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Biodiversity, carbon stocks and community monitoring in traditional agroforestry practices: preliminary results from two investigated villages in Berau, East Kalimantan

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Abstract

Traditional agroforestry practices in Berau, East Kalimantan, are suitable land use types to conserve that potentially support the implementation of REDD+. The objectives of this research are to assess biodiversity and carbon stock in various traditional agroforestry practices, also to determine the accuracy of the ability levels of local community in biodiversity and carbon stock monitoring. This paper presents the implementation plan and preliminary data in Kampung Birang and Kampung Merabu, in Berau district. Professional forester-led methods of biodiversity and carbon stock assessment follow the recommended procedures, while training component are carried out using different method in order to test the accuracy of monitoring level. First round of data collection in both villages identified main fruit trees, locally known as *langsat*, in Kampung Birang, while different durian were found in Kampung Merabu. Field observation showed that the total time taken for completing the monitoring work has declined in line with the work cycle progress supported by willingness of community to participate in the monitoring program.

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Keywords: agroforestry; Berau; biodiversity; carbon stocks; REDD+

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1. Introduction

Carbon emission from forest degradation and deforestation has caused global warming and climate change. REDD$^+$ (Reducing Emissions from Deforestation and Forest Degradation) is one of climate change mitigation approach. It aims to reduce deforestation and forest degradation, to maintain carbon stocks, to enhance sustainable forest management and conservation of biodiversity, and to strengthen the existing of carbon stock [1]. In general, preparation and implementation of REDD+ projects need substantial investments to implement required activities such as (a) baseline determination, (b) measurement, reporting & verification and (c) safe guarding program to prevent leakage and to ensure social and ecological sustainability.

One of alternative ways to enhance biodiversity and carbon stocks for the implementation of REDD+ was the need for safe guarding program to connect social and economic aspects of the community around the forests with the forest ecology. This could be achieved through the development of agroforestry practices. Agroforestry has been recognized to be suitable land use systems to maintain biodiversity and carbon stocks [2, 3]. Agroforestry areas enhance biodiversity in intensively farmed landscapes as agroforestry areas provide natural elements and shelters for economically important species. In the segregated landscapes, agroforestry plays an important positive role in biodiversity preservation by providing islands of semi-natural vegetation where many species can be found that would otherwise be totally absent [1]. Based on Shibu and Sougata [2], one of example agroforestry practices, namely organic coffee agroforestry farms, given contribution to greenhouse gases mitigation and biodiversity conservation in a synergistic manner which has implications for the effective allocation of resources for conservation and climate change mitigation strategies in the agricultural sector. Agroforestry has been recognized as having the greatest potential for C sequestration of all the land uses [4].

In Berau, East Kalimantan, agroforestry such as forest garden are commonly practiced. Forest management by agroforestry practices have been much applied by communities and promoted by the government of Indonesia including in Berau district, East Kalimantan. Almost 75% area in Berau is covered by forests and regional government has commitment to apply REDD+ mechanism there. Although the potential of REDD+ implication in Berau district was high, but it is still needed to be observed carefully since forest land cover in Berau is still high, as well as the threat of degradation and deforestation. In addition, most of land area in Berau district is rural, where livelihood still depends on forest products and forest resources [5].

Baseline information regarding the biodiversity and carbon stock status in various agroforestry types are still lacking that are indispensable to determine the role of existing agroforestry in Berau. This is due to lack of sufficient resources to monitor the biodiversity and carbon stocks and involving local community participation for such monitoring activities has been suggested with raised concerns on the accuracy level. Devolving monitoring of biodiversity and carbon stock to communities is desirable and possible as reported by Danielsen et al. [6]. According to Hartanto et al. [7], in managing the surrounding forests and natural resources, the community in this areas has committed to the following emissions reduction activities:

- Limit slash and burn or swidden agriculture to former plots.
- Manage around 10,000 ha of protection forest as a part of the Ministry of Environment & Forestry's Program on *Hutan Desa* (Village Forest).
- Secure and rehabilitate degraded areas within the *Hutan Desa*.
- Survey and protect caves inside the *Hutan Desa* where some of which are of high archaeological importance with unique handprint patterns.

Therefore, a study focusing on biodiversity, carbon stock and community monitoring has been designed in Berau with the following objectives: i) to assess the baseline information on biodiversity and carbon stocks in various agroforestry practices, and ii) to determine the accuracy and ability levels of community in work cycle of biodiversity and carbon stock monitoring.

2. Methods

2.1. Study site

This research is part of the collaborative research on the role of community monitoring on biodiversity & carbon

stocks, livelihood and forest rights in relation to safeguarding aspects of REDD+ implementation in Indonesia. This part of research focuses on traditional agroforestry that has been identified to be relevant with safeguarding aspects and field works are now being implemented in two sites (villages), namely Kampung Birang and Kampung Merabu (Fig. 1). Plot establishment has been done to develop baseline data on biodiversity and carbon stocks involving local community monitoring. The selection of the two villages in Berau was determined based on the following criteria: i) representing various agroforestry practices such as forest garden and rubber agroforestry, ii) being supported by the local community, and iii) having good accessibility. The selected sites are located in Kampung Birang (Gunung Tabur sub-district) and Kampung Merabu (Kelay sub-district) (Fig. 1).

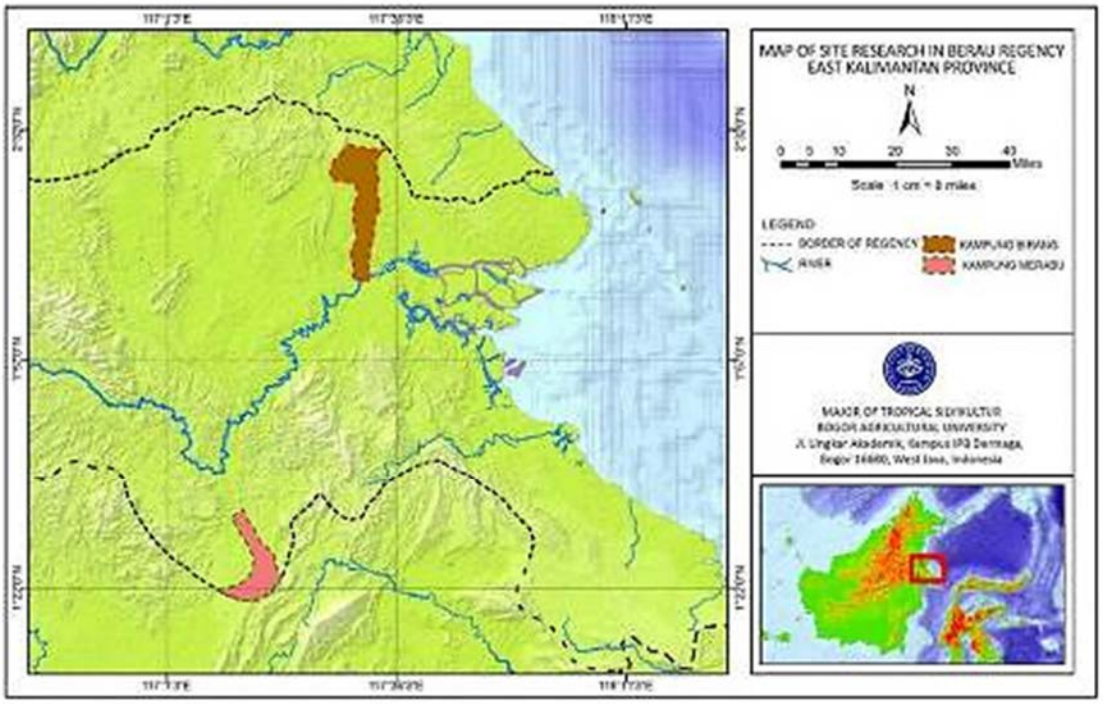

Fig. 1. Approximate location of two research sites in Berau, as marked by Kampung Birang and Kampung Merabu, Berau, East Kalimantan.

Kampung Birang was one of village in Berau District which is included in Gunung Tabur Sub-District, around 11.6 km of distance to Berau. Kampung Birang is the largest village in the Gunung Tabur sub-district with a total area of 302.58 km^2 comprising 301.27 km^2 of land and about 1.31 km^2 of water. The boundary of Kampung Birang is Bulungan district to the North, Makassang village to the East, Segah River to the South and Tasuk village to the West. The main livelihoods of community were farmer, gardener, the labour of company, fisherman, seller, and staff of government. In addition, community usually look for valuable *gaharu* or agarwood, and hunt for wild animals in the forests. Only a small proportion of the community (7-9 family heads or 10%) performs shifting cultivation activities [8]. The majority of Kampung Birang community had forest gardens along the edge of the Kampung Birang River. Moreover, productive fruit plants also grew along the road to the village. Those commodities were *rambutan*, *langsat*, *orange*, *duku* and others fruit trees. These fruits were seasonal fruit which were sold out of the village. The seeds had been provided by the mining company that had corporate social activity surrounding the village. In Berau district, Kampung Birang is known as one of the central producers to supply the needs of people in this district [8].

Kampung Merabu administratively belongs to Kelay sub-district, Berau district, East Kalimantan. The distance of this sub-district to Berau is about 300 km. This village has a total area of 22,118 ha [8]. This village area consists of protected forest (10,800 ha), production forest (12,200), and karst region (7,500 ha). Kampung Merabu is located in a

karst or limestone bedrock landscape, Berau. Mountainous area of Menyapa Protection Forest which extends into Kampung Merabu is one of a few small areas given the protection status in this karst ecosystem. The limestone caves are source of livelihoods for young men in this village who generate income as cave climbers and bird's nests harvester. The nests are sold in the international market as the main ingredient for the delicacy "bird's nest soup". However this way of life is threatened by mining interests that would like to extract coal from the village boundaries [7].

The climate in Berau's lowland is tropical humid with two peaks rainy season during December-January and around May and dryer period around August (Fig. 2). The relation of average monthly rainfall (solid and striped blue) to average monthly temperature (red line) illustrates Berau District's humid climate, with mean monthly rainfall above 100 mm throughout the year.

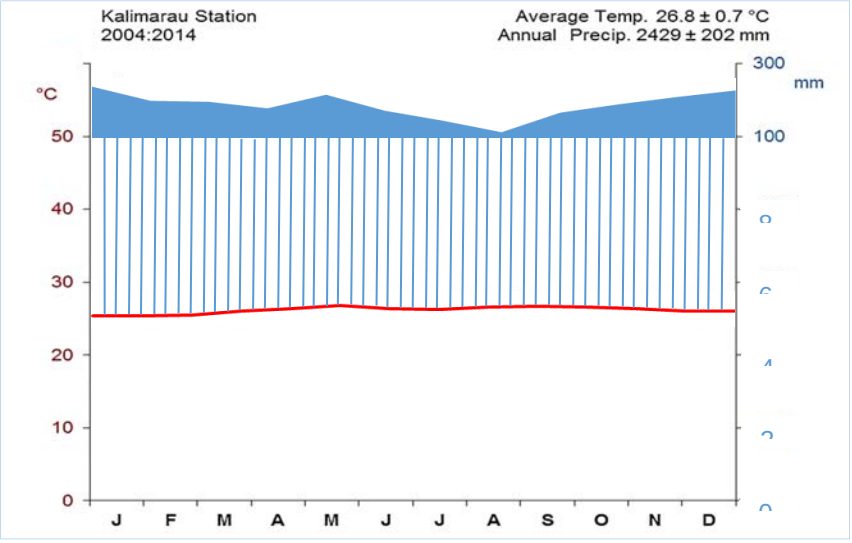

Fig. 2. Average monthly temperature and rainfall at Kalimarau Airport, Berau (2004-2014). Raw data were analyzed from the Meteorology and Climatology Agency of Kalimarau, East Kalimantan [9].

2.2. Sampling design

Sampling plots in each village were selected based on NDVI (Normalized Difference Vegetation Index) and they have been classified into 10 classifications of NDVI in which each classification of NDVI has 3 replicates (Fig. 3). In the first phase, preliminary field works were conducted to provide the overview of plant diversity and biomass, through measurements in nine research square plots (50 m x 50 m) in Kampung Birang (n=6 plots) and Kampung Merabu (n=3 plots) including total time taken to complete the work cycle.

2.3. Field observation on community monitoring

The field works were carried out through the following work cycle as described visually in Fig. 4. Training for the local community was conducted in line with plot establishment, measurement of tree diameter, identification of tree species, tree tagging, and also soil sampling. The trained villagers were the owners of the garden who showed their interest and willingness to participate in the monitoring program. At this stage, cumulative timing method was used to measure time taken to complete all elements of monitoring activities.

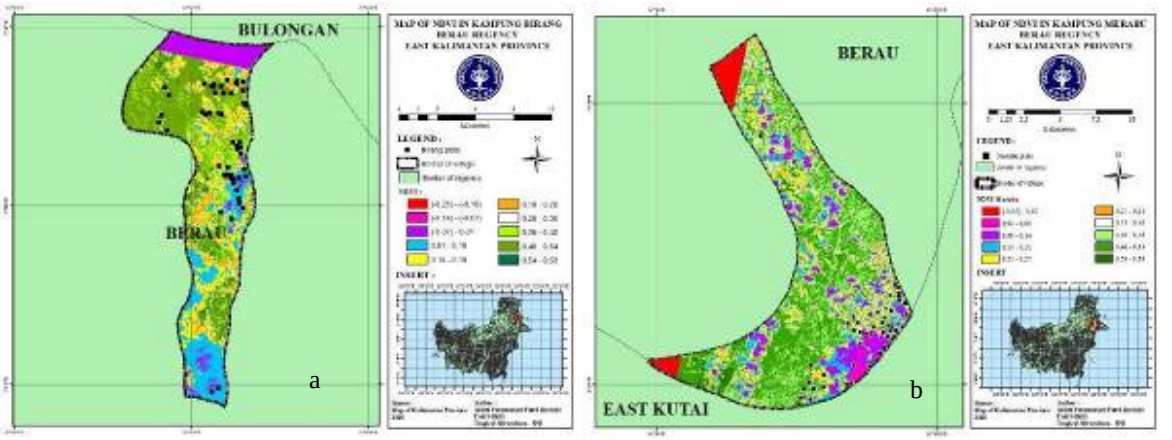

Fig. 3. The distribution of selected plots based (black dots) on NDVI in Kampung Birang (a) and Kampung Merabu (b).

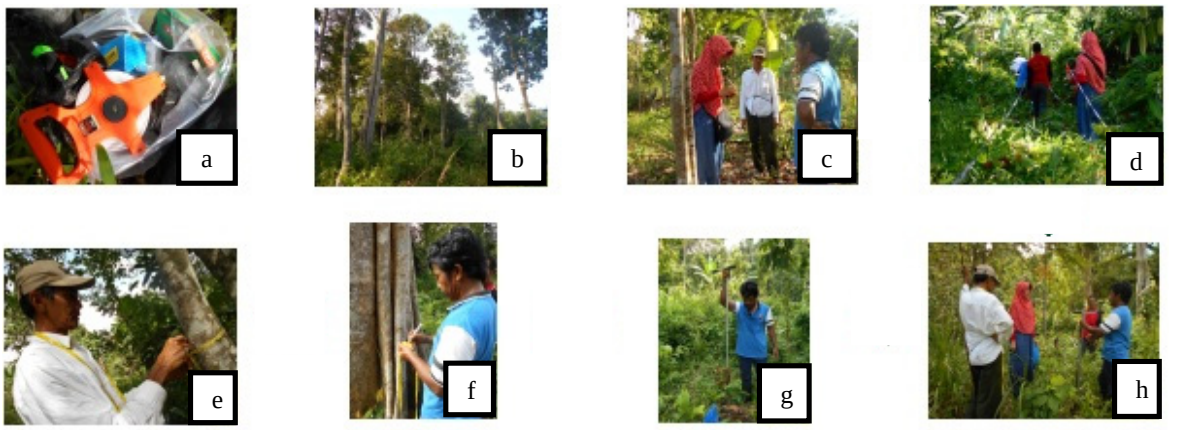

Fig. 4. Research preparation and activity in the field with community tools (a), forest garden in Kampung Birang (b), training to the community about tree tagging (c), plot establishment (d), measurement of tree diameter (e), tree tagging (f), soil sampling (g), and discussion with community (h).

2.4. Vegetation analysis

Preliminary data was collected in the first phase by performing remote sensing, ground checking, in-depth interview, and collecting secondary data including the ecology, socio-economy aspects. The training was conducted to transfer the knowledge on plot establishment, identification of species diversity and soil sampling technique to the local community. The training measurement of carbon stock is planned to be conducted in the second phase.

Vegetation structures on major tree species (seedling, sapling, pole, and tree) are analyzed to calculate the Importance Value Index (IVI). Importance Value Index (IVI) can be used to analyze dominant species in community. To obtain IVI, the value of relative density (RD), relative frequency (RF) and relative dominance (RD) from that species are added up [10], the formula are written as follows:

$$\text{IVI (seedling and sapling)} = RD + RF \quad (1)$$

$$\text{IVI (pole and tree)} = RD + RF + RDo \quad (2)$$

Misra [11] explained the way to calculate IVI, as follows:

$$\text{Density (D)} = \frac{Total\ number\ of\ individuals}{Total\ number\ of\ quadrats\ studied} \quad (3)$$

$$\text{Relative Density (RD)} = \frac{Number\ of\ individuals\ of\ the\ species}{Number\ of\ individuals\ of\ all\ species} \times 100 \quad (4)$$

$$\text{Frequency} = \frac{Number\ of\ quadrats\ in\ which\ species\ occured}{Total\ number\ of\ quadrats\ studied} \quad (5)$$

$$\text{Relative frequency (RF)} = \frac{Number\ of\ occurence\ of\ the\ species}{Number\ of\ occurence\ of\ all\ occurence} \times 100 \quad (6)$$

$$\text{Dominance} = \frac{Total\ number\ of\ individuals\ of\ the\ species}{Total\ number\ of\ quadrats\ of\ occurence} \quad (7)$$

$$\text{Relative dominance (RDo)} = \frac{Total\ basal\ area\ of\ the\ species}{Total\ basal\ area\ of\ all\ species} \times 100 \quad (8)$$

3. Results and Discussion

3.1. Forests and agroforests in Berau

The coverage of forest area in Berau district is more than 2 million hectares (Table 1). The forest function in Berau district is designated as permanent production forest (29.18%), limited production forest (29.90%), protected forest (16.07%), conservation forest (0.02%), and other uses (24.78%). The tree species dominating forest area are dipterocarps, while area for the other forest uses are dominated by fruit trees and rubber trees planted and maintained by the local community.

Table 1. Forest area of Berau district based on Forestry Minister Decree No. 79/Kpts II/2001.

No.	Forest	Area (ha)	% Area
1	Permanent production forest	616 210.93	29.18
2	Limited production forest	631 491.85	29.90
3	Protection forest	339 391.45	16.07
4	Conservation forest	500.00	0.02
5	Other forest uses	523 431.10	24.78
Total		2 112 025.33	100.00

Source: Forest Service of Berau district [7]

Historically, agroforestry practices in Kalimantan can be classified into two groups: i) traditional agroforestry and ii) modern agroforestry.

- Traditional agroforestry
  Various types of agroforestry practice have been applied by local community, for example the integration between woody plant (tree, shrub, palm, bamboo, etc.) with agriculture and/or livestock. This practice was found from a unit of land management until agro-ecosystem landscape. Thaman [12] defined traditional or classical agroforestry as integration between agriculture system and woody plant (by planting or maintenance of tree stand), as well as

social, economic, ecology and whole of the system (agro-ecosystem). Traditional agroforestry practices from East Kalimantan have been applied from generation to generation with different practices, which depend on the tribes, and also have high correlation with socio-culture, for example:

a) *Simpung Munaan*
   Simpung Munaan is one of cultivation area that was occupied by Dayak Tunjung community, after the farmer opens the farm fields. The farm fields which have been planted by paddy, then in some part of area will be planted by fruits. By the community of Tunjung tribe this routine activity was considered as efforts to utilize empty area. Beside Simpung Munaan there was other Simpung namely *Simpung We'* (rattan garden) and *Simpung Tanyut* (Benggeris trees that produce honey) [13].
b) *Lembo*
   In Dayak Benuaq community, forest gardens are planted by the owner after cleaning the area. During that time, the community lives in *rumah panjang*. Research showed that flora biodiversity in *lembo* is high in tree level to understory [14]. Despite the local people only know one *lembo* term, *lembo* can be classified into four types: *lembo ladang*, *lembo lamin*, *lembo rumah* and *lembo jalan*. Based on the structure, composition and distance from dwellings, *lembo* can be categorized into forest garden (far from settlements) and domestic garden (near settlements). Most *lembos* are quite small covering between 0.1 and 2.0 ha. Their extent depends on the number of families or group members who use them, how long the *lembo* has been used, and the duration of the main growing season. *Lembo rumah* and *lembo lamin* which take the form of small forests on farmland are much larger than *lembo ladang* which is tended by individuals. *Lembos* always integrate intimately into farmland or settlements. All can be identified as tree-covered area on farmland and/or around the houses of their owners [15].
c) *Kebun buah in Kampung Birang*
   In general, community of Kampung Birang has planted fruit trees from generation to generation in their gardens. The community uses traditional tool also traditional knowledge for forest garden cultivation. The main species in this forest garden is *langsat roko.*
d) *Uma in Kampung Merabu*
   Uma is the old field in Kampung Merabu Since 1990's in Kampung Merabu, community has converted the forest to be *Uma*. The community plants various types of fruit in the *Uma* usually like *durian*, *larung*, *sadon*, *kameng*, *nanakan*, etc.

- Modern agroforestry
  In general, modern agroforestry only depends on integration between perennials or commercial trees and crops. Different from traditional or classical agroforestry, hundreds of trees outside of the main component or wildlife which become an integration in traditional agroforestry, might not be found in the modern agroforestry [12, 14]. Besides, modern agroforestry usually depends on industry demand. As discussing the practices of modern agroforestry like cocoa and rubber agroforestry, several characteristics could be compared with respect to environmental settings, biodiversity and ecosystem services as well as human dimension aspects.
  a) Cocoa agroforestry
     This type of agroforestry is not yet common in Berau. Lessons from cocoa agroforests in other districts, i.e. Malinau and Kapuas Hulu, East Kalimantan, showed that the overall level of biodiversity in cocoa agroforests was higher than other agricultural landscapes [16]. Cocoa mixed garden is promoted to anticipate price volatility of cocoa beans due usually to speculative movement linked to international trade.
  b) Rubber agroforestry
     Kampung Merabu also implements modern agroforestry where rubber as the main woody plant in forest garden. Government has subsidized community with providing rubber seedlings. In this study, the age of rubber trees was 2 years at the time of field observation.

3.2. Work cycle and cumulative timing in community monitoring

Prior to data collection, training was conducted for the community to transfer knowledge on plot establishment, measurement of tree diameter, identification of tree species and tree tagging, also soil sampling. Representatives of the local communities in each village attended the training conducted in the selected agroforestry sites where data was

also jointly collected at Kampung Birang and Kampung Merabu by community and researcher (Table 2).

Timing was used for completing the following work cycle in community monitoring, namely plot establishment, tree diameter measurement, tree tagging (labelling), tree identification, and soil sampling. Results showed that total time taken for completing the activities has declined in line with the work progress (Fig. 5). Skills gained by the community from the training and more experience gained from work cycles may contribute to this pattern.

Table 2. Type of data and the data collector in the work cycle observation.

No.	Type of data or activity	Data collector
1	Plot establishment	Community
2	Measurement of tree diameter	Community
3	Identification of tree species and tree tagging	Community
4	Soil sampling	Community
5	Biophysical condition (coordinates, light intensity, temperature)	Researcher

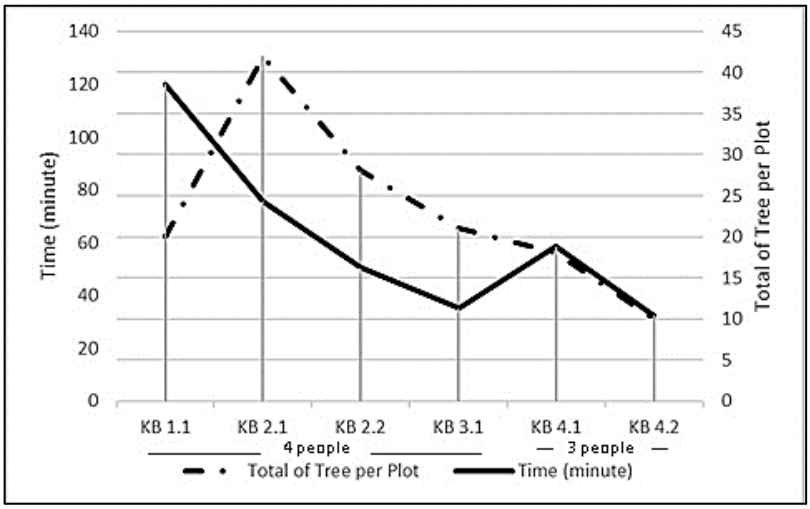

Fig. 5. Total time taken for plot establishment, tree diameter measurement, tree tagging, tree identification, and soil sampling by community.

3.3. Tree diversity in Kampung Birang

Results of vegetation analysis in Kampung Birang showed that *langsat* trees comprising of *langsat telur* and *langsat roko* are the most dominant tree species with Importance Value Index (IVI) at tree level of 223.17% and 53.18%, respectively (Table 3). A species can be classified as important if IVI at tree level is more than 15% and in the young level is more than 10%. Therefore *langsat telur* and *langsat roko* are important species in this agroforestry practices.

Table 3. Importance Value Index at tree level in Kampung Birang.

No	Species (Local name)	Importance Value Index (%)
1	Langsat roko	53.18
2	Durian	9.59
3	Langsat telur	223.17
4	Belimbing	1.68

No	Species (Local name)	Importance Value Index (%)
5	Pinang	4.65
6	Rambai	3.42
7	Nangka	1.44
8	Rambutan	2.88
Total		300

On March, community of Kampung Birang usually harvests the fruit and sells it to another village. *Langsat* is the main commodity in Kampung Birang.

3.4. Tree diversity in Kampung Merabu

Community in Kampung Merabu usually plants around 0.8 ha/year. In 2013 they only planted for 0.6 ha. Kampung Merabu has received government support to plant rubber trees. Thus, it is found that most villagers have at least one tree garden and expected to add several more trees in the future. In January 2014 community of Kampung Merabu submitted a proposal concerning the arrangement of village forest management that later received the support from central government with a decree letter of Minister of Forestry No. 28/Menhut-II/2014. This positive decision gives more long-term certainty to manage village forest (*Hutan Desa*) with a total area of 8245 ha [17].

Kampung Merabu has received government support to plant rubber trees, but community also plants the fruits species among the rubber trees. Those fruit trees are *durian larung*, *durian sadon*, *durian hutan* (local durian) , *lai hutan*, *keker*, *kelidang*, *kameng*, *kapul*, *tengok*, *dabai*, *bemotong*, *manggis hutan*, *mejalin*, *buah akar karet*, *dupar*, *buku-buku*, *meretem*, *kejirun*, *lenggajar*, *mali*, *kebayung*, *payang*, *bolang*, *pusok raa*, *buah akar lang*, *belak*, *kiran*, *terep*, *cempedak*, etc. Although they cultivate diverse fruit species, they only consume the fruits for themselves since selling the fruits is problematic due to lack of infrastructure for transporting the fruits.

Kampung Merabu has 3 species of durian, namely *durian larung*, *durian sadon*, and *durian hutan*. Morphologically, leaf size of *durian hutan* (local durian) is the smallest among *durian larung* and *sadon* (Fig. 6). In addition, leaf size of *durian sadon* is the biggest among the others. *Durian sadon* is the superior durian fruit in Kampung Merabu.

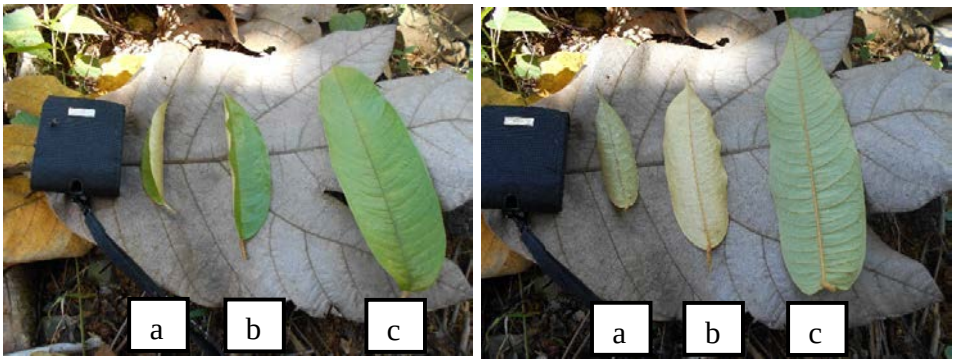

Fig. 6. Leave sizes of *durian hutan* (a), *durian larung* (b), and *durian sadon* (c).

4. Conclusion and Way Forward

Agroforestry practices in Kampung Birang is categorized as traditional agroforestry, while in Kampung Merabu could be classified as modern agroforestry. Dominant species in Kampung Birang are *langsat telur* and *langsat rook* as shown from the Importance Value Index at tree level, namely 223.17% and 53.18%, respectively. Kampung Merabu has three main species of Durian, namely *durian larung*, *durian sadon*, and *durian hutan*. With respect to the accuracy

of measurement by community, it was observed that amount of time taken to complete work cycle of monitoring activities has declined in line with the work cycle progress. These preliminary results are beneficial to plan further research steps including: i) new plot establishment (30 plots for each site), ii) biodiversity assessment (species identification, canopy profile and herbaria collection), and iii) carbon stock measurements.

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References

1. Atangana A, Khas D, Chang S, Degrande A. *Tropical agroforestry*. Springer; 2014.
2. Shibu J, Sougata B. Agroforestry for biomass production and carbon sequestration: an overview. *Agroforest Syst* 2012;**86**:105–111.
3. Nair PKR, Nair VD, Kumar BM, Showalter JM. Carbon sequestration in agroforestry systems. *Advances in Agronomy* 2010;**108**.
4. IPCC. *Land use, land-use change, and forestry*. Cambridge: Cambridge University Press; 2000. P. 375 A special report of the IPCC.
5. Rahmanulloh A, Sofiyuddin M. *REDD+ di Berau: Melacak emisi menimbang implikasi*. Bogor (ID): ICRAF; 2011 (in Bahasa).
6. Danielsen F, Adrian T, Brofeldt S, van Noordwijk M, Poulsen MK, Rahayu S. Community monitoring for REDD+: international promises and field realities. *Ecology and Society* 2013;18(3): 41.
7. Hartanto H, Hayden L, Madeira EM, Tomy SY, Hidayat T. Envisioning a green & prosperous future with the Berau forest carbon program. Kalimantan: The Nature Conservancy; 2012.
8. Statistic Agency of Berau. *Berau dalam angka*. Berau: Government of Berau; 2015 (in Bahasa).
9. Meteorology and Climatology Agency of Kalimarau, East Kalimantan. *Data iklim berau*. Berau: BMKG Kalimarau; 2015 (in Bahasa).
10. Mueller DD, Ellenberg H. *Aims and methods of vegetation ecology*. New York: John Wiley and Sons; 1974.
11. Misra KC. *Manual of plant ecology*. 2nd ed. New Delhi: Oxford & IBH Publishing Co.; 1980.
12. Thaman RR. Rainforest Management within Cintex of Existing Agroforestry Systems. In Heuveldop, J., T. Homola, H.-J. von Maydell, T. van Tuyll. Korolevu (Fiji): Proceeding GTZ Regional Seminar; 1989.
13. Angi EM, A Wijaya. *Nilai-nilai budaya lokal dalam praktek pengelolaan sumber daya alam di Kalimantan Timur kompetensi pengembangan keanekaragaman hayati dalam era otonomi daerah*. In *Forum Keanekaragaman Hayati Indonesia* on July 10-12 2001 in Jakarta (in Bahasa).
14. Sardjono MA, Samsoedin I. *Pengembangan pengelolaan hutan berbasis masyarakat di Kalimantan Timur*. Jakarta; 1997 (in Bahasa).
15. Wahyuni T. Model practices and programmes of community forestry in Kalimantan. FAO Corporate Document Repository; 2011.
16. Milz J, Busacker S. *Successional agroforestry systems for sustainable cocoa production within the conservation districts of Malinau and Kapuas Hulu*. Jakarta: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Forests and Climate Change Programme (FORCLIME); 2012.
17. The Nature Conservacy. SIGAP-REDD+: aksi inspiratif warga untuk perubahan dalam REDD+; 2014. Accessible on 17 October 2015 (http://www.nature.or.id/ruang-media/siaran-pers/sigap-redd-aksi-inspiratif-warga-untuk-perubahan-dalam-redd.xml.).