Carbon Emission Reductions through the Introduction of Improved Cookstoves and Cattle Mosquito Nets – A Case Study in Forest-dependent Community

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Introduction

- About 2.7 billion people (40% of global population) rely on wood biomass for daily energy need for many purposes (IEA 2010)
- Three-stone cooking stove is commonly used by forest-dependent community for daily cooking and wood burning practice is common for protecting animal from insects (Geres 2007)
- Their practices consume excessive fuelwood, resulting in deforestation and forest degradation (Zhang *et al.* 2005)
- Recent studies suggest that use of improved cookstoves (ICS) for daily energy and mosquito nets to protect animals show promising results in terms of reducing deforestation and emissions (Ty *et al.* 2011)
- Since reducing emissions from deforestation could be compensated under REDD+ scheme, it is important to understand carbon emissions and reductions achieved under ICS and use of mosquito nets
- Furthermore, cost-effective analysis needs to be performed for comparison and effective introduction of policy interventions

Study Objectives

- To assess the pattern of fuelwood consumption in forest-dependent community in Cambodia
- To project future fuelwood consumption, carbon emissions, carbon emissions reductions and to analyze carbon price when substitution of improved cookstoves (ICS) and mosquito nets are introduced over a 10-year period of hypothesized project implementation

Methodology: General

- Study Site: Phnom Tbeng Forests (Forest-dependent community, see Map)
- Forest Area: 43,041ha (FA)
- 3 Villages survey: Bak Kam, Sedthakkech and Moha Phal (105 households were interviewed on fuelwood consumption)
- 100% of population depends of fuelwood and charcoal for cooking & boiling and 90% burning wood to get smoke against insects

Methodology: Reductions and Prices

Carbon Emissions from Cooking & Boiling (CE_CB)

$$CE\_CB(t)=CB\times HH(t)\times 0.5\times 44/12 \quad (1)$$

Carbon Emissions Against Insects (CE_AI)

$$CE\_AI(t) = AI\times[HH(t)\times(1-HH_{no\text{-}cattle})]\times 0.5\times 44/12 \quad (2)$$

Household growth (HH)

$$HH(t) = HH(0) \times e^{a\times t} \quad (3)$$

Carbon Emissions under Baseline (CE_baseline)

$$CEBaseline(t)=CE\_CB(t)+CE\_AI(t) \quad (4)$$

Carbon Emissions under Project (CE_project)

$$CE\_project(t) = [CE\_CB\_baseline(t)\times(1 - NS)] + [CE\_AI\_baseline(t)\times RPI(t)] \quad (5)$$

Carbon Credit (CC) and Carbon Price (CP)

$$CC(t) = [CE\_baseline(t) - CE\_project(t)]\times(1 - Leakages) \quad (6)$$

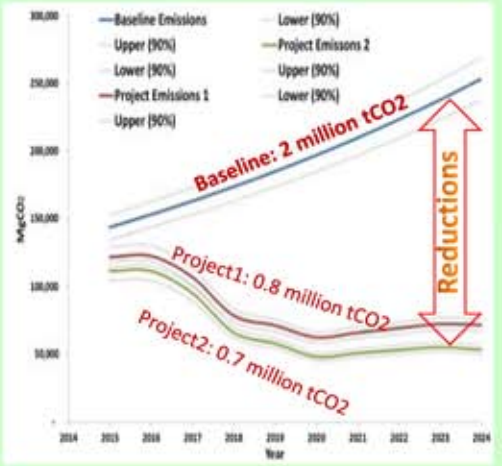
$$CP=TC(t)\times(1+r)^{-t}/\Sigma\, CC(t) \quad (7)$$

- t: time step; a: annual household growth 6.3%, $HH_{no\text{-}cattle}$= 10% (NDCC 2010); r= 5,10,15% (discount rate)
- 0.5 is carbon content (Conversion rate from wood to carbon);
- 44/12 is the ratio of molecular weight CO_2 to the molecular weight carbon; NS is net saving
- RPI= relative project impact taken from Ty et al. 2011
- Unit of CE_baseline, CE_project, CE_CB and CB_AI, CC is $MgCO_2$; Unit of CP is $/$MgCO_2$

Results: Wood Consumption

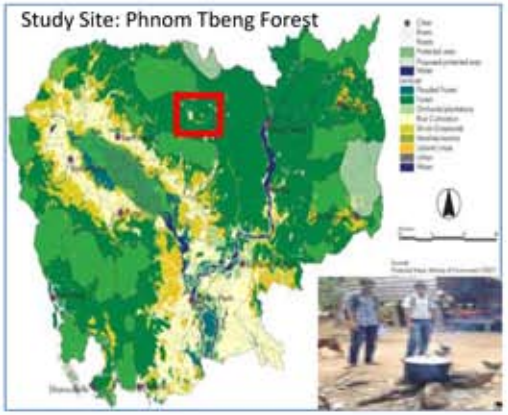
Household size	Household's Number	Cooking (kg day^{-1} family^{-1})	Boiling water (kg day^{-1} family^{-1})	Against insect (kg day^{-1} family^{-1})
Small (1-4)	44 (42%)	3.23±0.30	1.73±0.60	9.83±0.97
Medium (5-7)	55 (52%)	3.73±0.23	2.21±0.15	12.37±1.10
Large (>8)	6 (6%)	4.83±0.50	2.66±0.54	16.33±1.45
Average		**5.62**±0.27 (CI=5%)		**11.77**±0.89 (CI=8%)
		CB = **2.05**±0.1 tonnes yr^{-1} household^{-1} (Eq. 1)		AI = **4.3**±0.32 tonnes yr^{-1} household^{-1} (Eq. 2)

Results: Emissions and Reductions



Results: Carbon Prices

Project 1	Present Value of Total Costs from 2015–2024 (US $)		
	5%	10%	15%
ICS_{costs}	105,362	87,767	74,901
$Rice_{costs}$	21,647,718	17,619,913	14,715,200
Mosquito $nets_{costs}$	316,087	263,302	224,702
$Transaction_{costs}$	1,229,622	953,747	757,680
Total cost under project 1	23,298,788	18,924,729	15,772,481
Carbon Price under project 1 (US $ $MgCO_2^{-1}$)	**25.05**	**20.35**	**16.96**
Project 2	5%	10%	15%
ICS_{costs}	280,966	234,046	199,735
$Rice_{costs}$	21,647,718	17,619,913	14,715,200
Mosquito $nets_{costs}$	316,087	263,302	224,702
$Transaction_{costs}$	1,395,044	1,088,390	870,126
Total costs under project 2	23,639,815	19,205,651	16,009,763
Carbon Price under project 2 (US$ $MgCO_2^{-1}$)	**22.52**	**18.30**	**15.25**



Conclusion

- Introducing improve cookstoves and mosquito net could reduce carbon emissions about 0.9 - 1.1 million tCO_2 or about 6,187 – 6,983 ha of tropical forests being protected from clearing
- This study found that current carbon price ($4.9/$tCO_2$) is below the needed price in order to introduce ICS and mosquito nets, which need $15-$25/tCO_2, thus subsidies from governments are needed to support the project
- However, to further increase accuracy of the study results, surveys according to seasonal variations should be performed because households still have fresh memories and therefore provide better responses to our surveyed questions

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