# OPPORTUNITY COST ANALYSIS OF REDD+ AT THE DISTRICT LEVEL: CAN REDD+ PROMOTE TROPICAL FOREST REHABILITATION?

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## ABSTRACT

Opportunities to reduce emissions from deforestation and forest degradation are substantial if effective and efficient mechanisms can be established to offset real and legitimate opportunity costs. The opportunity cost analysis aims to: (1) calculate opportunity cost for reducing emissions from deforestation and forest degradation at the district level and (2) identify policy and intervention options using estimated opportunity cost. Transaction and implementation costs are not yet included in the analysis. The analysis incorporates the results of estimation of land use, land use change and forestry (LULUCF) carbon emission with the result of profitability analysis of dominant land uses in Berau district in East Kalimantan, Indonesia. Opportunity cost of avoiding/reducing emission is estimated by calculating economic gain per ($/ton $CO_2$-eq) unit $CO_2$-eg emitted. Significant proportion of emission from LULUCF are associated less than $ 5 increases overtime, from 44% in period of 1990-2000 to 59% in the most recent period (2005-2008). Several polices and interventions options were identified, ie. ranging from reforestation program, improving food security and law enforcement, and these options can be spatially linked to Berau landscape. Integrating them into spatial planning process for sustainable development of Berau should be promoted.

## INTRODUCTION

REDD+ mechanism creates opportunities for better management of tropical forest. The mechanism aims to reduce emission from deforestation and forest degradation through compensating the foregone opportunities. Emission from agriculture, forestry and other land use contributed about 20% of global climate change. In many cases in the tropics, the economic returns generated for each unit of carbon emission are very low. A case study conducted in three Indonesian provinces found that between 6 - 20% of emissions from AFOLU have generated financial returns less than 1$ per ton of $CO_2$-eq and between 64 and 92% of the emission provided financial gain less than 5$ per ton of $CO_2$-eq (Swallow et al, 2007). This opens up opportunities for REDD+ as part of feasible solution for climate change mitigation.

For REDD+ to be implementable, it is important to establish an effective emission reduction mechanism that enables to offset opportunity cost. The opportunity cost is usually the single most important type of costs a country would incur if it reduced its rate of forest lost to secure REDD payments (Pagiola & Bosquet, 2009). At the district level, a demonstration activity for REDD+ implementation will provide lesson learn for further replication and up scaling.

This study aims to: (1) estimate opportunity cost for reducing emissions from deforestation and forest degradation at the district level and (2) identify policy and intervention options using trade-off analysis between financial gain and emission. Transaction and implementation costs are not yet included in the analysis.

## METHOD

Berau is a district in East Kalimantan that previously known for large timber producers in the mid 1980s. The district has land area of 34,147 $km^2$ and its population has reached 164,501 persons in 2007 (BPS, 2008). The opportunity cost analysis in this study involves several steps: (1) clarification and description of major land uses; (2) analysis carbon stocks estimation for the major land uses; (3) profitability analysis of the land uses; and (4) opportunity cost analysis of emissions resulted from land use change. In carbon measurement, this study applies Rapid Carbon Stock Appraisal (RaCSA), a rapid and integrated tool to estimate carbon at landsacpe level (Hariah et all, 2011).

Land use changes in Berau district during the period of 1990-2008 was quantified using satellite images. Each land use change results in the changes of carbon stock and the change on financial return. Integration of the two components enables us to calculate the opportunity cost of each land use change at the pixel level (Swallow et al, 2007). **Figure 1.** illustrates steps in calculating the opportunity cost: REDD Abacus tool (Harja et al, 2011) was used to produce the opportunity cost curve. REDD Abacus is an application developed by ICRAF to support research on emission reduction at the landscape level. The opportunity cost curve shows the associated opportunity cost value of the cummulative emission from the Berau landscape.

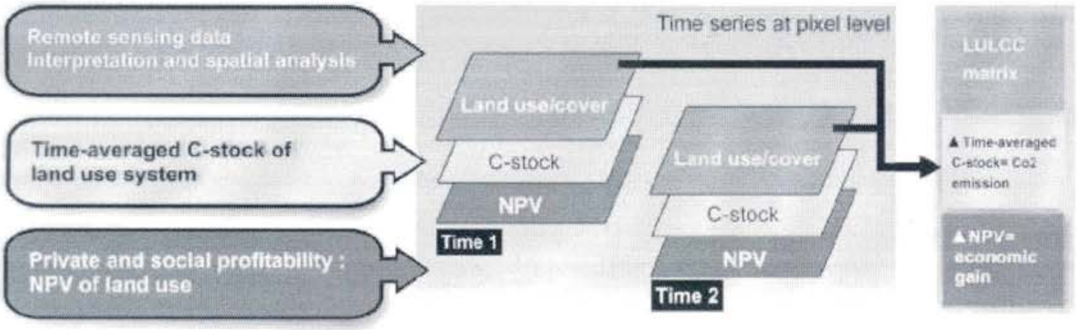


Figure 1. Scheme of opportunity cost estimation

## RESULT

1. Estimation result showing the average emission from the land use and land cover in Berau district have increased from period I (1990-2000), period II (2000-2005) and period III (2005-2008). At the period I, Berau emitted 6.57 ton CO2-eg/ha.year, then increased to 7.9 ton CO2-eg/ha.year at period II and 11.65 ton CO2-eq/ha.year at period III. Averaged emission for the entire period reached 9.2 ton CO2-eq/ha.yr. The highest emission contributed by logging activities that caused 21.4% of the total emission during the entire period.
2. Based on 2009 prices with 10% discount rate, private profitability estimation of selected land uses in Berau has ranked oil palm as the most profitable land use with NPV reached 3424 US$/ha. It was followed by pepper cultivation (2900 US$/ha), logging at high density (1765 US$/ha), cacao cultivation (1347 US$/ha), rubber monoculture (1260 US$/ha), timber plantation (575 US$/ha), logging at low density (398 US$/ha), coconut monoculture (352 US$/ha) and mixed garden (302 US$/ha).
3. Emission proportion that associated with the increase of NPV below 5 US$/ton increases from 47.9% at 1990-2000 to 70.8% in 2005-2008. **Figure 2** shows the Opportunity cost curve of Berau district emission in 1990-2000 (A), 2000-2005 (B), 2005-2008 (C) and 1990-2008 (D).

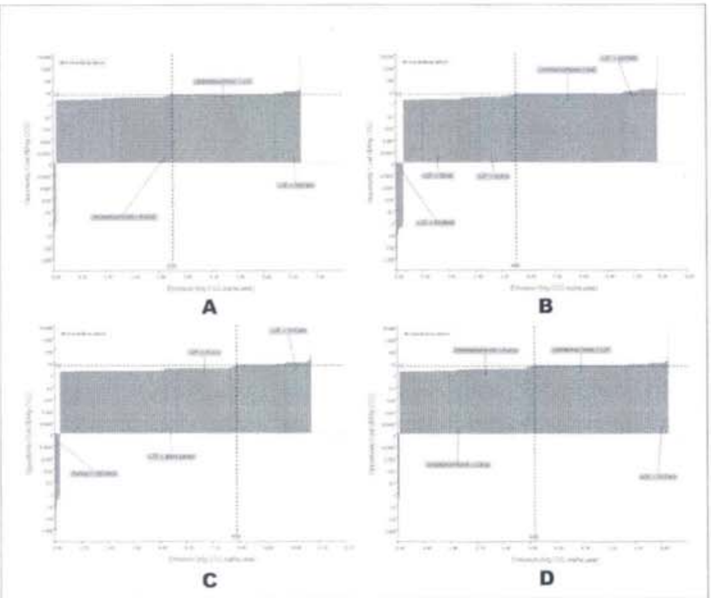

Figure 2. Opportunity Cost Curve,

4. There are four 'economic-emission' areas identified as showed in **Figure 3**. The areas consist of (a) emission area with positive NPV (b) sequestration area with positive NPV (c) emission area with negative NPV (d) sequestration area with negative NPV.

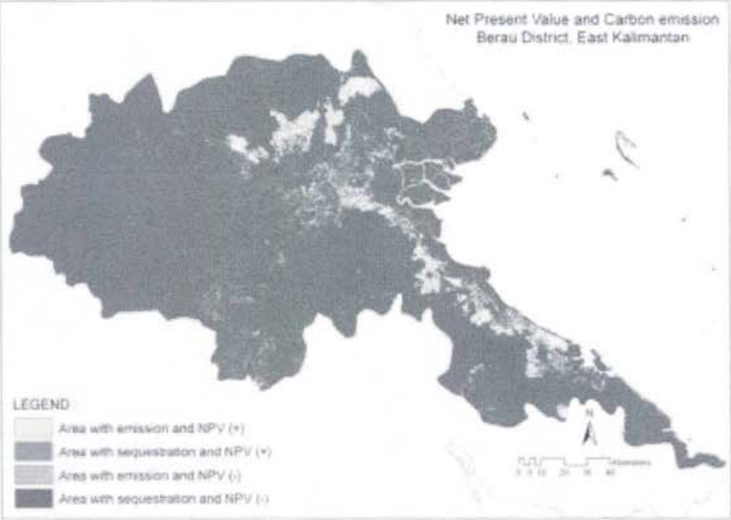

Figure 3. Berau situation by NPV and C emission

## DISCUSSION

The profitability analysis shows that conversion to oil palm is highest in term of economic gain, compared to other land-use; some associated with the high emission and low emission. Logging activity is source of the highest proportion of emission. Conversion of logged over forest (LOF) to oil palm also contribute significantly to emission with the economic gain also high (above 5$ threshold).

Estimating the scale of opportunity cost gives fair estimate of the pressure for deforestation (Pagiola & Bosquet, 2009). This is relevance for Berau district, where the forest still abundant and the oil palm is seen as the most profitable system. Converting forests for oil palm will be costly at side of emission reduction, but the oil palm would provide incentive for local government as well as generate labor opportunities and income for local people.

The opportunity cost curves demonstrate that some emission is associated with the low-economic gain. These cases are occurred at smallholder systems like upland paddy. In this system, people tend to maintain the system not necessary for economic reason, but food security motive. Hence, the emission reduction efforts should not solely depend on market-based mechanism.

Spatially explicit emission and NPV estimation should be one of the main information used for developing land use planning. Typology of area with different trade-off between emission and profitability will lead to different option of interventions.

a. Loss in stock associated with gain in profitability: *Production forest*: Applying reduced impact logging; *Protected forest:* Effective management of protected *forest; law enf*orcement; *Non-forest area (APL):* Support low emission activity *within high-eco*nomic lan*d-use agriculture prac*tice. *Others: re-arrange new* permits of forest conversion; *incentives/ rew*ard for f*orest protection effor*ts.
b. Ga*in in* stock associated with gain in profitability: New incentives to utilize marginal lands for high-carbon stock land uses; Tree-based farming; community plantation forest program (HTR); Oil palm land-swap program.
c. Loss in stock associated with loss in profitability: Reducing practice of shifting cultivation on high carbon stock land-use; incentives and reward to prevent forest fires; improvement of food security for people surrounding forests
d. Gain in stock is not always associated with any opportunity cost but incurs some implementation cost: Reforestation & rehabilitation programs within Forest Land; voluntary tree planting programs on non-forest areas

## CONCLUSION

Opportunity cost analysis can be used to identify areas within a particular landscape where AFOLU emissions are avoidable at low opportunity costs and where enhancement of C-stock can be achieved either with increased economic benefit, under tree-based farming for industry or as small-holder agroforestry practices on APL, or only incurs some implementation costs, in the case of forest rehabilitation on Forest Lands. REDD+ mechanisms can support the promotion of best practices in land use planning. Forest rehabilitation can be part of REDD+ scheme especially in enhancing C-stock; however cautions must be taken in selecting specific programs within the implementing areas to ensure that perverse impacts on C-stock, biodiversity and people's livelihoods do not take place.


## ACKNOWLEDGEMENT

This study was conducted under the the collaboration between ICRAF, University of Mulawarman and TNC. The authors appreciate the assistance and contribution of the collaborating entities and local government offices in Berau landscape.


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