Open Journal of Forestry, 2014, 4, 338-348
Published Online July 2014 in SciRes. http://www.scirp.org/journal/ojf
http://dx.doi.org/10.4236/ojf.2014.44040

Estimation of Potential GHG Emission Reduction through Corresponded REDD Plus Activities in Remote Area in Central Kalimantan, Indonesia—Case Study in the Paduran Area

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Received 14 April 2014; revised 20 May 2014; accepted 11 June 2014

Abstract

REDD plus activities corresponded in Central Kalimantan Province, Indonesia and their GHG emission reductions potential were analyzed. Target area is located in a remote area from Pa-langkaraya, Capital of Central Kalimantan Province and consisted of immigrating people mainly from Java Island. In the target area, most of local people conducted unsustainable land use activities (e.g. slash-and-burn agriculture). From analysis of past land use in the target area, there were drastic changes in land use from 1989 after migration began. Natural secondary forest with high density was greatly reduced (2010 levels are approximately 80% of 1996 levels) and converted to cropland and settlement. Also, the reduction in natural secondary forest with high density allowed *Melaleuca cajuputi* Powell forest to rapidly increase in size (2010 levels are approximately 3.7 times as 1996 levels). Additionally, as marked point, there was an increase in oil palm plantations from 2008 and onwards. From results of land use change in the past, mean annual GHG emissions of 5450 Gg CO_2e year^{-1} had been continued until year 2010. To consider counter-measure for reducing GHG emissions in the target area, the relationship between past land use changes and human activities was analyzed through workshops with stakeholders of 6 different groups (village authorities, forest fire fighting team, members of farmers group, large landowners, workers outside of village and oil palm plantation and mother having small children). The results of the workshops showed that the core problem of unsustainable land use faced by 4 of the 6 groups of

How to cite this paper: Hiratsuka, M., Iwanaga, S., Tsuzuki, H., & Yaginuma, H. (2014). Estimation of Potential GHG Emission Reduction through Corresponded REDD Plus Activities in Remote Area in Central Kalimantan, Indonesia—Case Study in the Paduran Area. *Open Journal of Forestry, 4,* 338-348. http://dx.doi.org/10.4236/ojf.2014.44040

stakeholders was the lack of job opportunities (means to earn a living) in the target area. Also, it was learned that core groups considered oil palm plantations is to alleviate the problem and provide a source of alternative income. Furthermore, the workshops indicated that future land use scenario (reference scenario) will be based on income from oil palm plantations and, to prevent such land conversion, counter-measures (REDD plus project scenario) of indirect activities of local people's lifestyle improvement (e.g. A new forestry system which uses abundant resources of *M. cajuputi* forest) and reducing pressures on forest resources should be introduced. This study indicated, by implementing REDD plus project in the target area, potential reduction in GHG emissions is quite large and such GHG reduction will be essential as mitigation activities under the new mitigation mechanism, the Joint Crediting Mechanism (JCM) between Indonesia and Japan.

Keywords

GHG Emission Reduction, REDD Plus, Alternative Livelihood

1. Introduction

Since the latter half of the 1980s, deforestation and forest degradation in tropics has increased dramatically due to a variety of causes, such as unsustainable timber production, forest fires, and conversion from forests to croplands and/or settlements (e.g. Mori, 2000; Page et al., 2002). The Intergovernmental Panel on Climate Control (IPCC) had shown the mitigating potential of counter-measures against deforestation and forest degradation in developing countries at an early stage, and in its Fourth Assessment Report (AR4) in 2007 (IPCC, 2007) gave a quantitative assessment which was approximately 17% of anthropogenic GHG emissions were from a forestry sector, and reported that there are the great mitigation potential of deforestation and forest degradation counter-measures in tropical forests. In addition to such great mitigation potential, Nicholas (2007) reported that deforestation and forest degradation counter-measures were highly cost effective in comparison with other sectors.

Upon hearing these results, the United Nations Framework Convention on Climate Change (UNFCCC) stipulated, through the Bali Road Map (UNFCCC, 2007) adopted by the thirteenth session of the Conference of the Parties (COP 13) in 2007, the importance of initiatives such as forest conservation, sustainable management of forest, and increased forest carbon stocks, as well as suppressing deforestation and forest degradation (all of which are collectively referred to as REDD plus). Meanwhile, REDD plus was stipulated as one of the mitigation measures to be carried out after first commitment period of the Kyoto Protocol (2008-2012). After this, at COP 19 in 2013, decisions relating to the implementation of REDD plus were adopted (i.e., the Warsaw Framework for REDD Plus) (UNFCCC, 2014) and it is assumed that GHG emission reduction from REDD plus will be used by countries after year 2020.

These mitigation measures have been giving international attention in Southeast Asia, especially in Indonesia, which still has vast tropical forests, but their forests are under severe deforestation (24 million ha was deforestation area from 1990 to 2010) (FAO, 2010). Furthermore, in recent years, a total of 1.78 million ha in Central Kalimantan Province has been converted, as of 2010, from what were mainly peatlands to oil palm plantation (Hayashida, 2007). Such type of deforestation and forest degradation mainly in peatlands in Indonesia is being noticed from a global warming perspective. In Indonesia, while addressing these large scale deforestation, progress in measures to counteract GHG emissions led to the setting of targets (approximately 1.1 Pg-CO_2 in 41% GHG emission reduction compared to 2005 by 2020) for GHG emissions reductions through the implementation of REDD plus and other mitigation activities, at COP 15 in 2009 (Thamrin, 2011). Additionally, in August 2013, Indonesia and Japan agreed with the Joint Crediting Mechanism (JCM) which reduces GHG emissions by collaboration with both countries (Ministry of the Environment Government of Japan, 2013) and REDD plus was considered as one of the important mitigation action. From such view, comprehensive approach is required to implement REDD plus in early stage (before year 2020) in both countries. Also, development of methodology and quantitative assessment of GHG emission reduction potential from REDD plus projects located in especially peatlands are required.

It was because that REDD plus was new mitigation measure and there were not enough experiences to analysis feasibility of GHG emission reduction and correspondence in local level, a comprehensive approach was needed when actually implementing REDD plus in the field, including technical efforts (technology for monitoring the amounts of GHG emissions), and institutional efforts (for dealing with land tenure and regional forest governance due to the substantial issues surrounding land use and changes in land use in developing countries). This study here analyzed the suitable activities of counter-measures of driving forces of deforestation and forest degradation which should be corresponded in a target site, and estimated GHG emission reduction after proposed activities in Central Kalimantan Province, Indonesia.

2. Study Site

2.1. Location

This study focused on the Paduran area, in Sebangau Kuala, of Pulang Pisau, in Central Kalimantan Province (**Figure 1**). Located approximately 100 km south of Central Kalimantan's capital, Palangkaraya, the Paduran area is located in the near center of Sebangau Kuala and has an area of 380,000 ha. Central Kalimantan Province was the subject of Presidential Law No. 82 "Presidential Order Concerning the Development of Peatlands into Grain Farmland in Central Kalimantan in 1995", and projects nicknamed "mega rice projects" began converting 1 million ha of forest (peat forests) on the outskirts of the Paduran area into cropland (mostly paddies). In order to decrease the water level of the peatlands, a total of 4400 km of drainage channels were built. As a result, most of the peat forests were lost, with an approximate figure reported of 1.5 million ha of peat forest gone from Central Kalimantan Province (Limin et al., 2007). In the Paduran area as well, large scale drainage channels crisscrossed the land, leading to huge land use transformation in the 1990s.

2.2. Characteristics of the Study Site

Among the socio-economic features of the Paduran area are administrative villages situated there through the Indonesian Central Government's migration policy. This is to say that the majority of the local people in the Paduran area are migrants moved there from the populous regions of Java Island and other areas. These migrants have lived in Central Kalimantan Province for around 20 years, and have customs and cultures different from the native people to Kalimantan Island. The migration into the Paduran area began in 1989. According to statistics from 2001, the first year for which reliable data are available, a total of 2721 households existed in the constituent parts of the Paduran area: 1721 households in Paduran 1450 in Paduran 2, and 550 in Paduran 3. However, due to the Paduran area being situated in vast peatlands, the low productivity of conventional farming methods, including slash-and-burn, and the lack of other nearby sources of income outside farming, a continuous

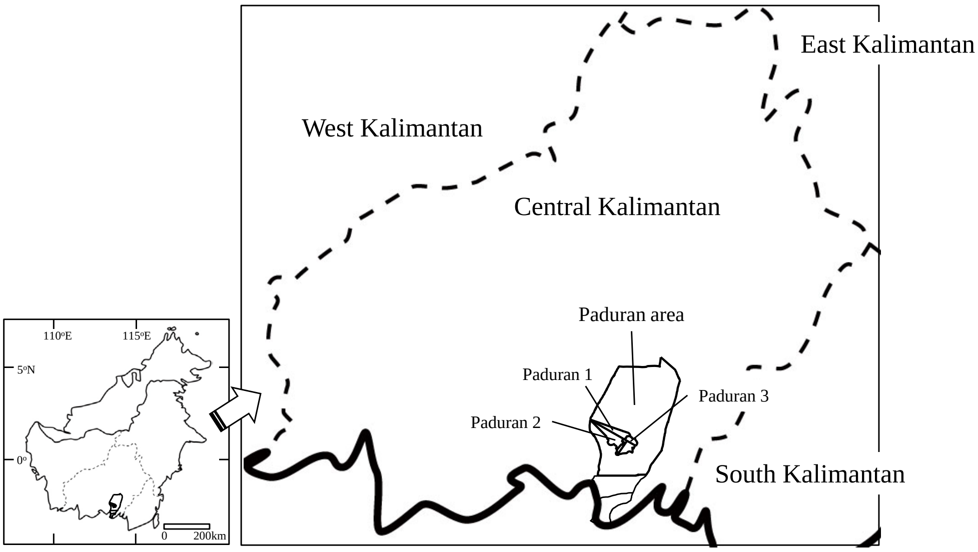

Figure 1. Location of the Paduran area in Central Kalimantan. Note: the Paduran area is consisted of several villages, but most of people lived in villages of Paduran 1, 2 and 3. Therefore, we focused on Paduran 1, 2 and 3 for analysis in this study.

trend of migrants leaving the area emerged after 2001. In 2007, Paduran 1 had 1027 households (3863 people), Paduran 2 had 163 households (625 people), and Paduran 3 had 258 households (1170 people), for a total of 1448 households-showing that about one half of the households had left the villages. This study, especially focused on Paduran 3, the part of the Paduran area that is said to have the lowest agricultural productivity and that has the most marked trend of depopulation. We conducted intensive surveys of migrants and migrant villages, though only 103 households actually existed in the area, due to some registered local people living elsewhere for the sake of work. These 103 households are approximately 20% of the 2001 numbers.

The Paduran area and its surroundings are covered by tropical rain forests in highly acidic peat soil (Murdiyarso et al., 2010). Since the 1980s, illegal logging, forest fires, etc., and since the 1990s, the construction of drainage channels around migrant settlements have led to land subsidence that caused invasion of pioneer tree species of *Melaleuca cajuputi* Powell or expansion of degraded secondary forests. Meanwhile, this study has shown that in Paduran 3, sources of income outside farming activities within the village have made a fixed contribution to living expenses and local people's way of life since the beginning of migration (Onda et al., 2013). Local people's reliance on forest resources was high, with non-farming income derived from activities such as tree cutting an the gathering of *Alseodaphne* sp. bark used for its mosquito repellant qualities as an ingredient in mosquito coils.

3. Methodologies

3.1. Land Use Change and Dynamics of Forest Carbon Stocks

In any REDD plus project, for estimation of GHG emission reduction, a reference level should be developed, and drivers of deforestation and forest degradation and their counter-measures were analyzed to reflect such effects on the reference level and implement the project (Meridian Institute, 2011). Firstly, to identify the changes in land use in the Paduran area, Landsat TM imagery were acquired in 1996, 2000, 2004, 2008, and 2010. Land uses in the Paduran area were divided into 9 categories: natural secondary forest with high density, natural secondary forest with low density, *M. cajuputi* forest, cropland and settlement, shrub, bareland, swamp, water body (lakes/rivers), and oil palm plantation. Each of the categories differs in the amount of carbon stock per unit of area. Also, aerial pictures (RGB images) and ground truth of the Paduran area were used to improve and refine the accuracy of the land use categories.

Next, the following methods were used to calculate the carbon stock per unit of area for each land use category. For estimating above-ground biomass in natural secondary forest with low densities, forest canopy height was acquired by LiDAR, and a wide area carbon stock was calculated after developing a relation between the forest canopy height and the carbon stock. Detailed practice of LiDAR approach is described in our separated paper (*see* detailed in report from Ehime University, 2012 and report from Mitsubishi UFJ Research and Consulting, 2012). For estimating above-ground biomass in the *M. cajuputi* forest, the allometric equations were developed through the survey of specimens of felled trees used diameter at breast height (DBH) as a dependent variable. The surveys mentioned in above were conducted from August to November 2011 (*see* detailed in report from Mitsubishi UFJ Research and Consulting, 2012). For estimating cropland land and settlement, shrub, bareland, swamp, water body (lakes/rivers), and oil palm plantation, default carbon stock in each category were was applied as appropriate for Indonesia or Southeast Asia, based on Ministry of National Development Planning/National Development Planning Agency (2013) and the IPCC Emission Factor Data Base (EFDB) (IPCC, 2014). Also, GHG emissions from soil organic carbon were estimated by applying an emission factor which was mean annual carbon emission from the unit of lands having the influence of forest fire and/or human activities (i.e., natural secondary forest with low densities, *M. cajuputi* forest, cropland and settlements and oil palm plantation). Detailed practice of estimating GHG emission from soil organic carbon is described in our separated paper (*see* detailed in report from Ehime University, 2012 and report from Mitsubishi UFJ Research and Consulting, 2012).

3.2. Identification of Relationship between Drivers of Deforestation and Forest Degradation and Livelihoods

In order to clarify the livelihoods and land use practices within the village, 30 households (29% of the total) in Paduran 3 were chosen at random to be the subjects of home visits and semi-structured interviews. Results from this showed that 26 households (approximately 87%) were receiving income from outside the village. The total of income in the Paduran area from outside the village is approximately 41% of overall income, showing that this form of income is crucial within the villages. In other words, there are not sufficient means within the villages to secure livelihoods, and sources of income from outside the villages are relied upon (Onda et al., 2013). Also the current state of affairs indicates that local people are not extracting sufficient productivity or income from their land. It was within this context that from some point after the year 2000, the area used in Central Kalimantan for oil palm production increased (Hayashida, 2007). From inside and outside of the area, eyes are looking to the Paduran area as a location of oil palm cultivation, with high expectations placed on that cultivation as a means of income in place of crop farming.

In this study, several local people's participatory workshops were held in order to touch on the issues of land use and livelihoods within the villages, as well as the significant effects of external capital investment in the future direction of that land use. The workshops also aimed to identify the drivers of deforestation and forest degradation, and analyze the relationship between those drivers and the livelihoods of local people, in order to implement effective measures against deforestation and forest degradation (project activities of REDD plus) in the Paduran area going forward. While analyzing the current state of land and forest management issues in the Paduran area during the workshops, it is vital to emphasize the choices of stakeholders in the Paduran area in order to identify concrete and effective measures for the implementation of REDD plus. Therefore, we carefully analyzed those connected to the Paduran area to canvass the stakeholders who are intricately involved with the forest resources or the use of cropland. We divided the results into 6 groups (**Table 1**) and interviewed each to learn their opinions. Note that the workshops were held in September 2011 and supplemental individual interviews with each of the stakeholders were carried out from August to October of 2011 and August of 2012.

4. Results

4.1. Land Use Dynamics and Estimation of Historical Carbon Stocks

The analysis of Landsat TM imagery of the Paduran area acquired in 1996, 2000, 2004, 2008, and 2010 were carried out to identify the changes in land use for each of the 9 land categories (natural secondary forest with high density, natural secondary forest with low density, *M. cajuputi* forest, cropland and settlement, shrub, bareland, swamp, water body, and oil palm plantation) (**Figure 2**). Results showed that land use was heavily impacted by the course of events that established the Paduran area and the methods in which forest resources have been used. In particular, drastic changes in land use types occurred from 1989 after migration began. Natural secondary forest with high density was greatly reduced (2010 levels are approximately 77% of 1996 levels) and converted to cropland and settlement. Also, we saw that the reduction in natural secondary forest with high density allowed the low density forest by native *M. cajuputi* forest to rapidly increase in size (2010 levels are approximately 3.7 times as 1996 levels). Furthermore, there was an increase in oil palm plantations from 2008 and beyond.

For quantification of carbon stocks in each type of the 9 land use, we applied following methods; carbon pool

Table 1. Characteristics of stakeholders.

Type of stakeholders	Participated number	Characteristics of stakeholder and reasons for selection for workshop
Village authorities	6 members	They understand village's history, land use and livelihoods. Also they are thinking about the future development plan of the village.
Forest fire fighting team	8 members	Their activities are connected to safety life and production of agriculture in the village.
Member of farmer's group	4 members	They still continued farming in a comparatively low productive land in the village and their life depends on farming strongly.
Large landowners	6 members[a]	They are key persons of land use, especially for land for typical agriculture (slash-and-burn), cash crops, oil palm plantation.
Workers outside of village and oil palm plantation	6 members[b]	They understand difference of working conditions between inside of the village and outside of the village. Also they know land use and its effects of oil palm plantation.
Mother having small children	6 members[c]	They are thinking future development plan from the viewpoints of mothers and children

Note: [a]They own land area over 1 ha for rubber plantation or others. [b]Three members experienced of working for oil palm plantation and the others experienced for other types of working. [c]Three members having child under 6-yerar-old and the others having child over 7-year-old.

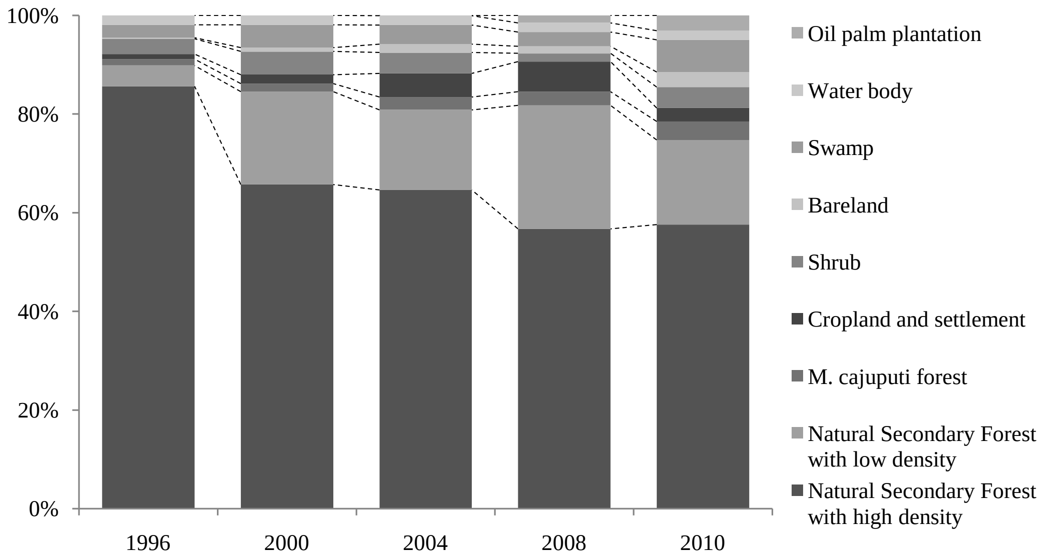

Figure 2. Land use change from 1986 to 2010 in the Paduran area.

of above-ground in natural secondary forest with low density were estimated by relationship between vegetation profile area/unit flight length (m) and above-ground biomass (**Figure 3**) and their below-ground was estimated by using factor of IPCC Emission Factor Data Base (EFDB) (IPCC, 2014).

Carbon pool of above-ground biomass in *M. Cajuputi* forest was estimated by results of tree census data and the allometric equations in this study (**Figure 4**) and below-ground biomass was estimated by using a factor of IPCC Emission Factor Data Base (EFDB) (IPCC, 2014). A carbon pool of litter and dead wood were neglected in this study because such carbon stocks cannot be changed in land use change.

From using above equations, carbon stocks of each land use categories in 1996, 2000, 2004, 2008, and 2010 were quantified (**Table 2**).

According to decrease of natural secondary forest with high density and increase of *M. cajuputi* forest, carbon stock in above- and below-ground in the Paduran area had been decreased (2010 levels are approximately 80% of 1996 levels) (**Figure 5**) and estimated GHG emission in 2000, 2004, 2008 and 2010 were 8231, 2871, 4124 and 6577 Gg CO_2e year^{-1} respectively, and mean annual GHG emission from 2000 to 2010 was 5450 Gg CO_2e year^{-1} (**Figure 6**).

4.2. Proposed Land Use Plan and REDD Plus Activities

From results of workshops, to identify the relationship between land use changes and human activities, we saw that residential areas dotted the land around the drainage channels across the Paduran area, and that forest resources have severe impacts from water drainage and forest fire. After workshops with stakeholders of 6 different groups, the current state of land use was evaluated by problem analysis in a form of participatory methods. Next, objective analysis was carried out on expectations for land use and forest resources, as well as means for local people to earn livelihoods going forward. Results of the analysis showed that the core problem faced by 4 of the 6 groups of stakeholders was the lack of job opportunities (means to earn a living) in the Paduran area. Also, it was learned that farmers, large landowners, and mothers considered oil palm plantations is to alleviate the problem of poor agricultural infrastructure (irrigation facilities, etc.) and lack of jobs in the village and provide a source of alternative household income and budget of some activities including fire fighting team and improvement of educational infrastructure (**Table 3**).

The workshops indicated that expectations of establishment of oil palm plantations as new means for securing income and for new village budget for conducting fire fighting team activities (i.e., activities for reducing GHG emission). It was because that, since 2008, near villages adjacent to the Paduran area had success experiences to get new income from about 40,000 ha of oil palm plantations and new agricultural infrastructure (irrigation facilities). From results of the participatory workshops held in the Paduran area (**Table 3**), it was summarized that

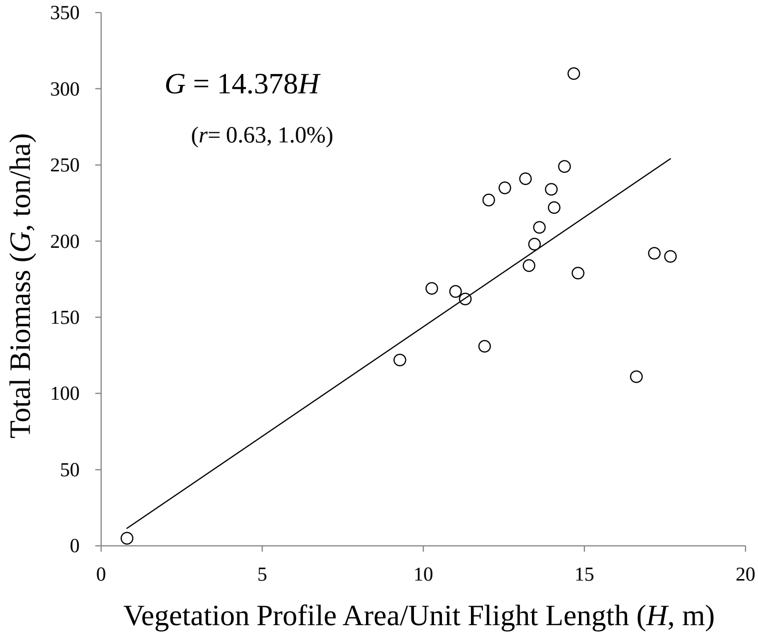

Figure 3. Relationship between vegetation profile area/unit flight length (m) and above-ground biomass (Mg ha^{-1}). Note: Percentages beside equations in the figure are significance level of correlation coefficient.

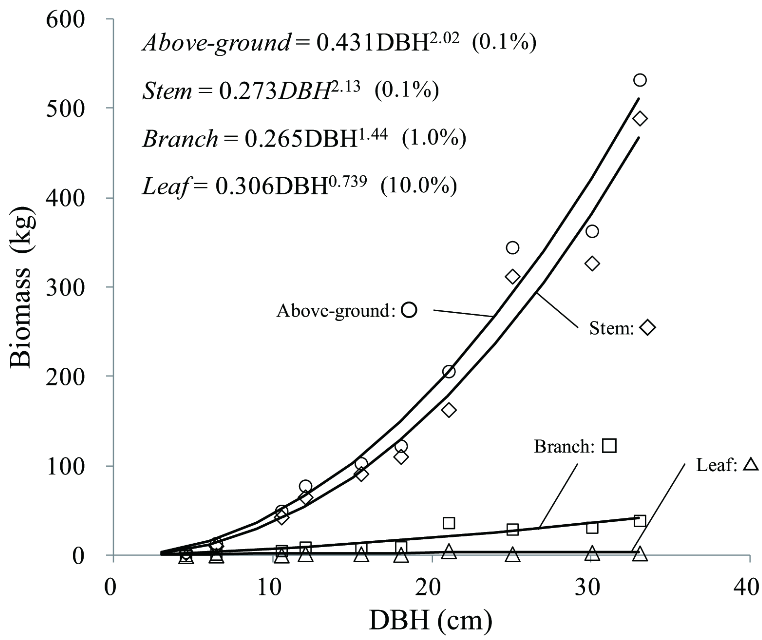

Figure 4. Relationship between DBH (cm) and biomass of each organ (kg). Note: Percentages beside equations in the figure are significance level of correlation coefficient.

the following two points are to be respected for implementing REDD plus project and estimation of GHG emission reduction;

1) The first point was about a future land use scenario (reference scenario), which strongly suggested oil palm plantations will continue to be attracted to the Paduran area, and GHG emission from forest fires will continue because of lack of village budget for activities of fire fighting team. Also, land conversion from *M. cajuputi*

Table 2. Carbon stocks in each organ of each land use type (shrub, cropland and settlement, bareland, swamp, and wate body were set as zero conservatively in this study).

Land use type	AGC[a] t-C ha^{-1}	BGC[b] t-C ha^{-1}	Dead Wood t-C ha^{-1}	Litter t-C ha^{-1}	Reference
Natural secondary forest with high density	113.1	41.9	0.0	0.0	AGC is quoted from Ministry of National Development Planning/National Development Planning Agency (2013) and BGC is from IPCC (2014).
Natural secondary forest with low density	60.2	22.3	0.0	0.0	AGC is quoted from Ehime University (2012) and Mitsubishi UFJ Research and Consulting (2012) and BGC is from IPCC (2014).
M. cajuputi forest	51.8	19.2	0.0	0.0	From this study.
Oil palm plantation	46.7	17.3	0.0	0.0	AGC is quoted from Ministry of National Development Planning/National Development Planning Agency (2013) and BGC is from IPCC (2014).

Note: [a]AGC is above-ground carbon. [b]BGC is above-ground carbon.

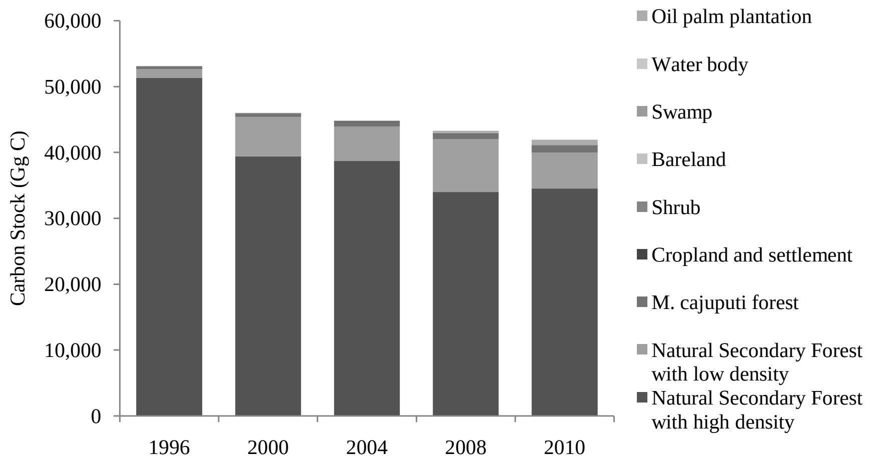

Figure 5. Carbon dynamics of above- and below-ground from 1986 to 2010 in the Paduran area.

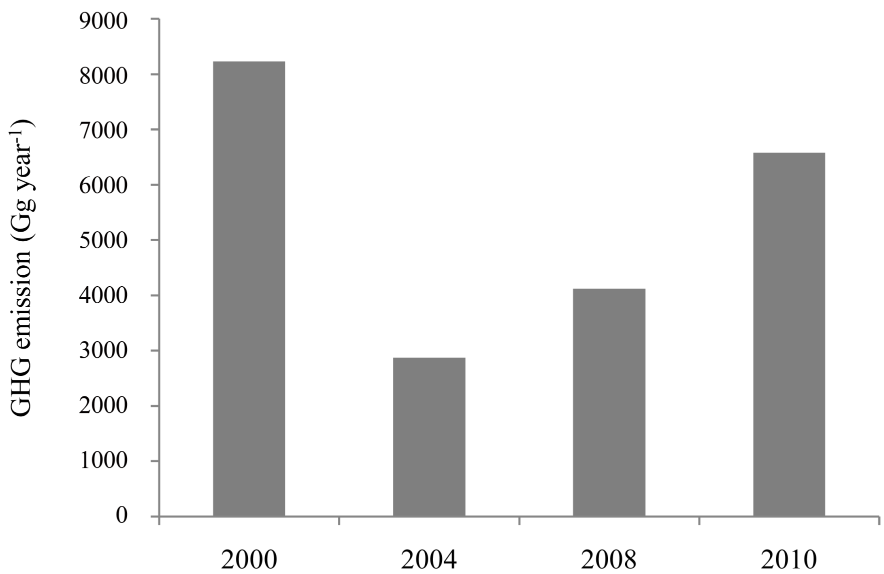

Figure 6. GHG emissions in 2000, 2004, 2008 and 2010 in the Paduran area.

Table 3. Results of each workshop.

Type of stakeholders	Problem analysis	Objective analysis
Village authorities	Low productivity due to frequent fires; poor accessibility to the market; turning to emigration; moving out of the Paduran area for work.	Expectation of oil palm plantations as new livelihood; stop depopulation and restart group activities (forest firefighting team).
Forest fire fighting team	Lack of technical assistance and financial assistance to pay as remuneration.	Giving incentive for establishing and operating fire fighting team.
Member of farmer's group	Poor agricultural infrastructure (irrigation facilities, etc.) and road infrastructure for shipping crops.	Technical and financial support for developing new agricultural (especially oil palm plantation) and road infrastructure.
Large landowners	Agricultural productivity is low and abandoned arable lands are increasing.	Introducing steady and new agricultural production (e.g. oil palm plantation).
Workers outside of village and oil palm plantation	Lack of jobs in the village.	Introducing steady agricultural production or fire fighting team.
Mother having small children	Lack of jobs in the village; declining the quality of the educational infrastructure.	Introducing steady and new agricultural production (e.g. oil palm plantation); facilitating participation in group activities.

forest to oil palm plantation will continue and such conversion brings significant GHG emission from dried peat soil by drainage channels of oil palm plantation. In 2011 and 2012, a moratorium on new oil palm plantations in Central Kalimantan Province was achieved based on a letter of intent (LOI) signed between Indonesia and Norway (Scheyvens & Setyarso, 2010; Murdiyarso et al., 2011). However, the substantial expectations within the villages for oil palm plantations, once the moratorium is lifted, new land use choices will lead to more oil palm plantations being opened. Consequently, it is necessary to follow through with specific REDD plus implementation until the end of moratorium.

2) The second point is about corresponded counter-measures (REDD plus project scenario) which is not direct forest projects, is indirect activities of local people's lifestyle improvement (e.g. new forestry system which use abundant resources of *M. cajuputi* forest) and reducing pressures on forest resources. This study showed that deterioration in lifestyles (livelihoods) in the Paduran area had negative impacts on sustainable land use as well as the forest management system, including the formation and operation of fire fighting team. Aside from fire, improper land management means the location of floodgates to be opened and closed during floods is unclear, which has resulted in flood damage.

5. Discussions

To estimate the amount of reduction in GHG emission through the implementation of REDD plus, we calculated reduction potentials of project implementation. The reference level in the future was based on historical trend (mean value) analyzed from the land use fluctuations (**Figure 2**) and the results of the participatory workshops (**Table 3**). GHG emissions under the implementation of REDD plus were assumed from 3 cases; the continuation of the past average (the worst case: no advantage of REDD plus project); a land use improved case involves; introducing new livelihood (forestry system using *M. cajuputi* as alternative livelihood of oil palm plantation), improving agricultural system to stop conversion from forests to cropland and operating fire fighting team to stop forest fires, which results reduce 50% of GHG emissions of the past average (the best case); and a middle scenario which results reduce 25% of GHG emissions of the past average (the moderate case). This study had not evaluated effectiveness of each counter-measures, therefore just estimated potentials of GHG emission reduction in each case were according to assumption of villager's experiences and comments. From such assumptions, upon making approximate calculations for the potential reduction in GHG emissions through the implementation of REDD plus projects, the best case had potential to reduce 2725 Gg CO_2e of GHG emissions per year, and the moderate case potential had potential to reduce 1363 Gg CO_2e of GHG emissions per year (**Figure 7**).

In securing alternative livelihood for earning income, the first step is introduction of alternative options on land use which reduce pressures on forest resources and prevent unsustainable land use (e.g. slash-and-burn agriculture). As one of the alternative option identified in this study, timber of *M. cajuputi* production system by collaboration among villagers was considered as essential, because the Paduran area has much amount of resources of *M. cajuputi* and cooperation among villagers through the system is substantial to assure their land use

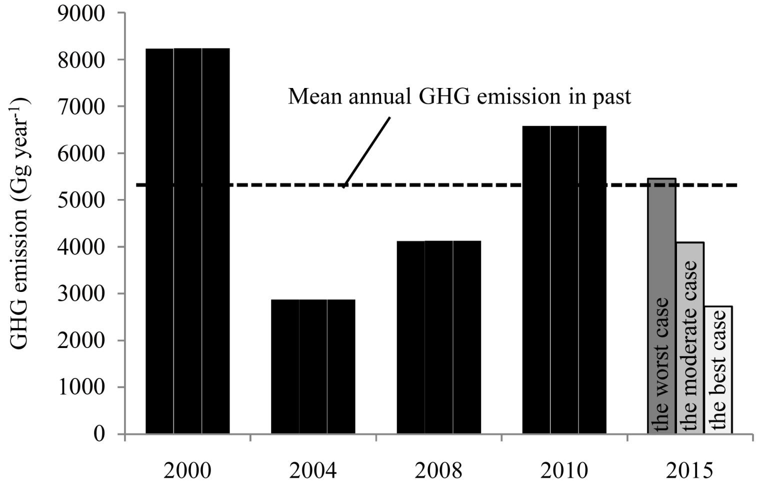

Figure 7. Assumption of GHG emission reduction in 3 cases.

plan not only timber of *M. cajuputi* production system but also other land use activities as well as sustainable use of forest resources in the future. Additionally, the system will solve some problems in the village, especially lack of job in the village, no budget for fire fighting team activities and poor agricultural and educational infrastructures. Unfortunately, under the present conditions, there were no case studies of local people of the Paduran area regarding collaborative activities. However, collaborative activities of timber of *M. cajuputi* production system might bring success experiences, and such experience will provide incentive to implement other collaborative activities including the management of drainage channels and floodgates and others, which are counter-measures against deforestation and forest degradation (i.e., activities for reducing GHG emission).

If approached in this way, GHG emission reduction of 2725 Gg-CO_2e year^{-1} (the best case in **Figure 7**) might be achieved through these initiatives in the Paduran area and such GHG emission reduction potential is quite an attractive in both Indonesia and Japan as mitigation project under the JCM. In order to implement these initiatives and to get GHG emission reduction, it is vital to develop methodology which estimates GHG emissions from peatlands, and is important to consider the kinds of incentives that will motivate local people to sustain activities. Also, in order to efficiently implement REDD plus, corresponded mechanism under the JCM and action plans to promote REDD plus activities are necessary. Additionally, in local level, long-term land and forest management systems which are adapted for the area and lifestyle of local people are required.

Acknowledgements

This study was conducted by "New Mechanism Feasibility Study in 2011" and "JCM/BOCM Feasibility Study in 2012" funded by Global Environment Centre Foundation (GEC). Also, the part of this study fund was provided by the Environment Research and Technology Development Fund (E-031) of Ministry of the Environment Government of Japan and Grants-in-Aid for Scientific Research (B22405025). In addition, we had valuable comments from Prof./Dr. Masahiro Amano and Prof./Dr. Yasushi Morikawa of Waseda university of Japan, Dr. Suwido H. Limin of Palangkaraya University of Indonesia and Mr. Masato Yano of Mitsubishi UFJ Research and Consulting Co. Ltd.

References

Ehime University (2012). *Above-Ground and Below-Ground Forest Carbon Budgeting by Multi-temporal Airborne Laser Altimetry (A-0901)*. Tokyo: Project Report of the Environment Research and Technology Development Fund (ERTDF) of the Ministry of the Environment, Japan.

FAO (2010). *Global Forest Resources Assessments 2010*. Rome: FAO.

Hayashida, H. (2007). Development of Oil Palm Estates and Absorption of Labor Force in Indonesia-Based on Nationwide Trend Since the Middle of 1990s, and Cases of North Sumatera and East Kalimantan. *The Social Science, 79,* 83-108. (in Japanese)

IPCC (2007). Fourth Assessment Report (AR4): Mitigation of Climate Change.

http://www.ipcc.ch/publications_and_data/ar4/wg3/en/contents.html

IPCC (2014). Emission Factor Data Base (EFDB). http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

Limin, S. H., Jentha, & Ermiasi, Y. (2007). History of the Development of Tropical Peatland in Central Kalimantan, Indonesia. *Tropics, 16,* 291-301. http://dx.doi.org/10.3759/tropics.16.291

Meridian Institute (2011). Modalities for REDD+ Reference Levels: Technical and Procedural Issues. Prepared for the Government of Norway, by Angelsen, A., Boucher, D., Brown, S., Merckx, V., Streck, C., & Zarin, D. http://www.REDD-OAR.org

Ministry of the Environment Government of Japan (2013). Bilateral Cooperation on the Joint Crediting Mechanism for the Low Carbon Growth Partnership between Japan and the Republic of Indonesia. http://www.env.go.jp/press/file_view.php?serial=22901&hou_id=17077

Ministry of National Development Planning/National Development Planning Agency (2013). *Technical Guideline for Monitoring, Evaluation and Reporting (MER) of RAD-GRK Implementation.* Jakarta: Ministry of National Development Planning/National Development Planning Agency.

Mitsubishi UFJ Research and Consulting (2012). New Mechanism Feasibility Study for REDD+ in Central Kalimantan Province, Indonesia. Report of New Mechanisms Feasibility Studies: FY2011 of Global Environment Centre Foundation (GEC). http://gec.jp/main.nsf/en/Activities-Climate_Change_Mitigation-FS2011newmex20

Mori, T. (2000). Effects of Droughts and Forest Fires on Dipterocarp Forest in East Kalimantan. In Guhardja, E., Fatawi, M., Sutisna, M., Mori, T., & Ohta, S. (Eds.), *Rainforest Ecosystems of East Kalimantan. Ecological Studies* (pp. 29-45). Tokyo: Springer. http://dx.doi.org/10.1007/978-4-431-67911-0_3

Murdiyarso, D., Hergoualc'h, K., & Verchot, L. V. (2010). Opportunities for Reducing Greenhouse Gas Emissions in Tropical Peatlands. *PNAS, 107,* 19655-19660. http://dx.doi.org/10.1073/pnas.0911966107

Murdiyarso, D., Dewi, S., Lawrence, D., & Seymour, F. (2011). *Indonesia's Forest Moratorium: A Stepping Stone to Better Forest Governance? Working Paper 76.* Bogor: CIFOR.

Nicholas, S. (2007). *The Economics of Climate Change: The Stern Review.* London: Cambridge University Press.

Onda, N., Iwanaga, S., Anakura, N., Wijaya, C. I., & Amano, M. (2013). Effect on Forest of Employment Structure and Land Use in Transmigration Village, Central Kalimantan, Indonesia: Discussion of Problems in Implementing REDD Plus. *Journal of Forest Planning, 46,* 45-56. (in Japanese)

Page, S. E., Siegert, F., Rieley, J. O., Boehm, H.-D. V., Jaya, A., & Limin, S. (2002). The Amount of Carbon Released from Peat and Forest Fires in Indonesia during 1997. *Nature, 420,* 61-65. http://dx.doi.org/10.1038/nature01131

Scheyvens, H., & Setyarso, A. (2010). Development of a National REDD-Plus System in Indonesia. In Scheyvens, H. (Eds.), *Developing national REDD-Plus Systems*. Hayama: IGES.

Thamrin, S. (2011). Indonesia's National Mitigation Action: Paving the Way towards NAMAs. http://www.oecd.org/dataoecd/54/44/47515998.pdf

UNFCCC (2007). Bali Action Plan (FCCC/CP/2007/6/Add.1 Decision 1/CP.13). http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=3

UNFCCC (2014). The Warsaw Framework for REDD-Plus (Decisions 9/CP.19, 10/CP.19, 11/CP.19, 12/CP.19, 13/CP.19. 14/CP.19 and 15/CP.19). http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf