality and quantity, and also to avoid species extinction.

The traditional forest communities also need guidance and facilitation to learn and do cultivation effort of the medicinal plants as an exsitu conservation, especially for the species where the root part and trees are used. The ethno-botanists should do phytochemically and further medical tests of the medicinal plant samples found in the three research locations.

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THEORETICAL FRAMEWORK FOR SPATIAL PLANNING AND FOREST MANAGEMENT IN INDONESIA: SECURING THE BASIC RIGHTS FOR ADAT PEOPLE

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THEORETICAL FRAMEWORK FOR SPATIAL PLANNING AND FOREST MANAGEMENT IN INDONESIA: SECURING THE BASIC RIGHTS FOR ADAT PEOPLE. Limited transparency, accountability, and participation in policy formulation as well as implementation mainly based on economic considerations, all lead to failure to attain sustainable forest management (SFM). Along with the reluctance of policy makers and lacking stakeholder capacity, less accurate data bases has also indicated a constraint in the development of appropriate action. The issues have been more complicated where they were correlated with economic imperatives, vested interest, ownership issues and the basic rights of indigenous communities living inside or adjacent the forest. Forest destruction will be no end without securing customary land and territorial rights. To cope with these issues, the concept of fair governance has been promoted as an alternative to the traditional pattern of administration. In this paper, we propose a theoretical framework for policy development in order to attain SFM while respecting the rights of the adat people. We show that adaptive governance, adaptive management, and participatory learning are strategic approaches in governance reform to achieve sustainable forest management securing the customary rights and traditional land use of forest dependent people.

Keywords: Forest management, adaptive governance, spatial planning, Indonesia, adat

KERANGKA TEORI UNTUK PERENCANAAN TATA RUANG DAN PENGELOLAAN HUTAN DI INDONESIA: PERLINDUNGAN HAK DASAR MASYARAKAT ADAT. Minimnya transparansi, akuntabilitas dan partisipasi dalam perumusan kebijakan dan implementasi yang hanya didasarkan pada pertimbangan ekonomi, mengakibatkan kegagalan tercapainya tujuan pengelolaan hutan lestari (PHL). Seiring dengan keengganan para pembuat kebijakan dan keterbatasan kapasitas pemangku kepentingan, kurangnya basis data yang akurat telah terbukti menjadi kendala dalam pemilihan rencana pengelolaan yang tepat. Masalah pengelolaan hutan ini menjadi lebih rumit ketika berkorelasi dengan kepentingan ekonomi, kepentingan kelompok tertentu, dan persoalan hak-hak dasar masyarakat adat yang tinggal di dalam dan sekitar hutan. Kerusakan hutan tidak akan berhenti tanpa menjamin hak masyarakat adat atas lahan dan teritorialnya. Untuk mengatasi masalah ini, konsep tata kelola yang berkeadilan dipromosikan sebagai alternatif pengganti dari pola administrasi tradisional. Dalam tulisan ini, kami mengusulkan kerangka teoritis untuk pengembangan kebijakan untuk mencapai SFM dengan tetap menghormati hak-hak rakyat Adat. Tata kelola adaptif, manajemen adaptif, dan pembelajaran partisipatif merupakan pendekatan strategis dalam reformasi tata kelola untuk mencapai pengelolaan hutan lestari dengan tetap melindungi hak-hak adat dan penggunaan lahan secara tradisional masyarakat yang bergantung pada hutan.

Kata Kunci: Pengelolaan hutan, tata kelola adaptif, perencanaan tata ruang, Indonesia, adat

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I. INTRODUCTION

Issues related to deforestation, land degradation, and disharmony between stakeholders, have formed an ongoing theme in many international forest-related workshops, scientific journals and publications for more than three decades. This interest is motivated by significant global deforestation and its effecton government revenue, environmental degradation, and the livelihood opportunities of forest-dependent people (Boafo, 2013; UNEP, 2011, 2012). Empirical data across countries show that a main cause of forest destruction and conflict among stakeholders is weak governance, which is characterized by limited transparency, accountability, and participation (Carothers & Brechenmacher, 2014; Drazkiewicz, Challies, & Newig, 2015; Rodríguez Bolívar, Navarro Galera, & Alcaide Muñoz, 2015). The term governance is used to label a process marking a decreasing role for the government and an increasing role for others in public service provision, addressing social as well as economic considerations at the same times in a balanced way (Rhodes, 1996).

Although concerns related to weak forest governance did receive attention invarious international forums, there is still limited knowledge about the effecton deforestation, degradation, and livelihoods at local levels, as well as how to address this issue to attain sustainable forest management (Blaser, 2010). The issues have been more problematic when they correlate with ownership issues, territory, and the basic right of indigenous community. For many indigenous peoples, the forest plays essential roles in ensuring their cultural, spiritual and different ways of economic well being (Marwa et al., 2010; Kawharu, 2011; Roslinda et al., 2012).

The term of indigenous peoples in Indonesia is associated with some different terminology such as native people, isolated people and adat communities or adat law communities. The Ministry of Social Affairs identifies some indigenous communities as *komunitas adat terpencil* (geographically-isolated indigenous communities) (IWGIA, 2016). However, many more peoples self-identify or are considered by others as indigenous. Recent laws and regulations use the term masyarakat adat to refer to indigenous peoples, including Law No. 5/1960 on Basic Agrarian Law, Law No. 39/1999 on Human Rights, Law No. 27/2007 on Management of Coastal and Small Islands and Law No. 32/2009 on Environment Protection and Management. Law No. 32/2009 on Environment Protection and Management, article 1 point 31 define Adat law community as a community group hereditary living in certain geographic areas based on the ancestral bond, the strong relationship with the environment, and the existence of value system determining economic, political, social, and legal institutions.

In Indonesia, a country with more than 1300 ethnic groups and more than 2500 languages (BPS, 2010). issues related to indigenous people and customary right have been considered as intriguing issues for many years and widely increased since the regional autonomy era (Banjade, Herawati, Liswanti, & Mwangi, 2016; Royer, Visser, Galudra, Pradhan, & Noordwijk, 2015). Most of the indigenous community territories are located within forest areas. According to AMAN (*Aliansi Masyarakat Adat Nusantara*/Indigenous Peoples' Alliance of the Archipelago), 90 percent of at least 84 million ha of adat communities' territories are forest (Zakaria, 2017). In many cases, adat people who lived on (state) forest for generations before the issuance of Forestry law are accused as forest encroachers (Hartanto, Rangan, Thorburn, & Kull, 2008; Wijaya, 2014). This accusation leads to conflict in almost every Indonesian region (IWGIA, 2011; Wijaya, 2014). Currently, there are 33 thousand villages in and adjacent to forest areas with a conflict, and without legal certainty (Tambunan, 2012).

The Spatial Planning Law No. 26/2007 and the Government Regulation of National Spatial Plan 26 (2008), stipulated that the adat community has a legal position to affect spatial planning policy particularly the spatial policy of the forest. However, involving the adat community in spatial planning process is not an easy process. Adat rights normatively are acknowledged but in practice they are not properly accommodated in land use planning processes. The recognition of usufruct right of indigenous people, –the right to derived benefits from the forest and forest land without any damage on the forest function- as stated in forestry-related statutes has not yet been translated in practical regulation (Kusumanto, 2007; Nizar, 2010; Raharjo, 2014). Meanwhile, as community groups with a large population depending on forest resources, adat communities are at an increased threat from land use change impact, global deforestation and environment degradation.

In the International Workshop on Deforestation and the Rights of Forest Peoples held in Palangkaraya, Indonesia March 2014, delegates agreed that forest destruction will be no end without securing forest peoples' land and territorial rights. Measures must also be taken at all levels to ensure full participation of indigenous people, who inhabit, use, have customary rights to, and rely on forests for their identity and survival as a key stakeholder in decision-making.

Concerning to above mentioned issues, this paper proposes a concept for the reform of forest-based spatial planning respecting the basic rights of the adat people, covering policy making as well as a way to introduce policy reform. The main focus is the design of a practical mechanism incorporating decision support systems, based on the answers to the following questions: (1) How to move from normative to measurable policies? (2) How to incorporate resources, needs, power, and knowledge? (3) How to formulate appropriate tools and mechanisms, involving all key stakeholders inspatial planning policy formulation, implementation, and monitoring?

II. MATERIAL AND METHOD

This paper is written basically based on series of literature studies consisting of series of activities from finding, reviewing and evaluating relevant material, and synthesizing information. This paper develop its arguments from extracting existing legal frameworks and other related policies, journals, textbooks and publications concerning spatial planning, forest management, governance, indigenous community, and adat. The narratives of spatial planning and forest management incorporating adat rights is viewed using a theoretical framework in the context of an appropriate spatial planning governance. A theoretical framework consists of concepts and existing theory that is used for a particular study. The theoretical framework demonstrates an understanding of theories and concepts that are relevant to the topic and that relate to the broader areas of knowledge being considered (McGinnis & Ostrom, 2014).The selection of a theory depend on its appropriateness, ease of application, and explanatory power.

The paper is structured in the following sections; the section one examines the weaknesses of traditional governance and the issues of adat peoples in Indonesia. The second section discusses differences between traditional administration versus modern governance. The third section depicts the history of spatial planning, forest governance, and adat rights in Indonesia. The fourth section explain theoretical framework toward a solution, and the last section is concluding remarks.

III. RESULT AND DISCUSSION

A. Administrative Reforms: Traditional Versus Modern

In the past two decades, many countries have been trying to formulate appropriate development policies to attain sustainable solutions, moving from conventional centralized development policies to a decentralized approach with increasing involvement of stakeholders (Faguet, 2014; Faludi, 2009; Yazdi, 2013). This new direction is in line with the growing awareness of the interrelationships between social-economic and ecological systems (Ekayani et al., 2014; Fabiny

Table 1. Differences between traditional administration and modern governance

Parameters	Traditional administration	Modern Governance	Literature
Dominant Players	Central government	Multi- player, multi-level	Ardanaz, Leiras, & Tommasi (2014); Bressers & Kuks, (2003); Heuer (2011); Jordan, Wurzel, & Zito (2005)
Policy development process	Centralistic; direct central governmental action, top down, minimal integration, strict command and control	Social humanitarian; socio-cybernetic system, self-organizing network, transparent, accountable, adaptive, and flexible	Ardanaz et al. (2014); Cimpoeru & Cimpoeru (2015); Drazkiewicz et al. (2015); Fung, (2014); Jordan et al. (2005); Osakede & Ijimakinwa (2015); Rhodes (1996); Rodríguez Bolívar et al. (2015)
Driving factors	Economic	Social-ecological and economic	Jordan et al. (2005); Lesliea et al. (2015); McGinnis & Ostrom (2014); Rhodes (1996)

et al., 2014; Lesliea et al., 2015; McGinnis & Ostrom, 2014).

In Indonesia, an archipelagic country with a republican system of government consisting of more than five hundred autonomous regions, inhabited by more than 240 million people from more than 1,300 tribes, and spread out over 6,000 inhabited islands, administrative reforms are essential. It is not a simple concept, but should be managed in a systematic way, from problem identification, policy formulation, and implementation, to monitoring and evaluation, while being highly influenced by stakeholders. Table 1 indicates the main differences between traditional administration and modern governance are summarized.

B. Spatial Planning, Forest Governance and Adat Rights in Indonesia

The turning point in the Indonesian political system from a highly centralized government to a new era of decentralization came in 1998, at the time of the resignation of President Suharto, the leader of the New Order regime. Since that year, there has been a gradual political power devolution from central to local government, in accordance with a reformation era. Expectations regarding the potential outcome of decentralization and power devolution were high. In fact, implementation of decentralization occurred much faster than the legal formal process (Moeliono & Dermawan, 2006). However, in forest management, reality did not match the expectations. Deforestation continued (Suwarno, Hein, & Sumarga, 2015), and the frequency of forest-related conflicts increased dramatically during the early implementation of authority decentralization (Nurrochmat, 2005; Wulan et al., 2004). The decentralization process, particularly in forest administration, was planned and implemented poorly (Barr et al., 2006; Hadiz, 2004). Local community interests were not properly accommodated in the land use planning processes (Kusumanto, 2007; Moeliono & Dermawan, 2006).

1. Spatial Planning and Forest Governance

The history of Indonesian forest related spatial planning dates from 1982, when the Ministry of Home Affairs formally requested the Ministry of Forestry (MOF) to create Consensus-Based Forest Land Use Planning or *Tata Guna Hutan Kesepakatan* (TGHK). Two years later, in 1984, the MOF produced TGHK maps, classifying forests as (1) protection forest, i.e., for watershed protection; (2) conservation forest, i.e., as national park or other protected area; (3) limited production forest, where timber harvesting needs protective measures to avoid soil erosion; (4) production forest, for timber harvesting; and (5) conversion forest, for conversion to agriculture, plantation crops, settlements, or other uses.

In October 1992, the central government enacted the first Indonesian law regulating spatial planning. Law No. 24 of 1992 on spatial planning forced the central government to delegate planning authorization to local governments and encouraged public participation. In this law, spatial planning was defined as a process of space planning, space utilization, and control over space utilization. This spatial planning law stipulated the principles of the spatial planning which included integrity, sustainability, effectiveness, efficiency, compatibility, harmony, openness, equality, justice, and legal protection. In accordance with the issuance of the new law, the MoF produced new integrated maps that merged the TGHK maps with the spatial plans of the new provincial and district planning agencies.

Milestones of decentralization and devolution in Indonesia were the issuances of Law No. 22 of 1999 on Regional Governance and Law No. 25 of 1999 on Fiscal Balancing between the Central and Regional Governments (Ardiansyah & Jotzo, 2013; Bennet, 2010). Under Law No. 22 and 25 of 1999, central government gave autonomous regions the opportunity to manage local resources directly (Fadli, 2014). In the forestry sector, the government issued Forestry Law No. 41 of 1999, replacing Basic Forestry Law No. 5 of 1967. In 2004, Laws No. 22 and 25 of 1999 were replaced by Laws No. 32 and 33 of 2004, respectively.

Following the institutional reforms, in April 2007, Law No. 26 of 2007 on Spatial Planning was promulgated, replacing Law No. 24 of 1992. The law provides more detailed regulations than the previous spatial planning law including rights, obligations and the forms of public participation in spatial planning. The new law contained some provisions that were not included in the previous one. The new law provides greater authority to local governments in the implementation, supervision, and control of spatial planning. The new law also emphasizes the importance of public participation in spatial planning, providing more detailed regulations regarding rights, obligations, and forms of public participation.

In reality, policy devolution and integration were not implemented and envisioned. Local governments only played a limited role, and participation was a concept rather than being implemented (Bennet, 2010). Two decades of reform and devolution of political power did not result in effective sustainable forest management. On the contrary, deforestation has been accelerated in line with the increasing trend of administrative fragmentation. From 1999 to 2010, 205 new administrative regions have separated from their former administrative jurisdictions. Unfortunately, of all 524 autonomous regions, 199 regions (provinces and districts) are partially situated in forest areas (Komisi Pemberantasan Korupsi, 2010).

2. Adat Rights

There are a few policies that regulate the rights of local communities to the land, but the recognition of people's customary territory is still limited (Johnson, 2015). Recognition of the rights of adat or customary rights in Indonesian law commenced five decades ago appears in the Law No. 5 of 1960 concerning Basic Agrarian

Law (BAL). The law provide general principles that accommodate recognition of adat communities, ulayat land rights, and adat laws. A definition of Adat community is stated in Law No. 32 of 2009 on Environment Protection and Management. The Law defines an adat community as a community group traditionally living in a certain geographic area, based on ancestral bonds, a strong relationship with the environment, and the existence of a value system determining economic, political, social, and legal institutions (Republik Indonesia, 2009a). Forestry Law No. 41 of 1999 and government regulation number 26 of 2008 concerning National Spatial Planning normatively regulate that adat people have certain rights regarding utilization/cultivation of forest areas: to collect forest products (usufruct) for their daily needs and to carry out forest management practices according to customary laws as long as these are not in conflict with the formal legislation (Republik Indonesia 1999).

In fact, many adat communities in Indonesia have little tenure security for lands they have been living on, managing, or cultivating for generations (Moniaga, 2009). Since the new era of decentralization (1999), there were many hopes that the democratisation process would open up opportunities for formal recognition of customary land rights. Yet, the government continues to consider many adat lands as state domain, state forest areas. Forestry Law No. 41 of 1999 stated that "customary forests are state forests located in the areas of custom-based communities".

As a response to a petition submitted by the Indigenous Peoples, in May 2013, Indonesia's Constitutional Court issued a decision on the Judicial Review of some parts of Act No. 41/1999 on Forestry. In the decision No. 35/PUU-X/2012, the Constitutional Court confirmed that Customary Forests are forests located in Indigenous territories, and should no longer be considered as State Forests.

Yet despite these important events, indigenous peoples in Indonesia continue to face conflicts of territory, land and natural resources (AMAN, 2014). The recognition of indigenous claims is still a complicated and sensitive issue.

The challenge is how to balance function-based sustainable forests and livelihood security of forest dependent people/adat communities. Since spatial conflicts involving local people communities have been a latent problem, holistic knowledge of the ecological system combined with a clear understanding of the social economic and cultural dynamics of the community is essential (Bryan et al., 2010; Ryan, 2011). The approach should pay attention to the issues related to certainty of land tenure and the basic rights of local people, and promote transparent and participatory processes in decision making.

C. Theoretical Framework Towards a Solution

Even in developed countries, spatial conflicts usually emerge where economic concerns and conservation benefits clash. Laws governing development and those governing conservation are often in conflict (Garmestani et al., 2008). Decentralization itself cannot guarantee the success of attaining sustainable forest management and securing the livelihood of local people (Angelsen, 2009; Ardiansyah & Jotzo, 2013; Suwarno et al., 2015).

We recommend two interrelated factors as a prerequisite of good quality forest-based spatial planning for achieving Sustainable Forest Management considering adat rights:

1. Availability of an appropriate institution to formulate forest-based spatial planning law based on various resource, needs, and knowledge of multi stakeholders
2. Availability of appropriate mechanisms and tools to formulate sustainable forest management technologies based on comprehensive and accurate data and information.

D. Determining Appropriate Institutions

Environmental governance is not only a matter of regulation and law enforcement, as the more important aspect is development of a framework for coordinating and controlling multiple stakeholders with multiple interests (Cronkleton et al., 2008; Drazkiewicz et al., 2015; UNEP, 2013) and synergizing their various resources, power, need and knowledge (Frost, Campbell, Medina, & Usongo, 2006; UNEP, 2013).

Determining appropriate institutions can be conducted in a systematic way by firstly assessing the existing and then the ideal conditions for a spatial planning process in terms of rules, structures and stakeholders involved. In our view, this systematic assessment should be based on data or information, which is generated from the perspectives of all stakeholders.

The key parameters in assessing the existing rules and structures (i.e. the process of policy formulation, interpretation, and implementation) of spatial planning are transparency of the political process, effectiveness of the policy instruments applied, economic efficiency of the use of resources, and legitimacy in line with democracy (Florini, 1999; Lindstedt & Naurin, 2010). This depends on whether the interest and the involvement of all stakeholders are consistent or not with the position, interest, and legitimacy they have. Referring to Schmeer (1999), stakeholder positions are related to whether stakeholders support, oppose or are neutral about the policy. Stakeholder interest is related to the advantages or disadvantages of the implementation of a policy for each involved party. Stakeholder importance is related to the capacity of stakeholders to interfere in the process of policy implementation (Schmeer, 1999). Meanwhile, in this case, legitimacy refers to public admission (formal or informal) regarding the right and authority of each stakeholder.

In Figure 1 we depict the process of improving appropriate institutions to fill the gap between the actual and the ideal as an important part of governance reform.

E. Synergizing Resources, Needs and Knowledge for Policy Formulation

As mentioned above, an important aspect of governance is the development of an effective mechanism for coordinating and controlling stakeholders with multiple interests. There must be clear roles and connections among stakeholders in synergizing resources, needs and knowledge for policy formulation. Holistic knowledge of the ecological system combined with a clear understanding of the social economic and cultural dynamics of the community at various levels is essential to improve the quality and effectiveness of an environmental policy (Bryan et al., 2010; Huber et al., 2013; Lesliea et al., 2015; Ryan, 2011). Thus, institutional activities are not only to assemble multi perspectives, needs and interest of stakeholders but also to develop a conducive environment and a better mechanism for data or information sharing. In the case of Indonesia Forestry, there are many stakeholders (either private or governmental institutions) responsible for producing data, but in reality the data produced are sometimes inaccurate, inaccessible, or do not match or are not suitable for certain needs in terms of their format and scale (temporal and spatial).

The critical point, however, is to ensure that the whole process will flow. A major challenge is thus to present stakeholders at all levels with knowledge and learning capabilities. Adat people or civil societies should be involved in the whole policy process, from upstream to downstream. Since local people and the forest inhabitants can be either potential agents for achieving a sustainable outcome or a potential agent of disorder, activating and placing them in an appropriate role and position determines the flow of the whole mechanism.

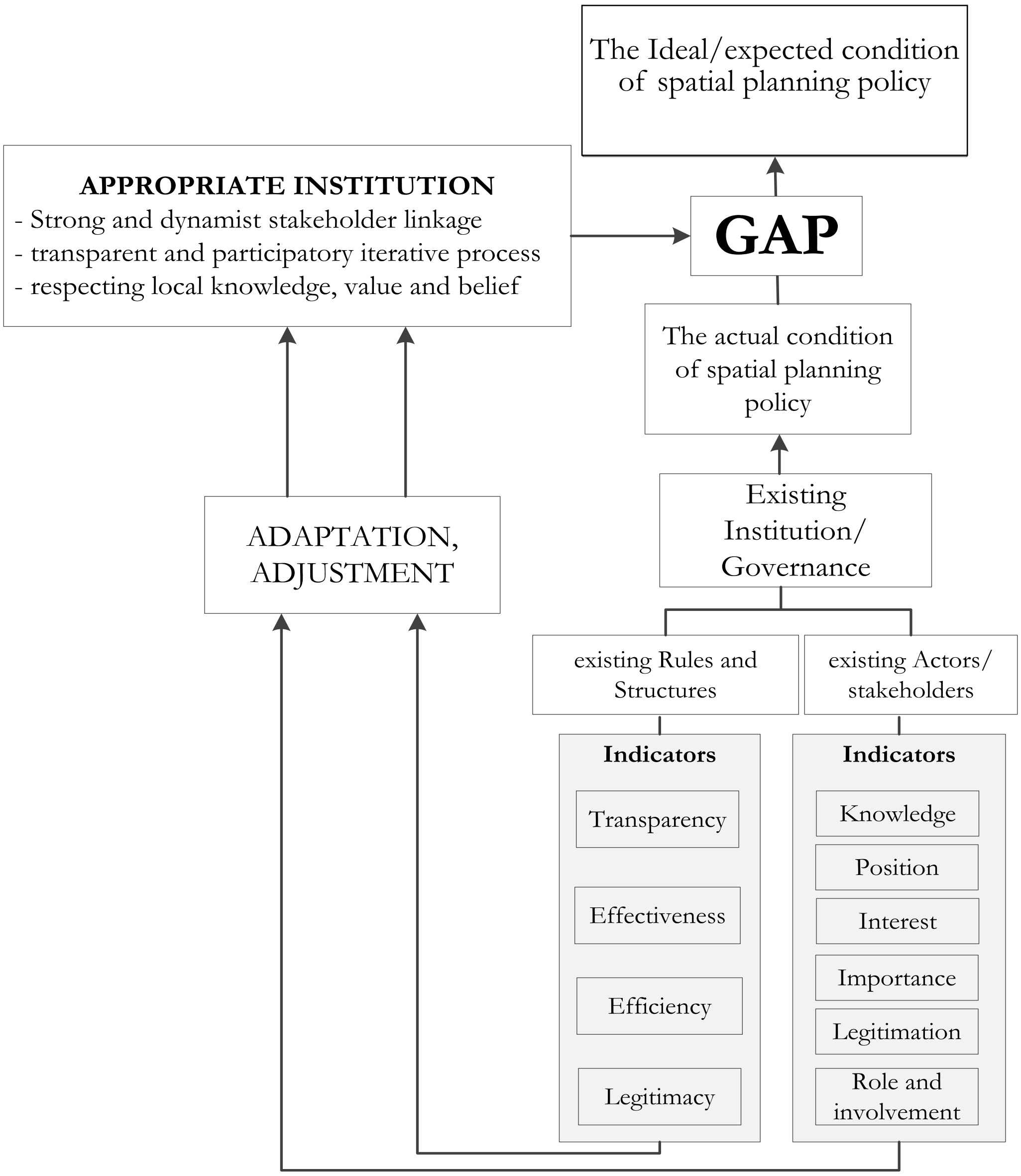

Figure 1. Framework of appropriate institution determination

F. Determining Appropriate Tools and Mechanisms for Policy Formulation: from Normative Into Measurable Policies

Forestry Law No. 41 of 1999 regulates that adat forest utilization by the adat community must be in accordance with the forest function. Utilization by the adat community is acceptable as long as it does not disturb this function. Similar to the Forestry Law, Government Regulation No. 26 of 2008 on National Spatial Planning, regulates that native people have the right to utilize or cultivate forest areas as long as there is no damage to the functions and under strict supervision. All regulation is however normative. In general, regulations are developed based on standards and guidelines or opinions of policy maker and do not take into account scientific principles which are actual, objective and testable. The problems thus are: how to implement the regulation; how to translate the regulation into a lower order and more practical regulation, such as technical guidance of site management; how to enable local people or the

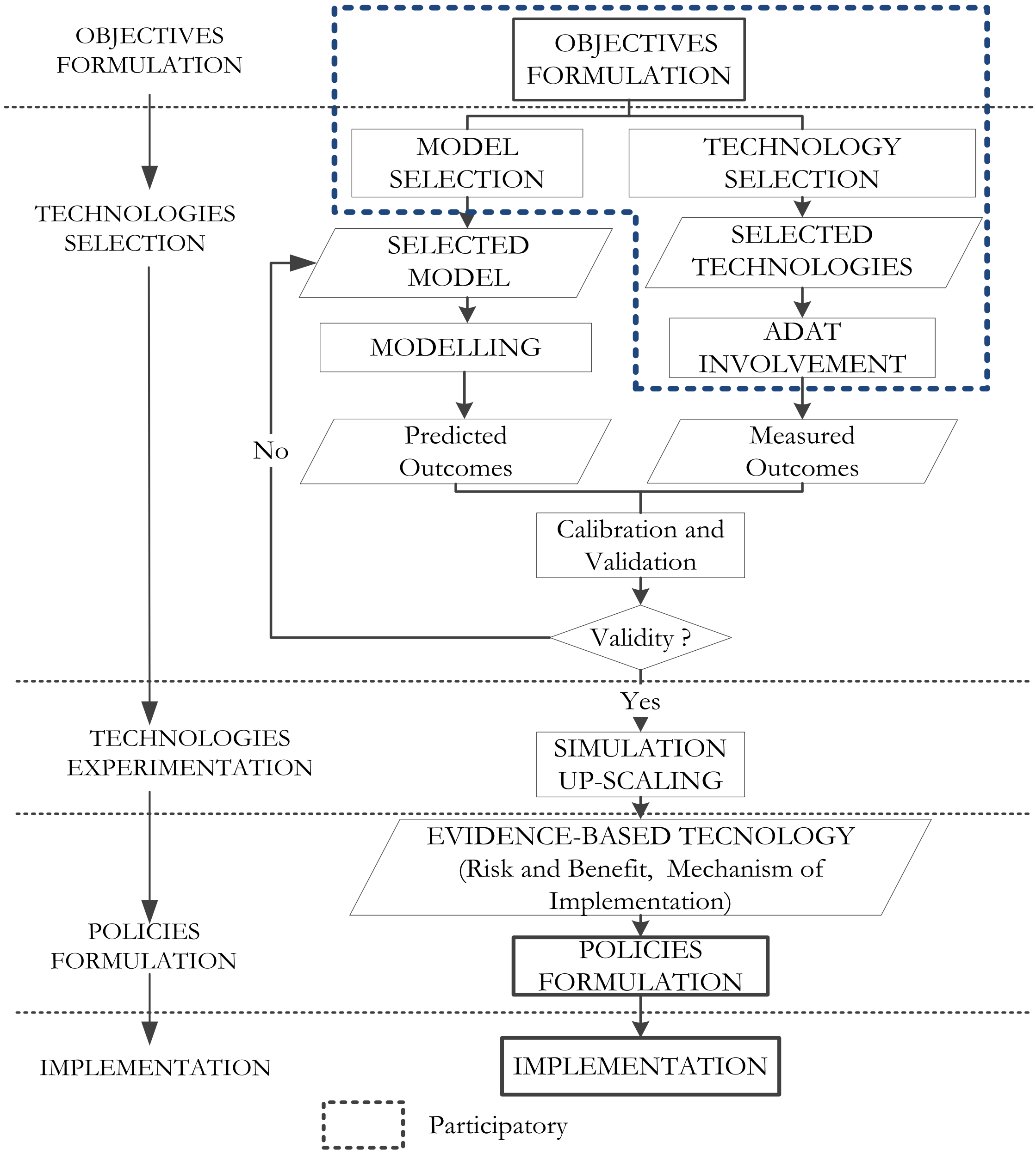

Figure 2. Framework for formulation of adaptive management technology

adat community to utilize their adat forest to gain direct or indirect income without breaking the rules?

For spatial planning in a forested region where the traditional community is a main stakeholder, an important aspect of management is to define a tool or mechanism that translates the rules into 'easily understood' technical language. The tool or mechanism should be able to explain the benefits and risks of each interpretation and implementation of each policy.

Using research findings as evidence, development policy is to be formulated as a combination of Spatial Decision Support Systems (DSS) and the process of "learning by doing". The process of "learning by doing" is a combination of a collaborative and systemic learning and a knowledge developing process (Eksva¨rd & Rydberg, 2010). In Figure 2, we present a conceptual framework of policy formulation adopting the principles of adaptive management and participatory learning. All processes are conducted in a participatory manner, involve key stakeholders, and start with objective formulation, guiding the process of achieving objectives into policy through adaptive procedures. A DSS helps decision makers to define the right alternative based on different scenarios, by combining the benefits of GIS, expert systems, and model simulations (Prasad, Strzepek, & Kopen, 2004). Meanwhile, participation is employed to enable local people as well as other stakeholders (e.g. local government, NGOs, investors) to witness the consequences of undertaking certain activities or not, and to learn from the real process.

By using the policy formulation process as mentioned above, the need to secure basic adat rights in balance with the need to attain sustainable forest management can be accommodated and tested transparently and scientifically. Using spatial modeling, the correlation between actual conditions, policy formulation process, formulated policies, and potential impact after implementation can be traced. The most suitable land for adat people and the best management practice for traditional landuse, (technically applicable, economically feasible, socially acceptable, and ecologically suitable) with efficient input, high yield, and low negative impact on the forest landscape can thus be determined and designed.

G. Application Prerequisites

As we mentioned above, the important factors of good forest-based spatial planning are the availability of appropriate institutions, the availability of holistic and accurate data and information and availability of appropriate mechanisms and tools to formulate adaptive management technologies. For Indonesia, as a quite young democratic country, the challenges are accessibility and availability to data or information, low quality of stakeholders' capacity, and political resistance. For almost all local governments, data and information are rather scarce and expensive.

The capacity of stakeholders involved in the process is seen here as a critical issue. Thus, building capacity and raising willingness of stakeholders responsible for policy formulation, interpretation, and implementation is essential.

Another hindrance is the mentality of certain individuals in local government. Their resistance blocks access to new mechanisms or approaches promoting transparency (Bellver & Kaufmann, 2005; Florini, 1999). In some cases, transparency has been avoided deliberately. There is an inverse relationship between transparency in governance and opportunities for corruption. Transparent decision making will increase the probability that corruption is detected (Cimpoeru & Cimpoeru, 2015; Peisakhin, 2012; Takim et al., 2013).

Related to the effort to increase local people participation, a transparent policy process is thus a key factor. People will only participate when there is trust. It is impossible to gain the trust of citizens without providing transparent factual information (Grimmelikhuijsen, 2012; Hasan, 2013). Transparency will not only increase efficiency in resource allocation, but will also make an equitable distribution of benefits possible (Bellver & Kaufmann, 2005; The Union for Ethical Bio Trade, 2013).

Another fundamental prerequisite for adaptive governance and management is the learning capability and willingness of stakeholders to move out of their 'comfort zone'. Two problems that will be encountered are defensiveness and the ego of actors. Defensive attitudes resulting from defensive reasoning will block any real change .

Learning therefore not only contains a technical aspect but also a moral-behavioral one. Kolb (1984) promotes experiential learning, where he considers experience as a source of learning. Learning is the continuous process of human adaptation to create knowledge as a transformation of experiences. To motivate local communities and to promote a dedicated approach to landscape management, a participatory learning approach (PLA) as an effort to involve communities in formulating and evaluating a problem and its solutions (Bottomley & Denny, 2011), should be employed.

IV. CONCLUSION

Failure of the previous classical spatial planning governance may be caused by the dominance of an interest group indifferent to open policy alternatives. Adaptive governance is a precondition for interaction between societal actors in participatory decision making by involving parties at multiple levels and multiple scales to support ecosystem management (Heuer, 2011; Loorbach, 2007). The governance process needs to assure that there will be equal opportunity for all stakeholders to benefit from the process. Thus, for agreement in governing, future interaction among stakeholders is a necessity.

We recommend two interrelated factors as a prerequisite of good quality forest-based spatial planning for achieving sustainable forest management considering adat rights: 1) Availability of an appropriate institution to formulate forest-based spatial planning law based on various resource, needs, and knowledge of multi stakeholders, and 2) Availability of appropriate mechanisms and tools to formulate sustainable forest management technologies based on comprehensive and accurate data and information.

We recommend that national policymakers allow flexibility in spatial planning policy implementation but develop mechanisms of accountability and control between local and central authorities. The quality of decision making can be improved if decision makers are aware of the implications of their actions (Krott, 2005; Nurrochmat et al., 2016; Ekayani et al., 2016).

Since information forms an essential factor in the formulation of future policies and the analysis of possible outcomes, the process of collecting and analyzing data must be conducted systematically and precisely. The quality of information reflects the accountability as a base for legitimacy. Public awareness and participation will not be attained unless they have access to information on what they will gain, and the risks and benefits of their involvement. Since the DSS is a computer-based mechanism of policy making, monitoring as a means of evaluation and control in this policy system is no longer difficult. The information concerning reasons behind a particular policy and the potential risks and benefits of a certain policy can be accessed through information technology (IT) systems. Again, the supporting effort to make all systems work is increasing the capacity and willingness of all actors responsible in policy formulation, interpretation, and implementation.

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ABSTRACT: Written in Bahasa Indonesia and English. Abstract should be no longer than 250 words, giving a brief summary of the content includes brief introduction, the reason for conducting the study, objectives, methods used, result and discussion and conclusion. Do not include tables, elaborate equations or references in the abstract.

KEYWORDS: Four to six keywords should be provided for indexing and abstracting. The word or term to be written under abstract; overviewing the issues, discussed, separately written from general to specific nature.

INTRODUCTION: State the objectives of the work and provide an adequate background of the research objectives, avoiding a detailed literature survey or a summary of the results.

THEORY/CALCULATION (if any): A theory or detailed calculation should be extended, not repeated, in the introduction. The theory or calculation mentioned should lay the foundation of the work.

MATERIAL AND METHOD: Provide sufficient detail of the research work to allow method to be reproduced. Describe the time and location of the study, materials and tools used, as well as research method. Methods already published should be indicated by a reference. Specific location should include the geographical information system. Only relevant modification to the method should be described clearly.

RESULT AND DISCUSSION: Results should be presented clearly and concisely. Discussion should explore the significance of the results work to the current condition or other research result, but not repeating the result. In case of large amount of result, result and discussion may be separated into sub chapter of result and sub chapter of discussion. Current reference (five years old reference) is an advantage to support the research finding than older references.

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ACKNOWLEDGEMENT: Acknowledgement is recommended for persons or organizations who has already helped the authors in many ways. Sponsor and financial support acknowledgements may be placed in this section. Use the singular heading even if you have many acknowledgements.

REFERENCES: At least 10 references; referring to APA style 6th edition; organized alphabetically by author name; 80% from last 5 years issues; and 80% from primary reference sources, except for specific science textbooks (mathematics, taxonomy, climate). To properly credit the information sources, please use citation tools such as Mendeley or EndNote to create a bibliography, references and in-text citations. Mendeley is a free reference manager that can be downloaded at https://www.mendeley.com/download-mendeley-desktop

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In Text Citation :

Water is a necessary part of every reasons's diet and of all the nutrient a body needs to function, it requires more water each daya than any other nutrients a body needs to function, it requires more water each day than any other nutrient (Whitney & Rolfes, 2011)

Or

Whitney and Rolfes (2011) state the body requires many nutrients to function but highlight that water is of greater importance than any other nutrient.

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JUDUL HARUS RINGKAS, INFORMATIF DAN SECARA JELAS MEREFLEKSIKAN ISI MANUSKRIP. Tuliskan terjemahan abstrak dalam bahasa Indonesia. Abstrak tidak lebih dari 250 kata. Abstrak menjelaskan keseluruhan isi artikel. Abstrak meliputi maksud, tujuan penelitian, metodologi yang digunakan, hasil dan kesimpulan. Maksud penelitian harus menjelaskan secara ringkas permasalahan yang diteliti menggunakan bahasa ilmiah umum yang mudah dimengerti oleh pembaca. Teknologi atau metodologi yang digunakan untuk pemecahan permasalahan penelitian harus dicantumkan secara lengkap dan ringkas dalam abstrak. Ringkasan hasil penelitian dan temuannya ditampilkan dalam ringkasan singkat. Kesimpulan harus menyatakan outcome yang dicapai dalam kegiatan penelitian.

Kata kunci: Empat sampai enam kata kunci untuk keperluan indeksasi dan abstraksi. Setiap kata mencakup isu yang dibahas dan diurutkan secara alphabet dipisahkan oleh tanda koma

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- There should no nonstandard abbreviations, acknowledgements of support, references or footnotes in the abstract.
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I. INTRODUCTION

State the objectives of the work and provide an adequate background of the research objectives, avoiding a detailed literature survey or summary of the results. To prepare your manuscript, a template can be downloaded from: http://ejournal.forda-mof.org/ejournal-litbang/files/IJFR_Template.docx

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This chapter of theory/calculation is noncompulsory or optional. A theory or detailed calculation should be extended, not repeated, in the introduction. The theory of calculation (if any) mentioned should lay the foundation of the work.

III. MATERIAL AND METHOD

Provide sufficient detail of the research work to allow method to be reproduced. The material and method chapter can be divided into several sub-chapters.

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Describe the time and location of the study, materials and tools used as well as research method.

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Methods already published should be indicated by a reference. Specific location should include the geographical information system. Only relevant modification to the method should be described clearly.

C. Your Analysis

Write the process of inspecting, cleaning, transforming and modeling data with the goal of discovering useful information, suggesting conclusions and supporting decision-making.

IV. RESULT AND DISCUSSION

Results should be presented clearly and concisely. Discussion should explore the significance of the results work to the current condition or other research result, but not repeating the result. References must be used to support the research findings and expected to be written at least in the last five years.

V. CONCLUSION

A brief summary of the possible clinical implications of your work is required in the conclusion section. Conclusion contains the main points of the article. It should not replicate the abstract, but might elaborate the significant results, possible applications and extensions of the work.

ACKNOWLEDGEMENT

Acknowledgement is a must for persons or organizations who that have already helped the authors in many ways. Sponsor and financial support acknowledgements may also be placed in this section. Use the singular heading even if you have many acknowledgements.

REFERENCES

At least 10 references are listed according to American Psycological Association (APA) referencing style, 6th edition. References must be listed in alphabetical order by another name. Eighty percent of references should be cited from primary sources and published in the last five years. To properly credit the information sources, please use citation tools such as Mendeley or EndNote to create a bibliography, references and in-text citations. Mendeley is a free reference manager that can be downloaded at https://www.mendeley.com/download-mendeley-desktop/.

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