PROCEEDING

1st "International Conference on Sustainable Agricultur and Environment"

1st ICSAE 2013
international conference on sustainable agriculture and environment

June 26th - 29th, 2(

LORIN SOLO HOTEL Central Java, Indo

Editors :

Dr. Prabang Setyono, S.Si., M.Si
Komariah, STP., M.Sc., Ph.D
Dr. Ir. Widyatmani Sih Dewi, MP

Organize(

Sebelas Maret University
INDONESIA

Publish by : UNS Press

In colaboration

Ditjen DIKTI · Karlsruhe Institute of Technology GERMANY · Chinese Academy of Tropical Agricultural Sciences · UK KENTUCKY USA · SUEZ CANAL UNIVERSITY EGYPT · SELÇUK ÜNİVERSİTESİ TURKEY · INDONESIA · delta med · E

tation :
abang Setyono, Komariah, Widyatmani Sih Dewi (Ed.). 2013. Proceeding of t International Conference of Sustainable Agriculture and Environment. Surakarta, ne 27th-29th, 2013.

sign cover:
ief Noor Rachmadiyanto

blished by:
PT Penerbitan dan Pencetakan UNS (UNS Press)
Ir. Sutami No.36A Surakarta, Jawa Tengah, Indonesia 57126
lephone. 0271-646994 Ext. 341
ebsite : http://www.unspress.uns.ac.id
mail address : unspress@uns.ac.id

BN 978-979-498-838-1

Graduate School, Sebelas Maret University:

OPYRIGHT :
l right of the papers in this book are reserved to the individual authors, and all rights of e other parts to Graduate School, Sebelas Maret University.

SCLAIMER :
ipers are published here unedited, as submitted by their authors. The conference does ot necessarily endorse their contents.

o part of this publication may be reproduced in any form or by any means, electronically, echanically, by photocopying, recording or other wish without the prior permission of e copyright owners.

PREFACE

We would like to thank Allah SWT has guidance so that all preparatory activities 1st ICSAE conference can be conducted successfully. 1st ICSAE International Conference (International Conference on Sustainable Agriculture and Environment) aims to disseminate the results of research in the field of sustainable agriculture and environment.

The conference areas are:

1. Tropical Agriculture
2. Biodiversity
3. Biotechnology
4. Horticulture
5. Climate Change
6. Environment
7. Local Ecological Knowledge
8. Agriculture Social Economy
9. Water Management and Soil Conservation
10. Hydraulic Structure, Maintenance and Operation
11. IPM / Integrated Pest Managament
12. Integrated Agriculture Managament
13. Food Sovereignty and Food Security

Results of this 1st ICSAE conference proceedings will be included ISBN proceeding, ISSN journal and best paper will be submitted to journals that indexed in Scopus. We hope this activity will continue on a regular conference once every 2 years with the results of the advance research in agriculture and environment again.

This conference was a success because it is supported by the Directorate General of higher education ministry of Education and Culture Republic Indonesia as well as sponsor that we can not mention one by one. The committee would like to thank to all those who have helped this conference.

In closing I wish to express my gratitude to all participant for their full cooperation and contribution to this conference. Lastly, I wish you all a fruitful conference and may we a could gain positive outcomes and conclusion from this conference.

Very Sincerely Yours,
Dr. Prabang Setyono, M.Sc
Chief of Conference 1st ICSAE

FOREWORD

Sustainable is the keyword in agricultural and environment management to assure the global food security and maintain high quality of human life. The world population explosion has resulted in natural resources exploitation and degradation drastically to meet the daily life demand. Food production through agricultural technology improvement in soil amelioration, various fertilizer productions, plant breeding, seed production, livestock production, pest management, human empowerment, horticulture production, irrigation technology, food security, and etc plays the main role to feed the population that grows double in the recent century. However, researches on the identification of unsustainable agricultural activities and the studies on reducing negative environmental and social impacts of farming as well as develop new ways to farm profitably while conserving natural resources must be improved and shared.

Together with sustainable agricultural management, biotechnology has successfully contributing and controlling the sustainability of providing foods through cross breeding, genetic manipulation, insect tolerant crop, drought tolerant crop, remove toxin from plants, etc. But desertification, water scarcity and global warming are some of the impacts of natural resources exploitation for food production. In the same way, biotechnology also has negative side impacts on bioresources such as unpredictable and unexpected results during genetic alterations, more infectious virus resulting from gene combinations of infecting virus, cancer risk by eating the genetically modified (GM) food, highly costly, and farmer dependency on commercial seed industry. We must consider our bioresources and environment sustainability by employing the environmental-friendly methods to guarantee the availability for our future generation through a sustainable management.

We must properly protect, develop and manage the technologies to reduce energy consumption, to support the renewable energy resources, such as solar and wind power, also other natural assets for a sustainable utilization. This conference offers a very good opportunity for experts, researchers, practitioners and stakeholders to discuss the most recent issue in agriculture and environment.

Best Regards,
Prof. Dr. Ahmad Yunus
Director of Post-Graduate School of Sebelas Maret University

TABLE OF CONTENS

Climate Change

Water Management and Soil Conservation

Agriculture Social Economy

1st ICSAE/CCh011

ASSESSMENT ON TREE PLANTING EFFECTIVENESS TO REDUCE GREENHOUSE GAS EMISSION

Arief Sabdo Yuwono[114]
[1] *Department of Civil and Environmental Engineering, Bogor Agricultural University (IPB), Indonesia*

ABSTRACT

Greenhouse gas emission problem is nowadays an international issue that tends to grow more and more important worldwide. It is also a national concern of which Government of Indonesia has taken a number of important mitigation and adaptation measures to counter the issue. However, at municipal or local level, mitigation and adaptation strategy is occasionally ineffective due to the lack of inventory data and bias scenario. Therefore, appropriate and effective mitigation measures are enormously important to improve the local strategy to reduce the greenhouse gas emission. The objective of this paper is to assess the effectiveness of tree planting to reduce greenhouse gas emission generated by a metropolitan municipality, namely Depok, located in West Java Province, Indonesia. The local emission reduction scenario consists of three measures, i.e. tree planting, reduction of municipal solid waste generation as well as reduction of electricity consumption. Greenhouse gas emission quantity was calculated according to the general classification of the sources, i.e. energy sector, AFOLU (agricultural, forest land and other land use) sector as well as solid waste sector. The total greenhouse gas emission during 2011 was estimated about $1.1*10^7$ ton CO_2-e whereas the total sequestered carbon by one million trees planting program was merely $5.2*10^3$ ton CO_2-e per year. Reduction of greenhouse gas emission by 5% solid waste generation and 5% electricity consumption were about $2.0*10^4$ ton CO_2-e and $4.5*10^4$ ton CO_2-e, respectively. The result of the analysis indicated that if effectiveness of one million trees planting scenario to reduce greenhouse gas emission is scored as one (1), then the effectiveness of GHG emission reduction by 5% solid waste generation reduction could be scored as four (4) and the effectiveness of those by 5% reduction of electricity consumption would be scored as nine (9). Furthermore, GHG reduction measure by one million trees planting would reduce no more than 0.05% of total municipal GHG emission. It indicates that a choice of local greenhouse gas emission reduction strategy should be based on a comprehensive inventory data, rather than based on any popular action of local authority.
Keywords: greenhouse gas, emission reduction, tree planting, solid waste, electricity.

INTRODUCTION

Greenhouse gas emission problem is nowadays an international issue that tends to grow more and more important worldwide. The greenhouse gas emission rise has been recorded by a number of researchers (Bilgen et al. 2007; Couwenberg et al. 2010; Dinsmore et al. 2010). The global warming phenomenon, as a consequence of the greenhouse gas emission rising (Anshari 2012; Ganesh 2011) has therefore become an important global environmental issue since the last decades.

[14] Corresponding author: Email: arief_sabdo_yuwono@yahoo.co.id

It is also a national concern of which Government of Indonesia has taken a number of important mitigation and adaptation measures to counter the issue. However, at municipality or local level, mitigation and adaptation strategy is occasionally ineffective due to the lack of inventory data and bias scenario. Some municipalities set up a local level global warming mitigation measures without any scientific study on the aspect of identification and quantification of the emitted greenhouse gas by the locality.

Some municipalities try to locally respond the global warming phenomenon by simply greening the open area such as urban forest (Yuwono et al. 2011) without any strategic calculation on the budget and effectiveness of the implemented action. As a consequence, the total greenhouse gas emission remains high due to ineffective action plan. Improvement on mitigation measures is therefore paramount important in order to make the local greenhouse gas emission scenarios better.

The first objective of this paper is to quantify total GHG emitted by Depok municipality in 2011. The second objective is to calculate the sequestration of the emitted GHG whereas the last objective is to assess the effectiveness of tree planting program to reduce GHG emission in comparison with the effectiveness by reduction of solid waste and reduction of electricity consumption.

METHODS

The effectiveness of tree planting to reduce greenhouse gas (GHG) emission is assessed quantitatively by calculating the total amount of GHG emitted by the Depok municipality per year, total amount of the sequestered carbon by one million planted trees, as well as the percentage of the sequestered carbon to the total amount of the emitted GHG under concern. Assessment method is started by emission source inventory which is then followed by emission quantity calculation. The inventory step involves emission sources identification and calculation of the emission quantity. By using corresponding emission factors, emission generated by the each sector can be found. Flowchart of the assessment methods is given in Figure 1.

The amount of emitted GHG is classified into three sectors, i.e. energy, AFOLU (agricultural, forest land and other land use), and solid waste. Each of sector emission is calculated by using its corresponding emission factor which is adopted from IPCC (Inter-Governmental Panel on Climate Change) Guideline 2006 and the database. Greenhouse gas emitted by each sector is firstly expressed in their responding unit, i.e. [ton CO_2/year], [ton CH_4/year] and [ton N_2O/year] and then converted into a single common unit of [ton CO_2-equivalent/year] or simply expressed in [ton CO_2-e/year] by using conversion factor, namely Global Warming Potential (GWP). The GWP for CO_2 is 1, CH_4 is 25 and N_2O is 298 according to IPCC Guideline 2006.

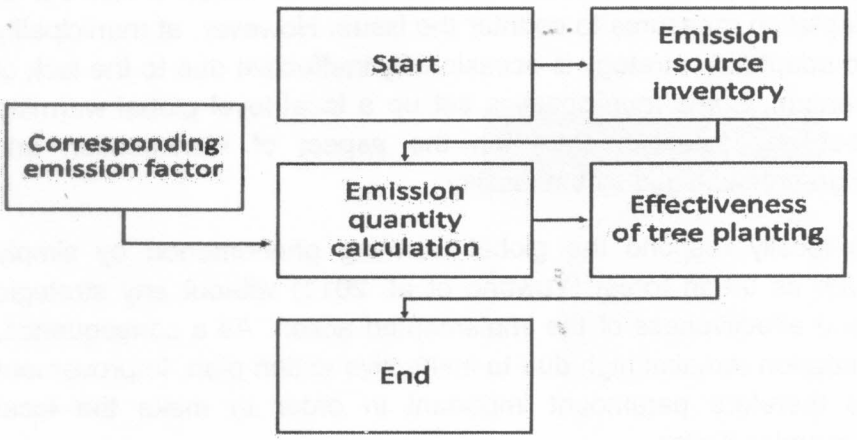


Figure 1: Flowchart of the assessment method.

Basic data was mainly obtained from database of a number of governmental bodies such as Municipality Agency for Development Planning (Bappeda), Office of Agricultural and Fisheries Affairs (DKP), Office of Industry and Trade Affairs (Disperindag), and Depok Branch of State Owned Electricity Company (PLN). Table 1 shows the compiled data necessary for calculation item. The set of equations to calculate the GHG emission quantity is presented in Table 2.

Table 1: Compiled data necessary for calculation item

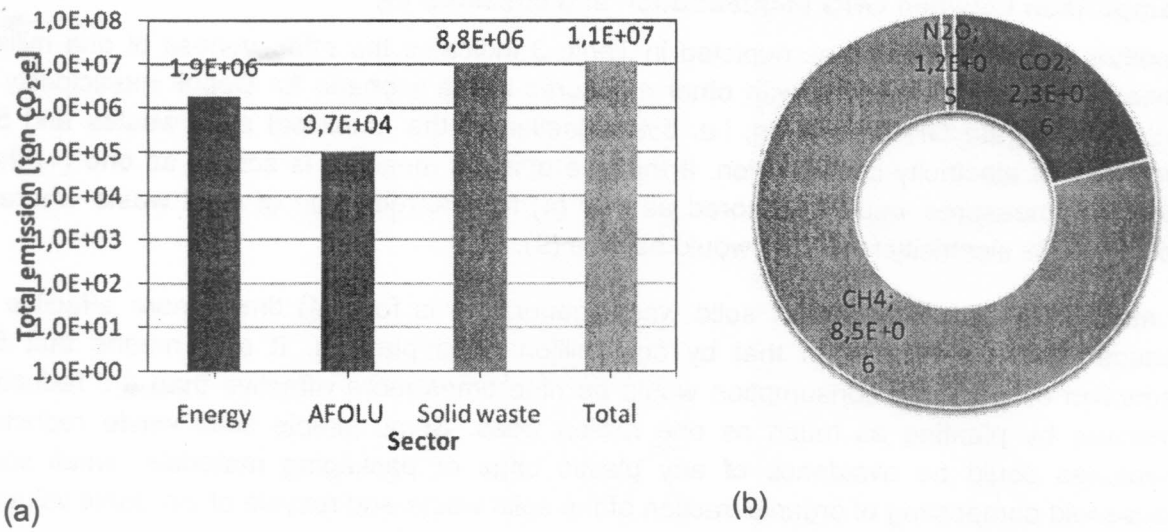
Aspect	Sector	Data	Calculation item
Emission (Sources)	Energy	• Number of small, medium, and large scale industry • Corresponding emission factor (e) • Diesel oil, gas, and electricity consumption	• Emission of CO_2, CH_4, and N_2O of each energy source. • Equivalent calculation of CH_4 and N_2O in term of CO_2 or [CO_2-e].
	AFOLU	• Area of paddy field • Number of livestock (ruminants and poultry)	• Carbon emission from paddy field. • Equivalent calculation of CH_4, and N_2O in term of CO_2 or [CO_2-e].
	Solid waste	• Municipal population • Solid waste generation quantity • Organic and inorganic fraction • Corresponding emission factor (e)	• Emission of CO_2, CH_4, and N_2O of each solid waste fraction. • Equivalent calculation of CH_4 and N_2O in term of CO_2 or [CO_2-e].
	Total	• GWP (global warming potential CO_2=1; CH_4=25; N_2O=298	• Equivalent calculation of CH_4, and N_2O in term of CO_2 or [CO_2-e].
Sequestration (Sinks)	AFOLU	• Area of forestland, crop land, estate crop, grassland, paddy field • Area of lakes and the primary productivity	• Carbon stock in forest, crop land, estate crop, grassland, and paddy field in term of CO^2 or [CO_2-e]. • Carbon stock in lakes in term of CO_2 or [CO_2-e].
Tree planting Effectiveness	-	• Total GHG sequestered • Total GHG emission.	• GHG reduction by tree planting, reduction of electricity consumption and solid waste generation.

Table 2: Basic equations to calculate emission (sources) and sequestration (sinks) of GHG

Aspect	Sector	Basic equation	Remark
Emission (Sources)	Energy	▪ GHG emission = (fuel consumption) * (net calorific value) * (emission factor)	✓Including diesel oil, gas and electricity ✓Calculated for each GHG (CO_2, CH_4 and N_2O) and then converted into CO_2-e.
	AFOLU	▪ GHG emission = (number of livestock) * (emission factor)	✓Including poultry and ruminants (large and small). ✓Calculated in term of CH_4 and then converted into CO_2-e.
	Solid waste	▪ GHG emission = (fuel consumption) * (net calorific value) * (emission factor)	✓Calculation for each of GHG (CO_2, CH_4 and N_2O) and then converted into CO_2-e.
Sequestration (Sinks)	AFOLU	▪ Carbon stock in biomass = (forest area) * (conversion factors) ▪ Carbon stock in lakes = (lakes area) * (primary productivity)	✓Including forest, crop land, estate crop, grass land and paddy field. ✓Only for freshwater lakes.

RESULT AND DISCUSSION

Result of the calculation on the total greenhouse gas (GHG) emission is presented in Figure 2. It shows that GHG from solid waste sector accounts for $8.8*10^6$ ton CO_2-e which equals with 82% of the total GHG emission during 2011. As a comparison, energy sector in India accounted for 69% of the total emission (Sharma et al. 2011). The rest of the emitted GHG is generated by energy sector (17%) and AFOLU sector (1%). Total GHG emission in 2011 accounts for $1.1*10^7$ ton CO_2-e. Figure 2b shows a strong correlation between solid waste sector domination (see Fig 2a) and CH_4 emission. It is clear nowadays that solid waste emitted methane as a result of organic fraction decomposition of the waste (Mackie and Cooper 2009; Aronica et al. 2010).



(a) (b)

Figure 2: GHG emission per sector (a) and their respective proportion of GHG gas (b).

The sequestered GHG is presented in Figure 3 where most of the sequestered amount was carried out by crop land followed by forest land and lakes. The minor contribution of forest land to sequester carbon, i.e. 93 ton CO_2-e, might be due to the limited forest area in Depok municipality. Depok Municipality is known as a sub-urban area of the Jakarta Metropolitan City where availability of forest land in such municipality is now rare to find. In the US, forests already offset about one eighth of the nation's annual CO_2 emissions (Daniels 2010).

The finding that lake contributes small portion of the GHG is in accordance with research result of McGuire (2010) where terrestrial region was a source of atmospheric carbon whereas the ocean sequesters carbon from both the atmosphere and the land.

Figure 3 (b) illustrates that the sequestered GHG is also very small ($5.4*10^3$ ton CO_2-e) in comparison with the emitted amount ($1.1*10^7$ ton CO_2-e). It means that the GHG emission is ca. 2023 times higher than the sequestered amount. It indicates that Depok is a net emitter municipality since the emitted GHG amount is higher than those sequestered.

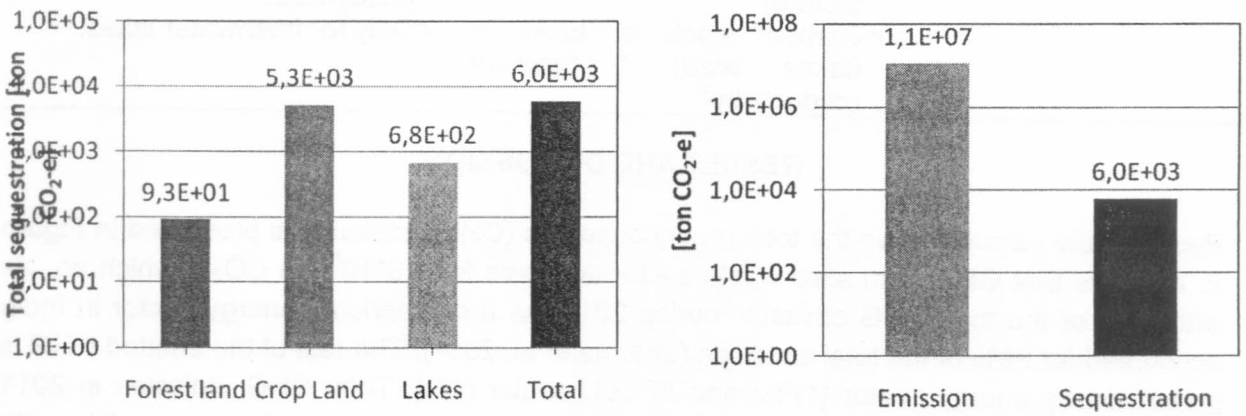


Figure 3: The GHG sequestration by forest land, crop land and lakes (a) and the comparison between GHG sequestration and emission (b).

Another result of analysis as depicted in Table 3 indicates the effectiveness of one million trees planting in comparison with other measures in the scenario for Depok municipality in order to mitigate GHG emission, i.e. 5% reduction of the municipal solid wastes and 5% reduction of electricity consumption. If the tree planting measure is scored as one (1) then the other measures would be scored as four (4) for 5% reduction of solid waste whereas score for 5% electricity reduction would be nine (9).

It means that 5% reduction of solid waste generation is four (4) times more effective to reduce GHG emission than that by one million trees planting. It also means that 5% reduction of electricity consumption would be nine times more effective than the reduction measure by planting as much as one million trees. Some simple solid waste reduction measures could be avoidance of any plastic bags or packaging materials, small scale household composting of organic fraction of the solid waste and recycle of inorganic valuable fraction carried out by scavengers.

The result of the calculation indicates that any local mitigation measures to respond global warming phenomenon should be considered first on quantitative analysis of the amount of emitted GHG, local GHG sources, reduction target as well as on appropriate particular and

potential reduction measure. It should also be fit with the relevant environmental condition such as land availability intended for tree planting area.

Table 3: Effectiveness of tree planting in comparison with other mitigation measures

Tree planting		**Reduction of solid waste**		**Reduction of electricity consumption**	
Number of tree [trunk]	1.0E+06	Reduction [%/capita.day]	5%	Reduction [%/capita.day]	5%
Planting area [ha]	250	Waste generation [kg/capita.day]	0.56	Reduction quantity [kwh/capita.day]	0.10
Ratio (below/above ground) biomass, R	0.2	Total municipal solid waste [Gg]	370	Electricity cons. after reduction [kwh/capita.day]	675
Specific biomass growth (Gw) [ton dm/ha.year]	10	Emission factor [kg CO_2/kg waste]	1.09	Total consumption [kwh/year]	1.2E+09
Carbon fraction of dry matter, [ton C/ton dm]	0.47	Municipal waste generation after reduction [Gg/year]	351	Consumption difference [kwh/year]	6.4E+07
Carbon stock of biomass (ΔCG) [ton C]	1.4E+03	Emission after reduction [ton CO_2-e/year]	3.8E+05	Emission from electricity [ton CO2-e/year]	8.5E+05
Emission reduction [ton CO_2-e/year]	5.2E+03	Emission reduction [ton CO_2-e/year]	2.0E+04	Emission reduction [ton CO_2-e/year]	4.5E+04
Total GHG emission in 2011 [ton CO_2-e/year]	1.1E+07	Total GHG emission in 2011 [ton CO_2-e/year]	1.1E+07	Total GHG emission in 2011 [ton CO_2-e/year]	1.1E+07
% total GHG reduction	0.048	% total GHG reduction	0.186	% total GHG reduction	0.420
Effectiveness [-]	**1**	Effectiveness [-]	**4**	Effectiveness [-]	**9**

The above table also indicated that one million trees planting scenario would reduce no more than 0.05% of total municipal greenhouse gas emission. It means that a choice of local greenhouse gas emission reduction strategy should be based on a comprehensive analysis on the municipal data inventory, rather than based on any popular measures such as city greening, urban reforestation and so forth. On the other side, however, some unpopular measures such as solid waste reduction and electricity consumption reduction have been proven quantitatively as effective GHG reduction measures.

Additionally, for a metropolitan municipality, land provision for a greening program such as one million trees planting might not be a simple problem to deal. A comprehensive mitigation measures with some accurate and effective alternatives should be considered first and well designed prior to any popular action plan.

CONCLUSION

Conclusions that can be drawn from the assessment are as follows:

a. In 2011 Depok municipality emitted GHG totally as much as $1.1*10^7$ ton CO_2-e consisting of $8.8*10^6$ ton CO_2-e contributed by solid waste sector, $1.9*10^6$ ton CO_2-e by energy sector and $9.7*10^4$ ton CO_2-e by AFOLU sector.

b. The total sequestration of GHG in 2011 was merely $6.0*10^3$ ton CO_2-e that was contributed by crop land ($5.3*10^3$ ton CO_2-e), forestland (93 ton CO_2-e) and lakes

($6.8*10^2$ ton CO_2-e). The emitted GHG is ca. 2023 times higher than the sequestered amount.

c. Effectiveness of one million tree planting program to reduce GHG emission accounted for merely 0.05% of the emitted GHG. If the effectiveness of one million trees planting program to reduce GHG emission is scored as one (1), then the score for 5% solid waste reduction is four (4) and the score for reduction of 5% electricity consumption is nine (9).

ACKNOWLEDGMENTS

The field activity of the research was fully supported by many governmental institutions in Depok Municipality. We would like to convey our gratitude to Head and the Staffs of Bappeda, DKP, Disperindag, and PLN for their valuable assistance.

REFERENCES

Anshari MS (2012). Improving solid waste management in Gulf Co-operation Council States: Developing integrated plans to achieve reduction in greenhouse gases. Modern Applied Science. 6(2), pp. 60-69.

Aronica S, Bonanno A, Piazza V, Pignato L, and Trapani S (2009). Estimation of biogas produced by the landfill of Palermo, applying a Gaussian model. Waste Management, 29, pp.233-239.

Bilgen S, Keles S, and Kaygusuz K (2007). The role of biomass in greenhouse gas mitigation. Energy Sources, Part A. 29, pp.1243-1252.

Couwenberg J, Dommain R, and Joosten H. (2010). Greenhouse gas fluxes from tropical peatlands in South-East Asia. Global Change Biology. 16, pp.1715-1732.

Daniels TL (2010). Integrating carbon forest sequestration into a cap-and-trade program to reduce net CO_2 emission. Journal of the American Planning Association, 76(4), pp.463-475.

Dinsmore KJ, Billett MF, Skiba UM, Rees RM, Drewer J, and Helfter C (2010). Role of the aquatic pathway in the carbon and greenhouse gas budgets of a peatland catchment. Global Change Biology. 16, pp.2750-2762.

Ganesh PHR (2011). Global warming/greenhouse effect. Indian Journal of Science and Technology. 5(3), pp.219-222.

Mackie, KR and Cooper, CD. 2009. Landfill gas emission prediction using Voronoi diagrams and importance sampling. *Environ. Modeling and Software,* 24, pp.1223-1232.

McGuire AD, Hayes DJ, Kicklighter DW, Manizza M, Zhuang Q, Chen M, Follows MJ, Gurney KR, McCleland JW, Melillo JM, Peterson BJ, and Prinn RG (2010). An analysis of the carbon balance of the Arctic Basin from 1997 to 2006. Tellus, 62B, pp. 455-474.

Sharma SK et al.(2011). Greenhouse gas inventory estimates for India. Current Science, 101(3), pp.405-415.

Yuwono AS, Kurniawan A, and Fatimah R (2011). A quantitative approach on the role of urban forest in a local carbon cycle. Proceeding of International Conference of Indonesian Forestry Researchers (INAFOR). pp. 518-526.