

Deforestation, Forest Degradation and Readiness of Local People of Lubuk Antu, Sarawak for REDD+

(Penyahhutan, Degradasi Hutan dan Kesiapan Penduduk Tempatan
dari Lubuk Antu, Sarawak bagi REDD+)

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ABSTRACT

Reducing emissions from deforestation and forest degradation-plus (REDD+) is considered as an important mitigation strategy against global warming. However, the implementation of REDD+ can adversely affect local people who have been practicing shifting cultivation for generations. We analyzed Landsat-5 Thematic Mapper images of 1990 and 2009 to quantify deforestation and forest degradation at Lubuk Antu District, a typical rural area of Sarawak, Malaysia. The results showed significant loss of intact forest at 0.9% per year, which was substantially higher than the rate of Sarawak. There were increases of oil palm and rubber areas but degraded forest, the second largest land cover type, had increased considerably. The local people were mostly shifting cultivators, who indicated readiness of accepting the REDD+ mechanism if they were given compensation. We estimated the monthly willingness to accept (WTA) at RM462, which can be considered as the opportunity cost of foregoing their existing shifting cultivation. The monthly WTA was well correlated with their monthly household expenses. Instead of cash payment, rubber cultivation scheme was the most preferred form of compensation.

Keywords: Deforestation; forest degradation; REDD+; shifting cultivation; willingness to accept

ABSTRAK

Pengurangan pelepasan daripada penyahhutan dan degradasi hutan-plus (REDD+) dianggap sebagai strategi mitigasi penting dalam menangani pemanasan global. Walau bagaimanapun, pelaksanaan REDD+ boleh menjejaskan penduduk tempatan yang telah lama mengamalkan pertanian pindah. Kami telah menganalisis imej Landsat-5 Thematic Mapper bagi tahun 1990 dan 2009 untuk mengukur kadar penyahhutan dan degradasi hutan di daerah Lubuk Antu, yang terletak di kawasan luar Bandar Sarawak, Malaysia. Hasil kajian menunjukkan kadar penyahhutan yang ketara pada tahap 0.9% setahun, kadar yang jauh lebih tinggi berbanding dengan kadar keseluruhan Sarawak. Terdapat juga peningkatan keluasan ladang kelapa sawit dan getah tetapi peningkatan keluasan yang ketara bagi hutan degradasi, jenis liputan tanah kedua terbesar. Penduduk tempatan yang kebanyakannya mengamalkan pertanian pindah bersedia menerima mekanisme REDD+ jika mereka diberi pampasan. Kami telah menganggarkan kesiapan untuk menerima (WTA) pampasan bulanan sebanyak RM462, yang boleh dianggap sebagai kos bagi melepaskan amalan pertanian pindah. WTA bulanan didapati berkait rapat dengan perbelanjaan bulanan isi rumah. Kebanyakan penduduk tempatan memilih pampasan berbentuk skim penanaman getah daripada opsyen lain termasuklah bayaran tunai.

Kata kunci: Degradasi hutan; kesiapan untuk menerima; penyahhutan; pertanian pindah; REDD+

INTRODUCTION

Globally, land-use change accounts for 15-18% of anthropogenic carbon emissions and the vast majority of these come from deforestation and forest degradation in the tropics (IPCC 2007), with shifting cultivation often mentioned as one of the main sources (Mertz 2009). The Conference of the Parties (COP) 13 to the United Nations Framework on Climate Change Convention (UNFCCC) had agreed on a negotiation pathway for the inclusion of a mechanism to avoid further release of greenhouse gases from forested areas in Bali in 2007. The resulting mechanism became known as the reduction of emissions from deforestation and forest degradation (REDD), which

has been seen as a cost-effective way of reducing global greenhouse gas emissions (Stern 2007). The REDD mechanism evolved into REDD+ that includes sustainable forest management, enhancement and conservation of forest carbon stocks (Schrope 2009). While deforestation is clearly defined as land use conversion, there is no clear definition for forest degradation. FAO (2003) emphasizes the reduction of forest carbon stock but given time, the stock should be able to recover.

While there are still a lot of uncertainties in the REDD+ mechanism, its implementation will certainly affect the local people who are largely dependent on shifting cultivation and forest produce for their livelihood (Mertz

2009). The rights of local people to farm, fallow and collect forest products are not secured in terms of land tenure (Fox et al. 2009) so they may be skeptical whether payments for their REDD efforts will indeed be disbursed in full or partially or simply lost in the administrative systems (Mertz 2009). Several papers argue for a 'nested approach' integrating subnational levels in the mechanism (Pedroni et al. 2009) or to be conducted on project-based systems (Peskett et al. 2008).

In Southeast Asia, the numbers of local people who depend on shifting cultivation are estimated to range from 14 to 34 million (excluding China and Cambodia where no estimates were found) (Mertz et al. 2009). There were only a few published articles referring to shifting cultivation and the REDD+ challenge were found (Fox et al. 2011; Mertz 2009). In East Kalimantan, optimal areas for REDD were identified (Harris et al. 2008) for conservation without considering the impacts on the local people. On the other hand, Jepsen (2006) only focused on estimation of above-ground carbon of shifting cultivation in Sarawak, Malaysia. Kamlun et al. (2012) analyzed deforestation and fragmentation in Sarawak between 1990 and 2009. Social scientists have been quick to warn that without taking into account the economic opportunity costs foregone by rural households, policy makers could not be certain about the level of REDD+ initiatives that would be needed to solicit a policy response from farm households (Fox et al. 2011). Most of shifting cultivators are poor and thus opportunistic in nature (Mertz 2009). Often, they convert from shifting cultivation to rubber plantation (Fox et al. 2011; Ziegler et al. 2009). We may therefore hypothesize that local people tend to convert from shifting cultivation to other economic activity that provides better economic return. In fact, the willingness of local people to adopt a new economic activity or not, can be assessed against their status-quo livelihood using environmental valuation method. Economic valuation methods have been used for assessing environmental value loss to the 1998 forest fire at a national scale (Varma 2003) and total economic value of Leuser National Park in Indonesia (Van Beukering et al. 2003). However, economic valuation studies that assess the readiness of acceptance for REDD+ mechanism in relation to shifting cultivation in Southeast Asia have been rare except for Van Beukering et al. (2009) that assessed the willingness to accept (WTA) of local people in Cambodia.

WTA and willingness to pay (WTP) can be assessed with Contingent Valuation Method (CVM) for goods and services that do not exist or have substitutes in markets (Phillips 1998). People showed their value for the benefits derived from a protected area their WTP for those benefits or through as compensation for foregoing the benefits. WTA is the stated price that an individual would accept as compensation for the loss or the diminution of an environment service (Minkler 1999). WTA could be applied to determine the opportunity costs of particular changes in activities for small-scale farmers for understanding their concerns in policy and measures related to REDD+ mechanism (Peskett et al. 2008). CVM therefore is able to

provide information concerning the level of compensation needed by people who have to forego the use of the forest for their livelihood activities (Hanley et al. 2010). In this paper, we quantified deforestation and forest degradation at Lubuk Antu District of Sarawak between 1990 and 2009 using multitemporal satellite images. We then assessed readiness of local people of Lubuk Antu for REDD+, which can affect their existing livelihood activities.

MATERIALS AND METHODS

STUDY AREA

Sarawak is the largest state that occupies 37.5% of the total land area of Malaysia. It is on the third largest island in the world, Borneo. Many rural areas are accessible only with boat and ferry because of complex and well-developed river network. This study was carried out at Lubuk Antu District, Sarawak. Lubuk Antu District is located about 250 km east of Kuching in Sri Aman Division of Sarawak, southwest of Sarawak and near to the border with Indonesia (Figure 1). Lubuk Antu District is a typical rural area in Sarawak. Local people are mostly Iban who depend on shifting cultivation, forest produce collection and making handicraft. They live together in long houses. The main access to the villages is by boat from the jetty at Engkali. There is a protected area named Batang Ai National Park (BANP) in the district. BANP is a protected area (IUCN's Category II) that is managed mainly for ecosystem protection and recreation. BANP covers an area of 24040 ha of rainforest and an artificial lake that functions as dam and recreation site.

LAND COVER CLASSIFICATION AND CHANGE ANALYSIS

Analysis of deforestation and forest degradation over a period of time falls into change detection, which is divided into two methods; spectral change detection and post-classification comparison methods in remote sensing. Post-classification comparison compares the land cover classes of multiple land cover classification maps to detect changes that occur in the time period. The principal advantage of this method lies in the fact that the two temporal images are separately classified; thereby minimizing the problem of radiometric calibration between dates (Coppin et al. 2004). We used post-classification comparison method for quantifying deforestation and forest degradation at Lubuk Antu District using multitemporal Landsat images.

Two Landsat-TM images (path: 120; row: 59) of years 1990 and 2009 were acquired for land cover classification (LCC). Both images had less than 10% cloud cover. A cloud mask was generated by threshold analysis of Band 1. Pixels with Band 1 value higher than 100 were identified as cloud. We then applied a 5×5 minimum filter on the cloud mask to increase the mask size for removing thin cloud edges. The clouds in both images were removed using the cloud mask before classification. Topographic effect is a known source of misclassification. Minaert topographic correction

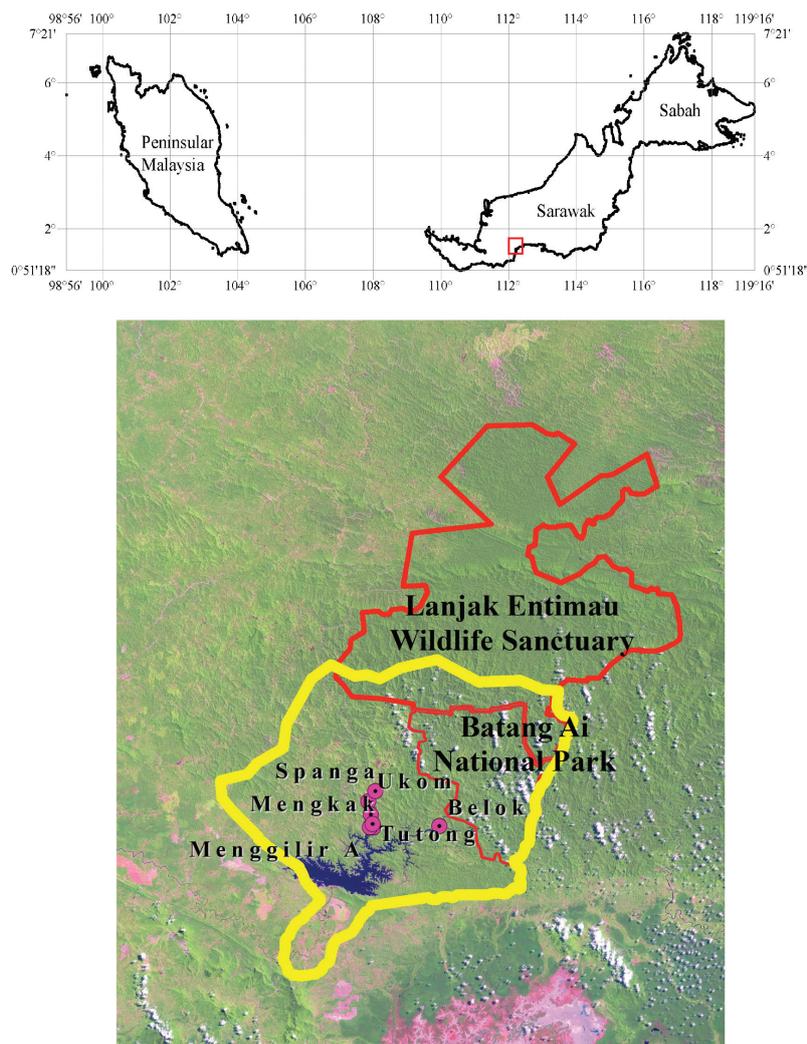


FIGURE 1. The study area

was applied to normalize the radiometric differences on the two images because of topography. Often, supervised classification is used to classify satellite images. The classification results depend on the quality and quantity of training sample data (Lu et al. 2004). We used the maximum likelihood algorithm that classifies a pixel to the most likely class of the training area. Elevation from SRTM-DEM was included as one of the bands in the multispectral dataset. We also conducted pre-classification filtering with 5×5 median filters, which can improve within-class homogeneity thus reducing the so-called salt and pepper effect of the LCC. Post-classification filtering (3×3) was carried out to remove the remaining salt and pepper effect in the LCC.

Nine land cover classes, consisted of intact forest, degraded vegetation, paddy, rubber, bare land, water, oil palm, cloud and cloud shadow, were identified. Training areas for the classes were selected based on interpretation of unchanged land cover information in topographic maps (1:50000) of the study area produced in 2005 by Sarawak's Land and Survey Department. Quicklook images of high-resolution satellite images in Google Earth were also used

for training area selection. Ground truthing was carried out in December 2009. We took photographs of land cover types at random stops along the roads and rivers. The coordinates were recorded with a handheld GPS for accuracy assessment.

QUESTIONNAIRE SURVEY AND ANALYSIS

While the land cover change analysis provided information on deforestation, contingent valuation method was used to elicit a value that registers the local people's willingness to accept (WTA) REDD+ against their existing livelihood activities. We carried out a questionnaire survey at seven long house villages, namely, Nanga Ukom Ulu, Menggilir A, Menggilir B, Ng Tutong, Belok, Mengkaka and Spanga in December 2009 and July 2010 (Figure 1). The respondents were selected through convenient sampling method. As the longhouse villages can only be reached by boat and relatively far from one another, we focused on interviewing adult members of the households who were present during the visit. In doing so, and as the findings show we were able to capture a good spread of age cohorts and gender mix.

The questionnaire consisted of three sections: socio-economic characteristics; forest dependency of the local people and monthly WTA of REDD+ and preferred form of compensation. We used the open-ended approach for identifying the range of monthly WTA values before estimating the central tendency in their value expressions. Respondents were asked to state the maximum money compensation for them to forgo the right of conducting their traditional cultivation and forest use. As for form of compensation, they were asked to choose between cash, agroforestry, oil palm or rubber plantation scheme. Levene's Test showed that the monthly WTA was not normally distributed. Thus, we employed the Spearman's Rho (r_s) for examining the correlations between the monthly WTA and other socioeconomic variables such as age, household expenses and income of the local people.

RESULTS

DEFORESTATION AND FOREST DEGRADATION AT LUBOK ANTU DISTRICT

Intact forest, degraded forest, bush vegetation, bareland, oil palm, rubber and water were classified using the Landsat TM images. Due to limited ground truths, the topographic maps were also used for accuracy assessment. We generated random points for overlaying with the topographic maps and Landsat TM images. Only 101 and 78 unchanged reference points were usable in accuracy assessment of LCC2009 and LCC1990. Although the number of reference points for rubber and oil palm was limited, the two land cover classes only covered 6% of Lubuk Antu.

The overall and kappa accuracies for LCC2009 were 97.0% and 0.96 (Table 1). The user's accuracy for all land cover classes exceeded 80%. The producer's accuracy was also high except rubber and oil palm, which had relatively high omission errors. On the other hand, the overall and kappa accuracies for LCC1990 were slightly lower, at 93.6% and 0.92. The producer's and user's accuracies for all land cover classes exceeded 80%. There were significant time lags between the topographic maps and the LCC1990 and LCC2009. The land cover types of some points may have changed during the time lags. Noting the limitations of the topographic maps, which were the main reference for

the LCC, we considered the accuracy in order to provide a general picture of the classification's accuracy, rather than as an indication of the absolute accuracy.

The classification results are presented in Figures 2 and 3. The most dominant cover change in Lubuk Antu District between 1990 and 2009 was decreasing intact forest and increasing degraded forest. In 1990, the dominant land cover types of the district were intact forest (60%) and degraded forest (20%). However, the intact forest was reduced to about 50% in 2009, while the degraded forest increased to 27% (Table 2). Increasing agricultural plantations also caused the loss of intact forest. The observed expansion of agricultural plantations followed generally a south-and-west to north trend. The large patches of bare land in the southern and western parts were commercial-scale oil palm plantation development. The northeastern and eastern parts of the district have been protected by Batang Ai National Park and Lanjak-Entimau Wildlife Reserve. Overall, small-scale shifting cultivation was the main player of the changing landscape of Lubuk Antu District. As indicated by bare lands along the rivers and the dam, the local people have been practicing shifting cultivation with boat as the major means of transportation. Table 2 shows the land cover changes in area and percent over the nineteen years. The intact forest and grass-like vegetation decreased approximately 13864 ha (16.8%) and 3756 ha (26.6%) while oil palm increased 832 ha (40.2%), rubber increased 1152 ha (29.1%) and bareland increased 7106 ha (375.4%). The only forest type that increased over the two decades was degraded forest (9044 ha). Relatively, the intact forest and bush vegetation decreased at 0.9% and 1.4% annually over the two decades, while oil palm, rubber and bareland increased, respectively, 2.1%, 1.5% and 19.8%. On the other hand, degraded forest increased to 32.9% from 1990 to 2009, with an annual rate of 1.7% (Figure 4).

RESPONSES OF THE LOCAL PEOPLE ON THE REDD+ MECHANISM

The questionnaire surveys that were carried out in December 2009 and September 2010 had yielded responses of 115 households in the seven villages. In spite of the limited time and difficult accessibility, on average, we were able to interview more than 60% of the households in the

TABLE 1. Accuracy of the land cover classifications

Class	2009		1990	
	Producers accuracy	Users accuracy	Producers accuracy	Users accuracy
Intact forest	100.0%	100.0%	100.0%	88.9%
Degraded forest	100.0%	83.3%	93.6%	100.0%
Bush vegetation	100.0%	95.8%	100.0%	95.7%
Bareland	90.0%	90.0%	100.0%	100.0%
Oil palm	75.0%	100.0%	100.0%	100.0%
Rubber	60.0%	100.0%	80.0%	100.0%
Overall accuracy	97.0%		93.6%	
Kappa accuracy	0.96		0.92	

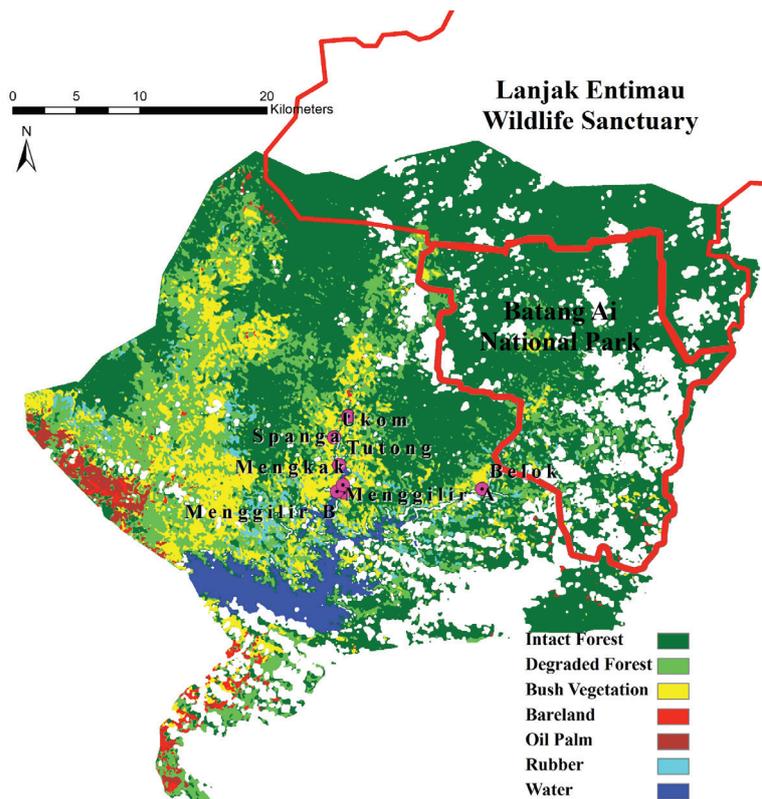


FIGURE 2. Land cover classification of Lubuk Antu District, Sarawak in 1990

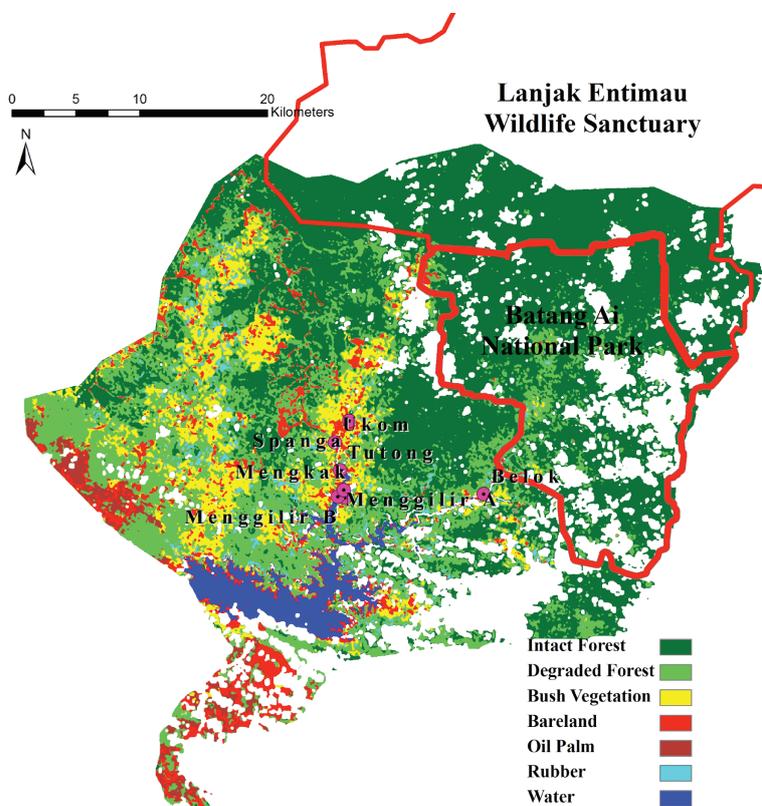


FIGURE 3. Land cover classification of Lubuk Antu District, Sarawak in 2009

TABLE 2. Land cover types and changes between 1990 and 2009

	1990 (ha)	1990 (%)	2009 (ha)	2009 (%)	Change (ha)	Change (%)
Intact forest	82750	60.1	68886	50.1	-13864	-16.8
Degraded forest	27461	20.0	36505	26.5	9044	32.9
Bush vegetation	14110	10.3	10354	7.5	-3756	-26.6
Bareland	1893	1.4	8999	6.5	7106	375.4
Oil palm	2067	1.5	2899	2.1	832	40.2
Rubber	3958	2.9	5110	3.7	1152	29.1
Water	5368	3.9	4854	3.5	-514	-9.6

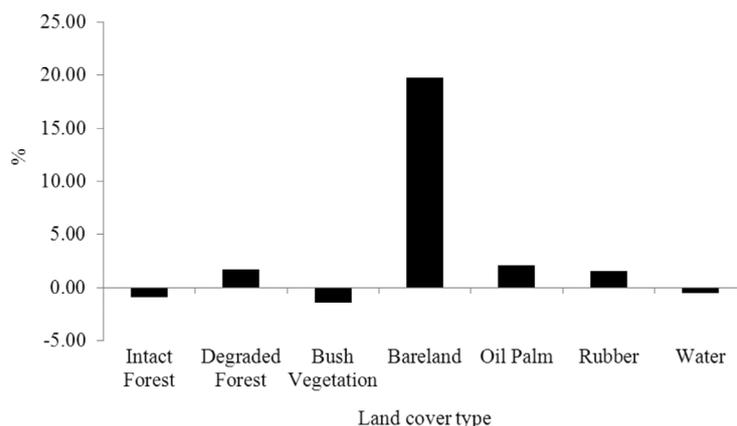


FIGURE 4. Annual change rate of land covers in Lubuk Antu District, Sarawak (1990 - 2009)

villages (Table 3). In fact, we interviewed more than 50% of the households in six out of the seven villages. Only about 20% of households were interviewed in Spanga, which was located furthest and thus relatively less time for conducting the questionnaire survey. Slightly more than half of the sampled respondents were male.

In general, nearly 70% of the respondents received no formal education and 90% were farmers. Only 7% of the respondents were single. The local long house population is aging that 33% of respondents were 50 years or older. Moreover, less than 40% of the respondents were younger than 40 years. Many older adults had experienced working away from the longhouse, in forestry, construction or plantation sectors in their younger age.

Approximately 90% of respondents were farmers who practiced shifting cultivation, hunting, fishing and

gathering forest products for their livelihoods. Their main agricultural crops were hill paddy, vegetables, fruits and pepper. The period of cultivation varied between six months and more than three years, depending on soil fertility. The local people still rely on forest products for their daily life for a variety of uses. About 87% of the local people collected firewood, food (wild fruits, vegetables and meat), building materials for house and boat and herbs for medicines. In sum, these longhouse dwellers had a strong dependence on forest products for their subsistence needs. Majority of the local people were in favor of the REDD+ mechanism. More than 85% of the respondents indicated their readiness to accept the REDD+ if compensation was given. The remaining local people declined to accept because they did not want to leave their ancestral lands. The three most preferred compensation schemes by the

TABLE 3. Sampling rates of households in the long house villages

	Total household	Household sampled	Rate (%)
Ng Ukom	29	29	100.0
Menggiling A	14	10	71.4
Menggiling B	15	10	66.7
Belok	28	14	50.0
Ng Tutong	8	7	87.5
Mengkak	37	35	94.6
Spanga	51	10	19.6
Total	182	115	Average: 63.2%

local people were the rubber scheme (69%), followed by rubber/others scheme (10%) and rubber/agroforestry scheme (8%). Only 4% of the local people opted for oil palm scheme (Figure 5).

On average, WTA of the local people was RM463.2 or US\$154.4 (US\$1= MYR3) per month. The highest monthly WTA of the local people was RM2,000 (US\$ 666.6) while the lowest was merely RM65 (US\$21.7). The Spearman's Rho (r_s) or Spearman Rank Order correlation was used to determine the relationship between the WTA and the socioeconomic variables. Among the five socioeconomic variables tested, only compensation type was not significantly correlated with the WTA (Table 4). There was a relatively strong, positive correlation between WTA and household expenses, which was statistically significant (r_s

=0.49, $P = .000$). This was followed by household income, cultivation period and age.

DISCUSSION

Clearly the results have shown that deforestation and degradation had been taking place at Lubuk Antu District between 1990 and 2009. The deforestation rate of 0.9% per year is not as high as the reported deforestation rate for Borneo (1.7% per year) (Langner et al. 2007), but significantly higher than the reported deforestation rate for Sarawak (0.6% per year) (Kamlun et al. 2012). Overall, intact forest of Sarawak had shrunken more than 0.55 million ha in the last two decades. The forests of Sarawak have been pressured for large-scale expansion of

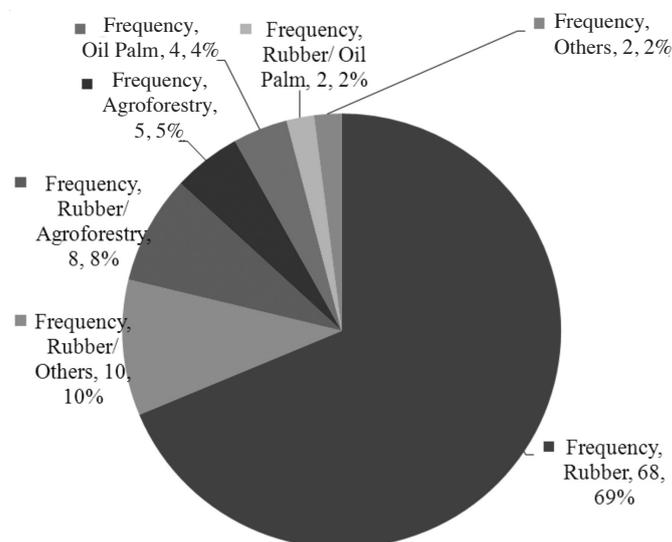


FIGURE 5. The percentage of individuals' preference on compensation scheme

TABLE 4. Correlations between the monthly WTA and socioeconomic variables

	Monthly WTA	Age	Compensation type	Cultivation period	Household income	Household expenses
Monthly WTA	1.000	0.271** (0.007)	0.181 (0.073)	0.299** (0.003)	0.337** (0.001)	0.490** (0.000)
Age		1.000	0.201* (0.046)	-0.003 (0.975)	0.267** (0.007)	0.221* (0.030)
Compensation Type			1.000	0.030 (0.768)	-0.108 (0.287)	-0.104 (0.314)
Cultivation period				1.000	0.234* (0.020)	0.376** (0.000)
Household income					1.000	0.387** (0.000)
Household expenses						1.000

Note: number in bracket is significance value (2-tailed); **: significant at 1%; * significant at 5%

oil palm plantation by agricultural sectors (Tsuyuki et al. 2011). Recent annual increment of oil palm plantation in Sarawak had exceeded 75% per year. Most of the plantation development took place at coastal area, where peat swamp forest is mainly found (Kamlun et al. 2012). Since 2007, the state government targeted to have about 1 million ha of oil palm plantation by 2010 (MPOB 2007). In Lubuk Antu District, oil palm plantations were restricted to western and southern parts that are accessible by road.

On the other hand, rubber increased at a relatively slow rate. Most of the rubber area planted in 1980s was abandoned by local people because rubber's latex price took a deep plunge since late 80s. The local people planted rubber again since the latex price hiked in early 2000s. This explained the relatively low increment of rubber area in the last two decades in Lubuk Antu District. This is the overall trend for Sarawak (Kamlun et al. 2012).

Except the south and western parts, Lubuk Antu district is a typical rural inland area of Sarawak. Almost all the local people in the surveyed villages have been practicing shifting cultivation. Not only the degraded forest was the second largest land cover type, it had significantly increased over the last two decades. Deforestation and forest degradation by shifting cultivators in areas immediately surrounding a park represent pressures to park management and can adversely affect its effectiveness (Phua et al. 2008).

Shifting cultivators in Southeast Asia are usually farmers of low income (Mertz 2009). Almost all the local people lived below the national poverty line, which is RM1000 (USD333.3) for rural area. In fact, more than half of the local people earned less than the monthly WTA of RM463.2 or less than half of the poverty line. About 8.8% of the local people that lived below the poverty line spent more than what they earned. In fact, these households had a monthly income less than RM250 (US\$83.3). They may have to trade their forest and farming produce to finance the excess of their cash expenses. Nevertheless, the 'actual' household income of shifting cultivators is usually higher than their stated cash income because a high proportion of forest resources is used for domestic purpose, and the value of these are therefore not included in the income (Van Beukering et al. 2009).

The annual WTA of the local people was US\$1,852.8 per year per household. Van Beukering et al. (2009) showed that the annual WTA of local people in Cambodia was US\$656 while Hanley et al. (2010) estimated the annual WTA for the case of Uganda at US\$417. The annual WTA elicited in the study area was at least 2.5 times and 4 times higher than the annual WTA for Cambodia and Uganda, respectively. This disparity is also reflected in attributed to the differences in Gross National Income per capita (GNI) between these countries. The GNI for Malaysia, Cambodia and Uganda were US\$7900, US\$760 and US\$490, respectively (World Bank 2011).

In Cambodia, the annual WTA of local people was influenced by household size, forest dependency, importance of selling forest products and type of preferred

compensation (Van Beukering et al. 2009). The correlation strength of household expenses was much stronger than the household income which could be due to difficulty of the respondents in assessing the income from forest produce collection. In contrast, household expenses were a more accurate measure of the household financial stance because it represented cash payment in exchange of manufactured goods and services. These variables imply the local people who either earned or spent more tend to expect higher compensation from the implementation of REDD+ . The cultivation period was also positively correlated with the monthly WTA; that is, local people placed a higher value on lands that can be cultivated for longer than those lands that have shorter cultivation potential. This is parallel to the dominant preference of compensation among the local people. Instead of cash, the local people preferred agricultural scheme especially rubber cultivation. The dominant preference has clearly been influenced by recent high price of rubber latex. Rubber cultivation, when integrated into existing farming systems, can result in significant increases in household income and greater resilience in the face of volatile markets (Fox et al. 2011). Rehabilitating existing shifting cultivation land while clearing new land to compensate local people through agriculture scheme can cause negative leakage in the context of REDD+ debate (Myers 2008). However, REDD+ policies and measure must take into account the needs of poor local people because shifting cultivation has been their livelihoods for generations. In Sarawak as it is in Sabah and in other parts of Borneo (Cooke 2013; Cramb 2007; Potter 2009), the risks to the poor especially the loss of access to land is one of their great concerns. Successful implementation of REDD+ must not only reduce carbon emissions but also improve local livelihoods. REDD+ is a success if it could achieve net positive leakage. New land area might be cleared as compensation of agricultural lands foregone by the people, if good agriculture practice that utilises less land area for higher yield can be implemented. Higher yield of crops would result in higher income and thus alleviate poverty of the local people.

CONCLUSION

Deforestation and forest degradation are anthropogenic activities that cause increasing carbon emissions into the atmosphere. Lubuk Antu District is a typical rural area in Sarawak, which has been experiencing deforestation and forest degradation over the last two decades. While commercial plantation development was found in accessible areas, most of the local people have been practicing shifting cultivation that causes forest degradation. The WTA application in this study provided not only a rough estimate of opportunity cost of the local people who are potentially affected by the REDD+ , but an indication of their readiness to accept the implementation of REDD+ . The monthly WTA of the local people was generally higher than their monthly household income

but critically under the national poverty line. If the REDD+ was to be successfully implemented, compensation in the form of rubber cultivation scheme that generates sufficient income is needed for the local people to forgo their current livelihood activities. Rubber has already been attempted by the local people, and has proven to be a flexible crop that can be abandoned when commodity prices are unfavorable and returned to when market price escalates. More conclusive information needs to be accumulated about changes of carbon stock level associated with different anthropogenic activities especially shifting cultivation and small-holder agriculture of cash crops. Nevertheless, supporting an agro diverse agricultural system, REDD+ could expand its horizon to include support for projects beyond that of carbon sequestration to those of supporting biodiversity maintenance and the provision of ecological services, not to mention the bringing into focus, the question of farmers' right to sustainable livelihoods.

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