TA-6289 REG: Core Environment Program and Biodiversity Conservation Corridors Initiative in the Greater Mekong Subregion

Carbon Neutral Transport Corridors

Feasibility study scoping report

13th of June 2011

CONTENTS

I. BACKGROUND

A. Introduction

1. The Greater Mekong Subregion (GMS) Core Environment Program Biodiversity Conservation Corridors Initiative (CEP-BCI) Phase 1 has begun assessing the feasibility of climate change interventions that could lead to substantial investments in the subsequent phases of the program. In order to look at the impacts of GMS transport corridors being developed across the region, the program is now embarking on a feasibility study to investigate the suitability of establishing a 'Carbon Neutral Transport Corridor (CNTC)' along the GMS East-West Economic Corridor (EWEC). A scoping consultation phase has recently been completed in order to initiate the feasibility study and develop a shared understanding of the approach. This included liaising with key stakeholders through scoping workshops and interviews.

2. The purpose of this scoping report is to establish the scope of, and methodology for, the CNTC feasibility study and to report on the consultation process carried out. The structure of the report is as follows: this first section outlines the rationale and context of the project, Section II details the scoping phase and highlights the main elements used to define the study methodology, Section III outlines the CNTC concept and Section IV describes the study framework, methodology and timescale. Finally, Section V defines the key resources and team structure for the study.

B. Rationale for study

3. Transport is one of the main drivers for the increase in greenhouse gas emissions globally and was responsible for 12% of greenhouse gas emissions (GHGs) in 2007[1]. A profile of the GHG emissions from GMS countries shows that transport was responsible for 9% of GHG emissions in 2005, and land use change and forestry was responsible for 26% of emissions in the same year. Further, transport emissions are expected to increase year on year - various projections of these show that within South and Southeast Asia GHG emissions from transport will see a three to five fold increase by 2030 (if no new policies are introduced to tackle these emissions), making Asia responsible for 31% of global transport emissions by 2030[2].

4. A CEP-BCI prefeasibility study of the EWEC conducted in 2007 estimated that emissions from transport were in the order of 1 million tonnes per year, of which just over half is attributable to freight traffic[3]. The CEP-BCI study found that in order to sequester these emissions 150,000 ha of land would be required – the potential offset benefit of these emissions could be as high as $10 Million[4].

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1 Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2010).

2 Schipper, L., Fabian, H., and Leather, J., 2009. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation. ADB Sustainable Development Working Paper Series. ADB: Manila.

3 Fraser, A., Linde, L., Kityuttachai, K and Tantasirin, C., 2007. Report on a preliminary assessment of the scope for implementing a Carbon Neutral Transport Corridor in the GMS. Environment Operations Center: Bangkok.

4 This estimate is based on the average price of forestry related offsets on the voluntary carbon market in 2010 (http://www.carbonpositive.net/viewarticle.aspx?articleID=2143).

Transport infrastructure has a direct carbon impact in that it facilitates an increase in traffic, and (particularly in developing countries), it has an additional induced carbon impact in that it facilitates land use change and deforestation by providing access to previously inaccessible landscapes. The overall direct and induced carbon emissions from the GMS transport corridors are likely to be considerable. There is a need for initiatives to address these.

II. STAKEHOLDER CONSULTATION TO DEVELOP PROJECT SCOPE

5. In order to initiate the CNTC project, a set of scoping workshops and meetings were carried out. The project scoping stage included three scoping workshop in Lao PDR, Thailand and Viet Nam on the 15th of February, 28th of February and 2nd of March respectively, and interviews with relevant stakeholders in each country. A draft concept paper was also circulated to a wider list of stakeholders for comment and discussion. Overall, the aims of the consultations were to:

- Consult on the draft concept paper in order to build a common understanding of the CNTC approach.
- Discuss the administrative, spatial and temporal boundaries of the proposed CNTC.
- Discuss the proposed CNTC feasibility study plan including the various activities that will be conducted.
- Collect information on ongoing activities and initiatives in each country with respect to low carbon transport and forestry sequestration
- Identify relevant private sector stakeholders to be engaged in the study.

A. Consultation in Lao PDR

6. The EOC mission team[5] visited Vientiane, Lao PDR from the 15th – 17th of February 2011. For the CNTC consultation workshop, attendees included key government stakeholders from the Ministries of Public Works and Transport, Agriculture and Environment. Other stakeholders included Lao Freight Forwarders Association (LIFFA), GMS Business Forum and F.S.E. University Lao. The meeting was chaired by the GMS National Secretariat. The list of participants and minutes of the workshop are given in Appendix 1.

7. The main issues arising out of the workshop and meetings with respect to the scope of the study are as follows:

- In terms of transport and pollution in Lao PDR, one of the main issues is the import of second hand vehicles into the country, and the lack of standards controlling the quality of these.
- With respect to the environmental impacts of transport, there is some existing legislation in Lao PDR relating to air quality and fuel standards and also some ongoing initiatives (e.g.

[5] Sumit Pokhrel, Energy and Climate Change Coordinator, Lothar Linde, GIS Specialist and Naeeda Crishna, Carbon Footprint Specialist

Environmentally Sustainable Transport initiatives). The main gaps lie in the enforcement, monitoring and implementation of these.

- The freight sector in Lao is characterized by multiple small and medium sized enterprises (SMEs). Many of these would be keen to adopt fleet replacement / upgrade activities due to the associated cost saving and enhanced access to business, but lack the financial set up and access to capital to invest in these.

- The main issue regarding sequestration is the increasing land demand for competing uses, and also, the uncertainty in robust technical feasibility based on proper surveys to match appropriate tree species to maximize GHG capture without compromising other ecosystem services.

- With respect to sequestration, there is much ongoing REDD work in the country being done by the Department of Forestry including the development of the REDD Readiness Proposal (R-PP) and some demonstration activities (in conjunction with GIZ).

B. Consultation in Thailand

8. The consultation in Bangkok, Thailand took place on the 28th of February 2011. Attendees at the workshop included key government stakeholders from the Ministry of Transport and Ministry of Natural Resources and Environment (MNRE). Other stakeholders included UNESCAP, FAO, UNOPS and private sector transport stakeholders. The list of participants and minutes of the workshop are given in Appendix 1.

9. The main issues arising out of the workshop and meetings with respect to the scope of the study are as follows:

- It is important that the CNTC study and outcomes are aligned with ongoing initiatives, and policy aims in Thailand.

- The CNTC study should consider the CDM mechanism that is in place in Thailand when developing emissions reductions and monitoring systems for transport projects – for example, MRV systems for transport projects should be explored.

- With respect to reducing GHG emissions from transport, the Thai government has in place many different mechanisms to promote biofuels in the country.

- In terms of sequestration projects, benefit sharing mechanisms must be built into the design of these at the outset as a safe-guard for local communities.

C. Consultation in Viet Nam

10. The consultation in Ha Noi, Viet Nam took place from the 2nd to the 3rd of March 2011. Attendees at the workshop included key government stakeholders from the Ministry of Transport, Ministry of Agriculture and Rural Development (MARD) and Ministry of Natural Resources and Environment (MNRE). Other stakeholders included academic institutions, non-governmental organizations and private sector transport stakeholders. The meeting was chaired by the Institute of

Strategy and Policy on Natural Resources and Environment (ISPONRE). The list of participants and minutes of the workshop are given in Appendix 1.

11. The main issues arising out of the workshop and meetings with respect to the scope of the study are as follows:

- The CNTC study should consider how to best align the overall approach and emerging recommendations / pilots with ongoing forestry and transport sector development in Viet Nam.

- Though Viet Nam has a comprehensive legislative framework in place, compliance capacity with respect to fuel and vehicle standards is still an area where work can be focused.

- The main institutions to engage during this work include MARD and Ministry of Transport. This engagement will be necessary in order to collect relevant data, conduct the policy gap analysis, and engage with the freight sector and also to identify sequestration projects. Facilitation by a locally based consultant will ensure that this engagement is effective.

- When considering initiatives to reduce the fuel use from freight fleets, soft measures like eco-efficient driving and vehicle maintenance should be considered as these have been used and seen to be effective in Viet Nam.

- There has been much work conducted in Viet Nam with respect to afforestation and reforestation – the government has in place targets for these, but there is still an investment gap in order for the government to achieve these targets.

- The government also has in place guidelines for the planting of trees – priority is given to a) species that can be used to generate bio-fuels b) optimum species for sequestration c) species that can survive in the context of climate change and d) species of higher economic value.

III. CARBON NEUTRAL TRANSPORT CORRIDORS CONCEPT

12. Building on the prefeasibility study completed in 2007, a draft concept paper for the Carbon Neutral Transport Corridor (CNTC) approach has been prepared which focuses on the EWEC (see Appendix 2). The draft paper entitled 'What is a Carbon Neutral Transport Corridor' outlines the concept of a CNTC and has proposed the following definition:

> *A Carbon Neutral Transport Corridor is the area surrounding a transport network that realizes net zero greenhouse gas emissions through a parallel process of reducing emissions through increasing efficiency, and offsetting unavoidable emissions through protection and enhancement of forest ecosystems and increasing natural sequestration.*

13. In order to identify and define initiatives the focus of a CNTC as defined above, it is important to first understand where GHG emissions are likely to be arise as a result of the EWEC. A holistic estimate of 'whole life' carbon for the EWEC would need to consider GHGs emitted as a direct result of the road project at each of the different stages of the life-cycle, as well as the induced emissions arising as a result of the outcomes of the project. However, accounting for and measuring all the various

sources of carbon that may be emitted as a result of one project may not be feasible or necessary. For the GMS, it is important to consider all the *significant* sources of emissions within the boundaries of a CNTC and to understand which areas should be targeted in order to achieve the greatest reduction in carbon emissions. Figure 1 illustrates the main sources of direct and induced GHGs at each stage in the life-cycle of a road transport project and highlights the difference in the magnitude of these emissions.

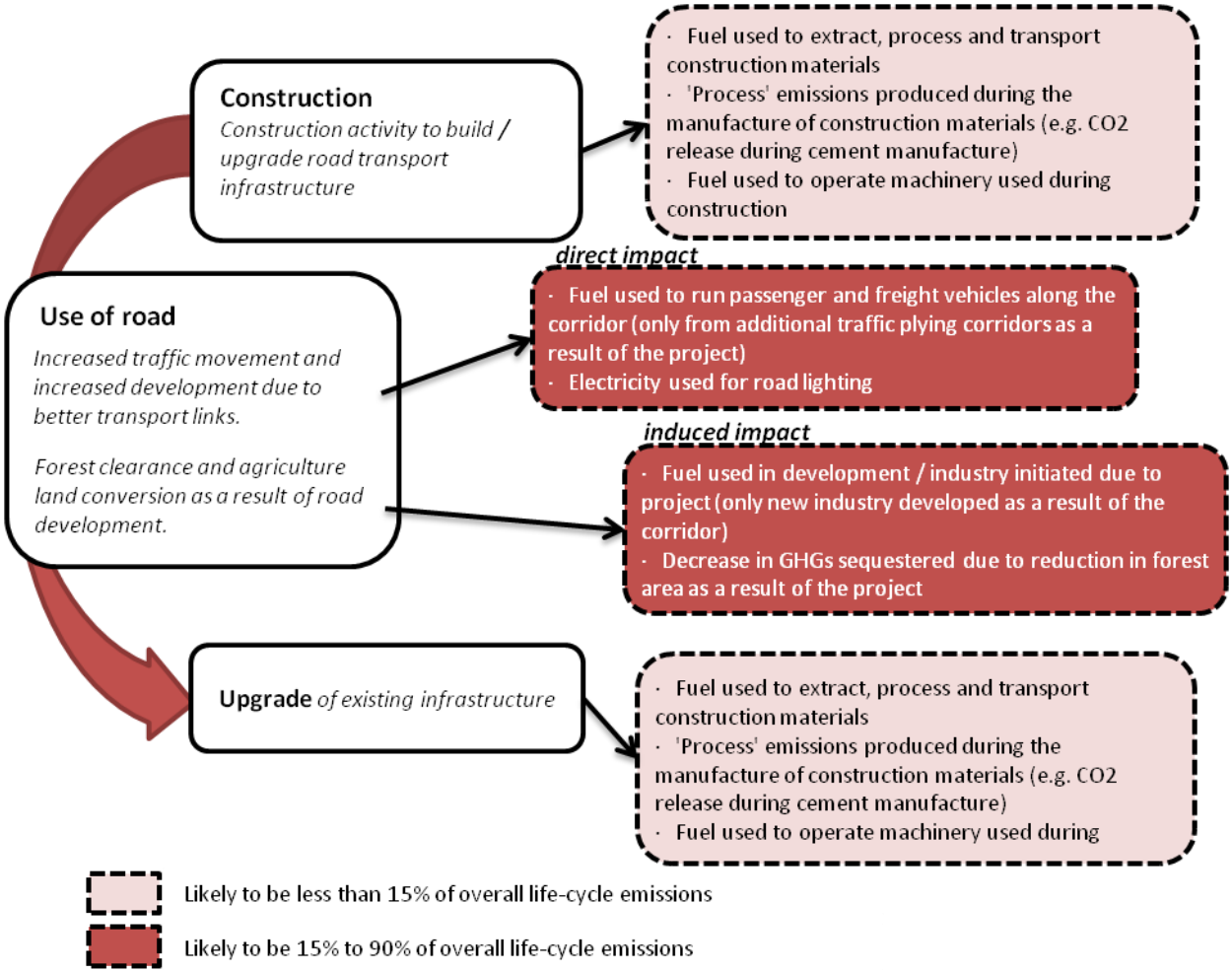


Figure 1: Sources of greenhouses gases throughout the life-cycle of a GMS transport corridor[6]

14. As shown in Figure 1, the main sources of emissions across the life cycle of a road project occur during the use phase of the road. In order to achieve maximum impact, therefore, the CNTC concept will focus initiatives in the transport and forestry sectors in order to address:

[6] Based on information from 1) Asian Development Bank, 2010. Reducing Carbon Emissions from Transport Projects. ADB: Manila. 2) Fraser, A., Linde, L., Kityuttachai, K and Tantasirin, C., 2007. Report on a preliminary assessment of the scope for implementing a Carbon Neutral Transport Corridor in the GMS. Environment Operations Center: Bangkok. And 3) Switalski, A., 2005. The Ecological Effects of Roads in the Brazilian Amazon: Current Status and Prospects for the Future. Road-RIPorter, Volume 10:3. http://www.wildlandscpr.org/road-riporter/autumn-equinox-2005-volume-10-3 . Accessed on 07.10.10.

- Emissions from increasing freight traffic along the corridor
- Decreased carbon sinks due to deforestation of the land around the corridor

15. Thus there will be two elements to a CNTC in the GMS – reducing emissions from transport (i.e. freight) and reducing and offsetting emissions through reforestation / sequestration. The aim of establishing a CNTC will be to reduce and offset GHG emissions with the long term aim of moving towards net zero carbon emissions. The approach will emphasize efficiency and prioritize actions that have a co-benefit of facilitating growth and furthering sustainable development.

IV. CNTC FEASIBILITY STUDY FRAMEWORK AND METHODOLOGY

16. The main aim of the feasibility study is to identify how to implement a CNTC in line with the concept described above i.e. the study will identify the technical, policy and financial feasibility of implementing defined initiatives to reduce emissions from freight traffic and increase carbon sequestration under the CNTC umbrella. The main output of the study is recommendations for pilot projects to be driven by national governments and private sector companies in the region. These pilot projects will be implemented under CEP (2012 – 2016).

17. The overall study framework is based on the proposed definition and concept of the CNTC and is shown in Figure 2. Three main sets of activity are proposed in order to investigate issues particular to the baseline of the CNTC, transport related emissions and reduction of carbon sinks due to deforestation. Details of what each activity will cover is given in Section B below.

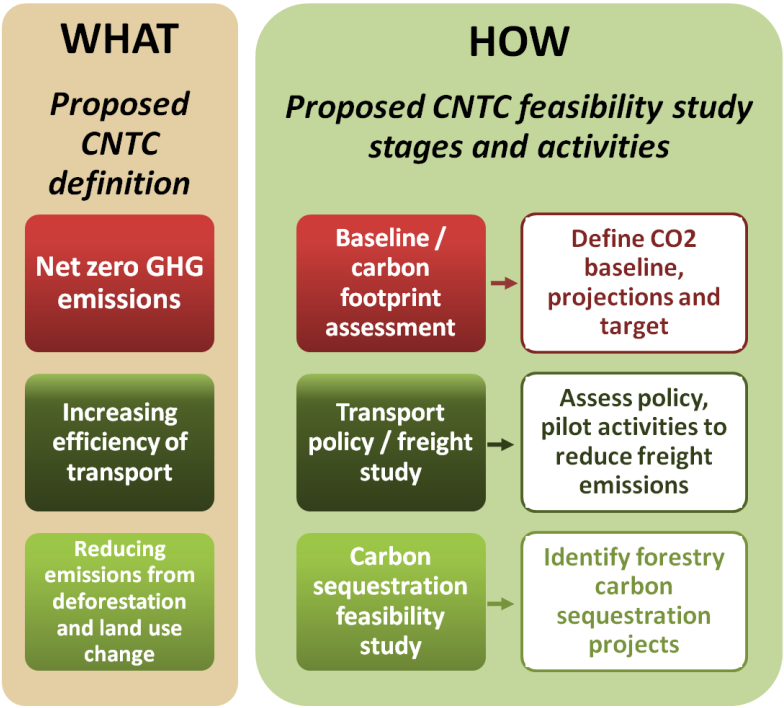


Figure 2: The three main stages and activities of the feasibility study based on the proposed definition and focus of a Carbon Neutral Transport Corridor

A. Spatial boundaries of the study

18. The study will focus on the East-West Economic Corridor (EWEC) that traverses Myanmar, Thailand, Viet Nam and Lao PDR. The focus of the study will be Thailand, Viet Nam and Lao PDR. As the study is expected to produce both national level policy recommendations as well as provincial level recommendations for pilot projects, two sets of boundaries will be applied. At a national level the study will focus on Thailand, Viet Nam and Lao PDR. At a provincial level, the study will take into account all the provinces through which the EWEC traverses in each country. Figure 3 presents the overall provincial boundaries for the CNTC.

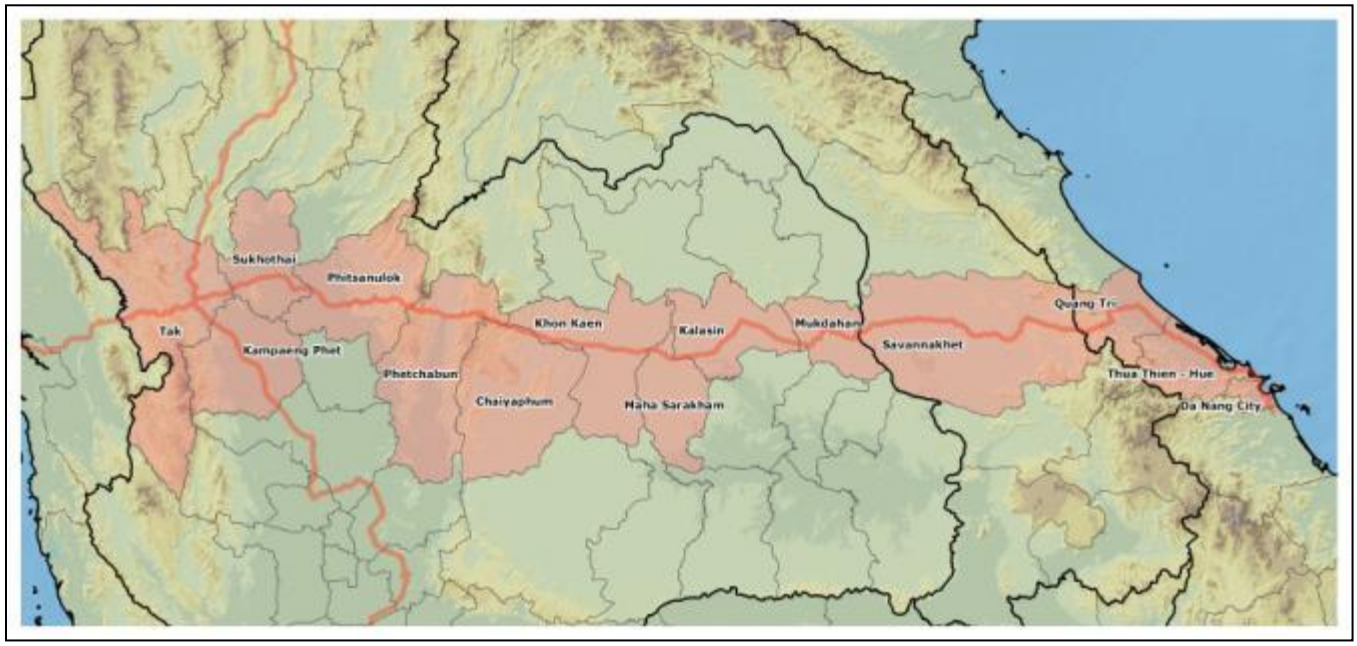


Figure 3: Spatial boundaries of the CNTC including provinces in Thailand, Lao PDR and Viet Nam

B. Key study activities and methodology

1. Baseline / carbon footprint assessment

19. It is important to understand the magnitude of emissions arising as a result of the EWEC both currently and in the future. This activity will build on a previous study by CEP-BCI in 2007 which quantified traffic emissions and possible sequestration potential around the EWEC. The assessment of emissions will take into account all sources of emissions within the defined boundaries of the CNTC over a specified time frame and will include emissions from traffic, deforestation and land use change. The assessment is expected to achieve the following objectives:

- Establish the baseline emissions for the CNTC in the base year
- Quantify the emissions for the CNTC over a specific time period
- Quantify the carbon emissions reduction and savings targets to be achieved by CNTC initiatives

20. Building on the foundations of previous work, this assessment will be conducted using traffic and transport data and GIS land cover conversion maps for the specified area. The assessment will aim to provide a disaggregated footprint for the corridor, by focussing on particular areas of the road.

21. In order to analyse GHGs arising due to increased road transport on the EWEC in a particular year, a variation of the ASIF (Activity – Structure – Fuel Intensity – Emission Factor) approach[7] will be used. ASIF is a bottom-up approach to measure GHG emissions from transport which links vehicle and vehicle activity to fuel used by vehicle types and mode. The advantage of using a bottom-up approach in this study is that it will allow policy scenarios to be developed based on changes to vehicle type, fuel efficiency and type of fuel which can then be analysed in terms of carbon reduction potential. The main elements of the analysis will include A - travel activity across all types of vehicles (distance travelled along the EWEC); S - mode structure (measured in number of road vehicles of different types and age brackets); I - the fuel intensity of each vehicle type and age (measured in km travelled/litre of fuel consumed) and F - emission factor for each fuel type. National level traffic flow data will be coupled with national fleet structure information in order to define the types and ages of vehicles using the corridor as well as heavy and regular road users. Emission factors for fuels will be developed based on IPCC coefficients and / or sourced from international sources like the GHG Protocol.

22. The baseline carbon footprint will be projected by developing different scenarios for the corridor, including a 'business as usual' scenario as well as various carbon reduction scenarios, over the next 20 years. These scenarios will be based on projections of traffic and trade for the EWEC, as well as recommendations arising out the different stages of the CNTC study. The impact of the scenarios on the EWEC will be modelled using the Long-range Energy Alternatives Planning System (LEAP) and possible carbon reduction based on each scenario will be assessed.

23. Emissions from deforestation along the EWEC will be analyzed using Remote Sensing and Image Analysis techniques. One component of this assessment is the establishment of Reference Emission Levels (REL) from medium resolution (spatial and temporal) satellite imagery for province level areas. The study is currently evaluating which sensor to use for this task, with a particular focus on 1) a spatial and temporal resolution that is sufficient to qualify the approach for REDD REL requirements, 2) long term continuity of the sensor / sensor program (past and future), and 3) cost efficiency considering potential institutionalization in government agencies. Images of the chosen sensor will be sourced for three different time periods (present, -5 years, -10 years) and forest cover classified using (depending on the image quality) supervised and/or decision tree classification techniques. The present day satellite image and its classification results will be validated through field surveys including 1) verification of initial forest classification results, and 2) related above ground biomass (AGB) estimation. The first will be used to refine the classification algorithm for the present and the past images, the latter to translate the forest maps into AGB maps. The deforestation rates and carbon emissions (trends) will finally be calculated through an overlay and geo-statistical summary of the three forest cover and AGB maps, respectively. This work will be undertaken by a PhD student,

[7] Schipper, L., Fabian, H., and Leather, J., 2009. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation. ADB Sustainable Development Working Paper Series. ADB: Manila.

supervised by the Asian Institute of Technology and the Environment Operations Centre. The research proposal for this project can be found in Appendix 4.

24. A second component of studying emission levels is to establish a better understanding on the correlation between road construction / upgrade and AGB fluctuations around the road. EOC is currently exploring to partner with the Swiss National Center for Competency in Research (NCCR) of University of Bern. NCCR has a program in Lao PDR out of WREA, and has used low spatial resolution / high temporal resolution MODIS imagery to measure AGB fluctuations along two major economic corridors (NSEC and EWEC). In combination with the more detailed, province-wide REL assessment, this small sub-study is expected to provide a better understanding of the short term dynamics of forest carbon emissions within distance to a corridor road construction.

25. Projections of how land use is expected to change within the boundaries of the EWEC in the future will be modelled using a scenario-driven land conversion model. The CLUE-s model—short for Conversion of Land Use and its Effects for small geographic areas—consists of four major components: 1) land use requirements (land demand), 2) land use type specific conversion settings, 3) spatial restrictions, and 4) location characteristics. While the first two are non-spatial "qualitative" components that lay out potential development trends and pathways in the target region, the latter two are geographically specific, providing the "quantitative" dimension of the model (www.cluemodel.nl). The future land use maps generated by the model complement the REL map sequence with an outlook on land conversion pattern and related carbon emission trajectories in the future. The model will be used to visualize these both for a "business as usual" land demand scenario (from REL study), and subsequently compare where increasing or decreasing land demand will increase or decrease land conversion and corresponding carbon emission along the corridor, providing the level of geographic disaggregation required finding vulnerable areas and for targeting interventions.

26. The Remote Sensing and GIS modelling components will focus on Savannakhet Province in Lao PDR to optimize on the individual outputs and their integration.

27. The data requirements and potential sources for the carbon footprint assessment are given in Table 1.

Table 1: Data requirements and sources

Data requirement	Potential source and availability		
	Thailand	**Lao PDR**	**Viet Nam**
Transport activity data (traffic flow)	UNESCAP Asian Highway database – 2008 / 2010 data; Department of Highways (MoT) - 2008 data	UNESCAP Asian Highway database - 2008 / 2010 data; Ministry of Public Works and Transport – 2010 data (based on JICA road improvement study conducted in 2010)	UNESCAP Asian Highway database - 2008 / 2010 data; traffic flow data - Department of Planning and Investment (MoT), road network in Viet Nam - Directorate for Roads of Viet Nam (MoT).
Fleet structure information including type and age of vehicles	Department of Land Transport (annual publications)	Ministry of Public Works and Transport; National Statistics Bureau (NSB)	Viet Nam Register (annual publications)
	Private sector companies that make use of the corridor.		
Fuel consumption (province level)	Ministry of Energy		General Statistics Office (GSO)
General socio-economic development information	National Statistical Office	NSB	GSO
Land cover information	Land Development Department (LU), Royal Forest Department (FC)	Ministry of Agriculture and Forestry – Forest Inventory and Planning Department (MAF-FIPD), National Land Management Agency (NLMA)	Ministry of Agriculture and Rural Development – Forest Inventory and Planning Institute (MARD-FIPI)
Land ownership information	n/a	National Land Management Agency (NLMA), Ministry of Planning and Investment (MPI)	Ministry of Natural Resources and Environment (MONRE),

2. Transport policy and freight assessment study

28. GMS transport policies related to fuel use by vehicles will be assessed in order to identify any policy gaps and develop policy recommendations. The focus of the review will be on road based transport and freight GHG emissions and will also take into account air quality related initiatives that may be applicable. The main questions to be addressed by this review will be:

- What current policies / regulation / initiatives exist in the GMS to reduce / control road traffic / freight emissions? How are these being implemented? Where are the gaps?

- What potential exists for integration of policies i.e. air pollution and CO_2e reduction?

- What role does cleaner technology have to play in reducing freight emissions? What is the status of engine technology in the GMS?

29. The focus of the review will be on assessing the status of different measures to reduce freight emissions is each of the GMS countries (see Table 2).

Table 2: Possible ways of reducing GHG emissions from freight

Technical solutions	Operational solutions	Policy level solutions
• Freight fleet modernization / replacement • Freight fleet upgrade • Use of alternative fuels e.g. bioethanol	• Corridor traffic management (e.g. congestion management, speed management, traffic flow smoothening etc.) • Logistics management like reducing vehicle / driver idling, optimization of routes traversed, better information sharing across companies to increase efficiency of freight operations etc. • Regular road maintenance • Training for drivers on eco-efficient driving practice	• Air quality standards • Vehicle emissions standards • Vehicle fuel efficiency standards • Incentives / subsidies to increase efficiency • Penalization of polluting vehicles (i.e. through taxes) • International road standards

30. The policy review will be followed by a freight business climate assessment. This will involve engagement with private sector freight companies that work in the region in order to understand operational issues faced and the appetite for reducing GHG and vehicle emissions from freight transport. The questions that this piece of work will seek to answer include:

- What are the main drivers, current trends and future projections for the freight transport industry?

- What is the structure of the industry (in each country) and who are the main players involved?

- What enabling conditions are required in order for the freight private sector to reduce its use of fossil fuels?

31. General information on the business climate for the freight industry will be collated from secondary sources (industry publications and articles, national statistics). This will be supplemented by interviews with the different companies and associations in each country. Possible modes of engagement with the freight private sector in each country will differ. In Thailand a sample of companies will be engaged through associations like the Board of Trade, GMS Business Forum and the Federation of Thai Industries. In Lao PDR, companies will be contacted through the GMS Business Forum, Lao Freight Forwarders' Association as well as the Ministry of Public Works and Transport. In Viet Nam, the Ministry of Transport will help identify companies to engage, and this engagement process can be facilitated by local implementation groups working in the sector (e.g. the Viet Nam Clean Air Partnership).

32. In order to establish the feasibility of pilot projects it will be necessary to investigate technical and financial aspects of such projects. Particularly, models of how to engage the private sector so that the project is sustainable in the long run would need to be investigated. For example, one possible way of increasing efficiency among freight companies would be to facilitate the development of a nodal group that could help SMEs to increase fleet utilization, reduce idle time and capacity and help companies gain access to financial capital required to modernize fleets. To establish the feasibility of such models a survey of freight companies will be conducted both in towns along the EWEC and settlements located close to border crossings, as well as in the capital cities in all three countries. The survey would take the form of both interviews as well as participatory workshops with freight and logistics companies in order to understand applicability and appetite for such models, and collect information on business practices and existing fleets.

3. Carbon sequestration and reforestation study

33. The aim of this study is to define the types of measures that could be applied to reduce emissions from deforestation and offset emissions through reforestation / sequestration projects. Initial review work will focus on financial and policy feasibility and will include a review of measures / policies that could be applied to reduce emissions from deforestation complemented by an assessment of the current conservation and forestry related strategies within the GMS countries. Financing mechanisms that could be applied to develop sequestration projects will also be explored (e.g. PES, REDD). This study will build on other CEP-BCI studies currently ongoing in this field (e.g. SMCA work, PES as applied to hydropower development, REDD preparedness capacity building in the GMS).

34. In parallel with the desk based review of forestry policy, the CNTC provinces will be analysed using basic spatial criteria (e.g. slope, land use etc.) to understand specific provinces which will be studied in detail. A Spatial Multi Criteria Analysis (SMCA) will be undertaken on the focus provinces in order to identify suitable areas for sequestration. This analysis will focus on identifying potential areas which serve multiple ecosystem functions i.e. watershed protection, soil conservation, erosion control etc, and where carbon sequestration (i.e. reforestation) would be restoring these functions and their economic benefit to other sectors.

35. The SMCA is split into three essential parts: 1) the development of a criteria tree, 2) the translation of the criteria tree into a suitability / vulnerability map, and 3) the extraction of focal areas from this map along minimum suitability (e.g. >80%) and/or plot size requirements (e.g. >1000ha). The criteria tree – which is the conceptual backbone of an SMCA – is developed in 7 steps: 1) *Formulate* the planning question, 2) *Identify* factors that need to be considered, 3) *Separate* out legal restrictions, 4) *Organize* the suitability factors hierarchically, 5) *Define* suitability criteria for each factor, 6) *Weigh* them by their relative importance, and 7) *Link* with GIS datasets for spatial dimension. In a previous activity in Lao PDR, EOC has already developed a criteria tree (for rubber plantations) and collected / processed related GIS datasets. The results of that study will be revisited for this component of the CNTC project and adjusted / updated where required.

36. Field work will then be conducted in order understand land ownership status of the land identified in the SMCA. Areas identified under the SMCA will need to be divided into those that are (i) definitely state land not under any claim by local communities (ii) state land but occupied or claimed by local communities (iii) land over which communities have title or a recognised use-right and (iv)

privately owned land. Data on land ownership will be collected both through National Land Registration bodies as well as through field work. In order to develop sequestration pilots, land that is state owned will be prioritized.

37. Based on the response from partners (state organisations, private individuals, or communities), participatory land-use planning will be conducted to identify the actual areas that can be reforested within an overall land unit. Site surveys based on satellite images (or air photos if available) will be conducted to identify the main types of current and future vegetation. Where there are trees growing, sample plots will be measured to determine likely growth rates of different species on different site types. National forest researchers or universities will also be consulted in order to advise on the likely growth rates of different species. If possible, areas to be reforested for sequestration will be reasonably large (at least in aggregate within a management unit e.g. 1,000 ha). A site will also be identified for a nursery to supply the planting stock.

38. In order to define future arrangements for reforestation, institutional arrangements to manage each of the blocks to be reforested will be explored with relevant stakeholders (i.e. state or private enterprise, NGO or a cooperative). Benefit sharing arrangements will also be explored. Costs of establishment and maintenance will be estimated in order to prepare the overall budget.

C. Study outputs and outcomes

39. The main output expected from this work is a feasibility report on the CNTC concept with recommendations on how it could be implemented in the GMS and a detailed plan of activities / initiatives to be tested at a site level in the next phase of the CEP-BCI. It is expected that the feasibility report will include the following (through the collation of outputs from different individual activities):

<u>Assessment of GHGs (baseline and projections)</u>

- Definition and boundaries (geographic, spatial, temporal) of a CNTC in the EWEC
- Carbon targets (both Reduce and Offset) for the CNTC based on an assessment of the emissions arising from the development of the corridor over a particular time period

<u>Transport policy and freight business climate study</u>

- Identification of ‘control’ and ‘incentive’ measures that could be applied to reduce freight emissions at a policy level, and the barriers to the uptake of these
- Identification of private sector led initiatives that could be implemented to reduce transport emissions (with respect to cleaner transport technologies and management), and the technological and market barriers to these
- Identification of possible private sector transport companies that could be involved in future stages of work
- Recommendations on the pilot activities needed to establish the feasibility reducing transport emissions within a CNTC

Carbon sequestration feasibility study

- Technical feasibility - identification and description of possible sequestration sites (taking into account the matching of species to soil types and opportunity costs of different land uses) and sequestration potential of these

- Financial feasibility – identification of the main funding streams and sustainable financing mechanisms that could be deployed to facilitate such sequestration projects

- Policy environment - identification of policy level initiatives that could be implemented to reduce emissions from deforestation and

- Recommendations on pilot activities needed to establish the feasibility reducing deforestation emissions and increasing reforestation savings within a CNTC

40. The following high level outcomes are expected as a result of this initial background development work:

- Increased capacity and awareness of monitoring carbon emission and savings targets

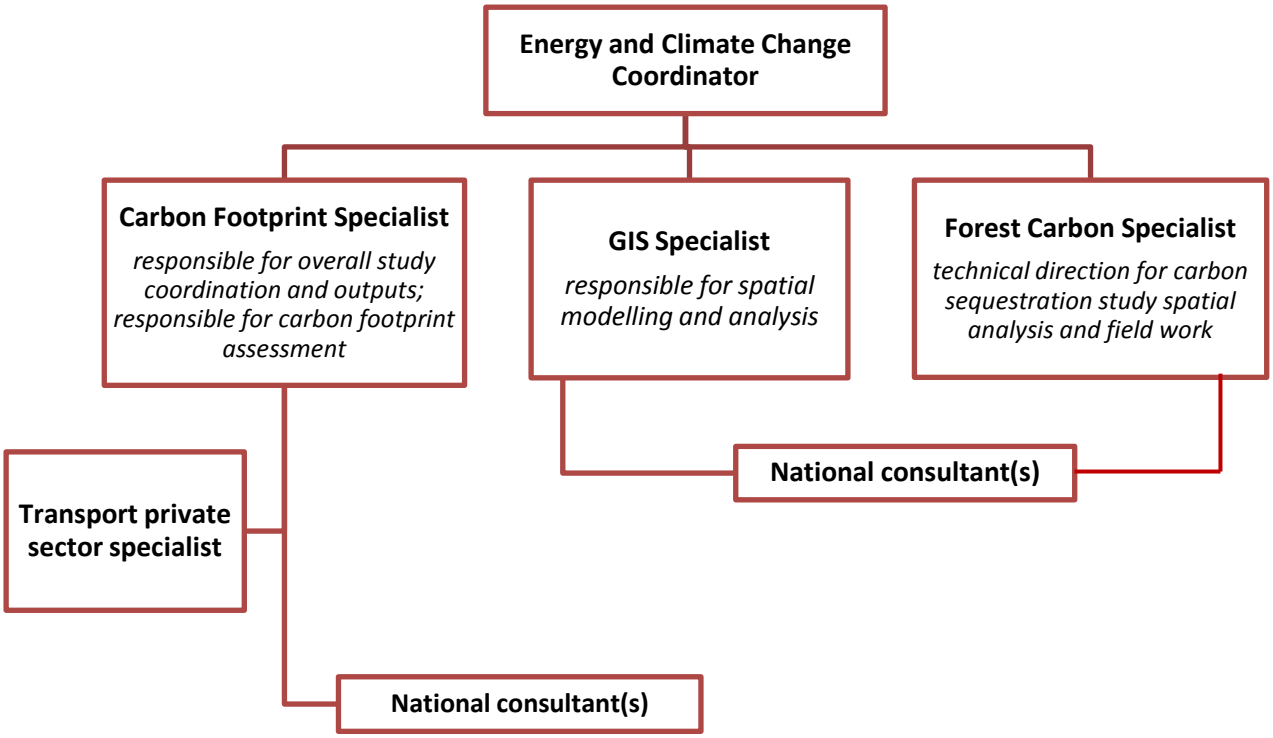
- Contribution towards GMS REDD targets through the development of REDD projects and capacity

- Closer engagement with private sector companies and development of public private partnership models

V. IMPLEMENTATION ARRANGEMENTS

A. Organizational structure of study team

41. The study team will report to the Energy and Climate Change Coordinator at the EOC who will be responsible for the technical direction and overall outcomes of the project. The activities for the feasibility study will be coordinated by the Carbon Footprint Specialist, and key study activities will be directed (from a technical standpoint) by specialist resources at the EOC including the Forest Carbon Specialist and GIS Specialist at the EOC. Data collection, analysis, field work and survey activities in each country will be carried out by national consultants as required. The study organization is shown below. Terms of references for key study personnel are given in APPENDIX 3.



42. The focal point agency in each country will be the WGE focal points i.e. Ministry of Natural Resources and Environment (MNRE) in Thailand, GMS Secretariat (WREA) in Lao PDR and the Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE) in Viet Nam. Other key government stakeholders that will be engaged in the study include the Ministry of Transport, the Department of National Parks and Office of Natural Resources and Environmental Policy and Planning (MNRE) in Thailand; Ministry of Public Works and Transport and Department of Forestry (MARD) in Lao PDR; and Ministry of Transport in Viet Nam. Private sector transport associations and companies will also be engaged through the transport policy and freight assessment study.

B. Parallel activities

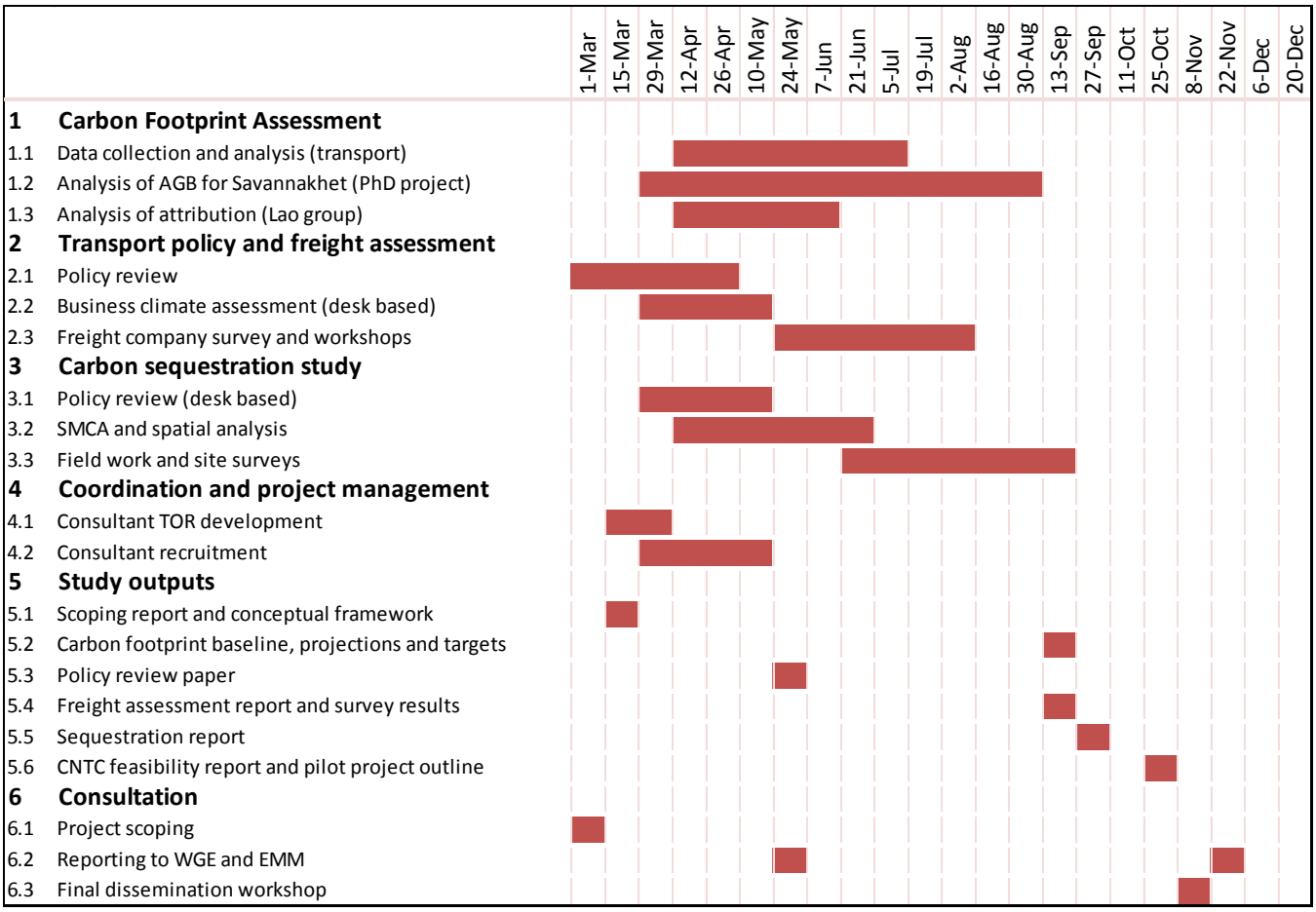
43. A few activities are ongoing related to the CNTC theme which enhance and validate the results and outcomes of the CNTC feasibility study. These two initiatives will be initiated in 2011 and include: a project by the Greenhouse Gas Inventory and Research Centre of Korea (GIR) that will build the long term monitoring capacity in transport and greenhouse gas inventory systems, and a project by the Korean Forest Research Institute which will help build forest carbon baseline monitoring systems. Both projects will be focused on Lao PDR, and will use the CNTC project objectives to conduct research based on primary data. This process will be used to develop institutional and human resource capacity in Lao PDR by applying a 'learning by doing' approach to capacity building activity.

C. Study schedule

The feasibility study schedule is given below. Major milestones for the activities are as follows:

- Scoping report – June 2011

- Policy review report – August 2011
- Carbon emissions assessment paper – September 2011
- Freight business climate assessment report – September 2011
- Sequestration and reforestation feasibility report – September 2011
- Overall CNTC feasibility study report and workshop – October / November 2011



APPENDIX 1 SCOPING WORKSHOP PARTICIPANTS AND MINUTES

Consultation on the 'Carbon Neutral Transport Corridors' concept and scope of the feasibility study (EWEC), Vientiane, Lao PDR

16th February 2011

I. PARTICIPANTS

(Attached separately)

II. INTRODUCTION

1. The first consultation on the Carbon Neutral Transport Corridors (CNTC) concept and scope of the feasibility study (focusing on the East-West Economic Corridor EWEC) was held in Vientiane, Lao PDR on the16th February 2011. The meeting aimed to bring key stakeholders from Lao PDR together to discuss the CNTC concept and the activities planned under the CNTC feasibility study.

2. The meeting was chaired by Mr. Chanthachit Amphaychith, Deputy Director of the GMS National Secretariat (Water Resources and Environment Agency). Mr. Chanthachit opened the meeting with a short introduction of the GMS program and the proposed activity and introduced the Environment Operations Center (EOC) team.

3. Mr. Sumit Pokhrel, Energy and Climate Change Coordinator at the EOC, briefly introduced the background to the activity. Ms. Naeeda Crishna, Carbon Footprint Specialist at the EOC, presented the background and rationale and explained why the CNTC concept was needed. This was followed by an introduction of the concept and an explanation of how the key ideas within the concept would be investigated during the feasibility study. Key study stages were also introduced and the proposed boundaries of the study introduced to the group.

4. The presentation was followed by a scoping consultation during which time the participants discussed key issues including observations / comments on the proposed concept and study, ongoing transport and sequestration initiatives in Lao PDR, engagement with the private sector, spatial and temporal boundaries of the feasibility study and the study plan.

5. A short description of the discussion is given in the following sections.

III. DISCUSSION

A. Comments / observations on proposed concept and study

- The concept and study focus on climate change mitigation – climate change adaptation is not considered.

- Greenhouse gas emissions following road building are a cause of concern and should be considered in the study.
- There is some uncertainty on different types of forest and how much carbon dioxide each type can sequester. It would be good if this study investigated and disseminated information on this.
- When investigating sequestration potential, alternative demands on the land should be considered as well.
- The key environmental issues related to transport in Lao PDR are associated with the import of second hand vehicles and 2-stroke engines in motorcycles. There is also a need to encourage a shift from private to public transport (more relevant for urban areas).
- The key concern raised by private sector participants (LIFFA, GMS BF) was where the money to implement fleet upgrades / replacement will be sourced from. The business climate in Lao PDR is such that raising such a large investment, especially by SME enterprises, will be difficult.
- Besides transport and forestry, industry and landfills (methane) will also contribute to GHG emissions.
- Another aspect that the study should include is how the study outcomes will link to socioeconomic (poverty reduction) country priorities.
- The GMS ECP was implemented to increase development and progress – increased traffic as a result of this is inevitable. It is important that the study focus on increasing efficiency, rather than decreasing the volume of traffic. Efficiency increase should also take into account impacts of the CBTA.
- The study could also consider alternative clean fuels.
- There is very low institution capacity in Lao PDR and this study should consider including an aspect of capacity building and awareness raising for government officials.
- There is a danger that focusing on too many uncertain impacts of road transport (e.g. cumulative impacts etc.) will dilute the study results – transport focus should be encouraged.

B. Discussion related to clean transport

1. Ongoing transport initiatives and gaps

- There are a number of initiatives being developed under the ‘Environmentally Sustainable Transport (EST)’ umbrella including an ADB Urban development project completed Jan 2011 and a JICA supported project looking at Nationally Appropriate Mitigation Action (NAMA) in Lao PDR (Ministry of Energy). As of now, there are no plans to look at CO2 reduction in corridor or rural areas yet.
- In terms of low carbon transport, there are some planned railway projects that might move from diesel to electricity.
- The GMS BF is developing a standard for freight called the Freight Forwarders &Transport Association (FRETA). This standard for road freight (including stipulations for pollution, safety, physical requirements etc.) will be encouraged across the GMS as a way to allow trucks to move within other GMS countries.

2. Policy framework and gaps

- Lao PDR does have environmental standards and fuel standards that have been developed and are enforced (National Authority of Science and Technology). Air quality standards are in place, but few monitoring systems exist. Thai and Vietnamese air quality standards have been used for the development of these. Currently fuel quality regulation is waiting for approval.
- There are no emission standards currently being enforced for second hand vehicles in LAO PDR – this is a rapidly expanding sector and its impacts in terms of pollution and energy use are significant.

3. Private Sector Engagement

- One major issue with respect to freight emissions is due to the current bilateral agreements in place - trucks run empty one way and trans-shipment of goods takes place at the borders. Increasing coordination among companies is difficult due to competition for contracts. It would be desirable from energy / cost savings point of view to upgrade engines and manage logistics better, but Lao companies do not have enough capital to pay for these and also lack the business environment in which they would gain access to such capital.
- LIFFA is under the administration of DOT – the DOT should be the main entry point to engage with private sector as they maintain records of registered companies both at a national and provincial level.

C. Discussion related to forestry and sequestration

- Forest carbon partnership fund (FCPF) is implementing projects to identify the main drivers of deforestation (in conjunction with the Department of Forestry). These are linked to the National Strategy on REDD and the REDD readiness plan (R-Plan) that is currently being prepared.
- WREA and MAF are the main agencies to plug in climate change related activities and pilot activities – these two agencies have the mandate and also the highest level of capacity in this field.
- Forestry Strategy to the Year 2020 manages overall forest sustainability – it defines three types of forest in Lao PDR (production forest, conservation forest and protection forest). Under this strategy sites the 5 year action plans – the current target is to maintain 500,000 hectare of forest in Lao PDR (land allocated to reforestation). The strategy encourages the use of native species, but this is difficult to implement. The DOF also identifies private plantations (through concessions).
- With respect to REDD, the current Readiness Preparation Proposal (R-PP) outlines activities that need to be executed and the estimated cost of these is USD 25 million.
- REDD demonstration activities with GIZ have been on the ground in Northern Laos in 2 protected areas for the last year. These will test baseline assessment methods. They are being conducted in conjunction with WCS and WWF. Some of the map work was conducted by DOF as well.
- Two ongoing CDM projects in Lao PDR are being conducted by the Climate Change Office - a rubber plantation in Xayabury and a project with a Beer Lao brewery.

D. Boundaries of the study

- Overall the proposed study boundaries were accepted. One suggestion from the stakeholder group was to include the neighboring province of Salavane.

E. Data requirements

- The MoT collects information on traffic including the number of vehicles and also different vehicle types.
- The UNESCAP Asian Highway Database maintains information on traffic flow by road – the EWEC is also included.
- A recently completed project on the improvement of Road 9 (EWEC) collected data on traffic flow in three areas including Vientiane, Savannakhet and Champassak. The study was conducted and supported by JICA – the lead consultant Atsushi Saito visited the main agencies in Lao and used a team to collect primary data. This study has recently been concluded though the report has not been officially handed over to the MoT as yet.
- Another source of information may be the Customs Department.
- Vehicle registration statistics are compiled and collected by MoT.
- NLMA (land authority) collects district level data on land use. Forest inventory for the whole country was complied in 1998. Forest assessment is conducted only every 10 years, and the last one dates to 2000. The 2010 images have bought, but interpretation is ongoing now – DOF administers this, though the technical work is being conducted by FIPD. The private sector may have better maps of land use for various regions (e.g. Oji which is a plantation company) including concession boundaries.

Consultation on the 'Carbon Neutral Transport Corridors' concept and scope of the feasibility study (EWEC), Bangkok, Thailand

28th February 2011

I. PARTICIPANTS

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II. INTRODUCTION

1. The second consultation on the Carbon Neutral Transport Corridors (CNTC) concept and scope of the feasibility study (focusing on the East-West Economic Corridor EWEC) was held in Bangkok, Thailand on the 28th of February 2011. The meeting aimed to bring key stakeholders from Thailand together to discuss the CNTC concept and the activities planned under the CNTC feasibility study.

2. The meeting was chaired by Mr. Jim Peters, Chief Technical Adviser of the GMS Environment Operations Center. Mr. Peters opened the meeting with a short introduction of the GMS program and the proposed activity and introduced the Environment Operations Center (EOC) team.

3. Mr. Sumit Pokhrel, Energy and Climate Change Coordinator at the EOC, briefly introduced the background to the activity. Ms. Naeeda Crishna, Carbon Footprint Specialist at the EOC, presented the background and rationale and explained why the CNTC concept was needed. This was followed by an introduction of the concept and an explanation of how the key ideas within the concept would be investigated during the feasibility study. Key study stages were also introduced and the proposed boundaries of the study introduced to the group.

4. The presentation was followed by a scoping consultation during which time the participants discussed key issues including observations / comments on the proposed concept and study, ongoing transport and sequestration initiatives in Thailand, engagement with the private sector, spatial and temporal boundaries of the feasibility study and the study plan.

5. A short description of the discussion is given in the following sections.

III. DISCUSSION

A. Comments / observations on proposed concept and study

- As greenhouse gases (GHGs) are not classified as direct pollutants like particulates, sulfur dioxide etc., in Thailand the co-benefit approach to managing these gases is used. This means that policies and measures that educe both air pollutants as well as GHGs are prioritized.
- The transport sector overall needs to focus on a modal shift to more sustainable forms of transport. Vehicle efficiency may aid in reducing greenhouse gases, but efficient road vehicles are still not as effective in reducing GHGs as switching to a different mode of transport like rail.
- The 11th National Development Plan of Thailand aims to balance economic progress and threats like energy and food security, climate change etc. Increasing the efficiency of sectors will be important under this plan.
- The main focus of TGO is mitigation policy and execution. One of the big issues faced by Thailand is the lack of a legislative framework i.e. the country has no set targets for

reducing GHGs. TGO is currently conducting a policy assessment in order to define some initial targets.

- Another issue is the institutional arrangement for climate change mitigation. Currently, ONEP manages adaptation and TGO manages mitigation policy. If targets were established it would be challenging to identify the line agencies that would be required to make the reduction in emissions.
- GHG data for the transport sector is an issue. There is little precise data for developing a transport inventory. For CDM certification, TGO has developed an in-house methodology for transport projects, but this has not been certified by the CDM board as yet.
- Land use planning is an issue in Thailand with respect to climate change. Congestion, increasing inefficiency of transport modes, accidents are all an outcome of this. Also capacity is increasing rapidly and there is little infrastructure to support this.
- With respect to forest sequestration projects there is a fundamental issue in that policies in Thailand do not give tenure rights to the land – i.e. people are not made responsible for tending the land. As a result, with forestry sequestration projects there tends to be a lack of ownership. External funding reduces this, but is not a sustainable solution in the long run.
- It is important that the study align itself with ongoing development and policies in the forestry sector in Thailand.
- Benefit sharing mechanisms must be built into the sequestration projects at the outset as safe-guards for the local communities.

B. Discussion related to clean transport

1. Ongoing transport initiatives and gaps

- The Office of Transport Policy and Planning (OTP) is developing a plan to reduce the GHGs from transport. They are also supporting the Ministry of Energy in the promotion of bio-fuels in Thailand.
- In terms of air pollution standards, Euro 4 is being rolled out for all new passenger vehicles by 2012 – this does not apply for HGVs yet.
- Application of standards in Thailand – for new vehicles certification is required from the manufacturer or importer that the vehicle adheres to the current regulation in Thailand. For in-use vehicles an ongoing inspection system is used (annual inspection required for all HGVs, passenger cars over 7 years old and motorcycles over 5 years old). The inspection for in-use vehicles is normally stationery (for gasoline engines hydrocarbons and carbon monoxide is measures, for diesel engines particulates and black carbon is measured).
- A recently completed study by FAO (Bio-energy and Food Security project) found that Thailand is one of the most prominent in Asia for bio-fuel development. In general, bio-fuels can be used to reduce GHGs, however there are some trade-offs to consider. For example, the cost to subsidize consumption could be quite high for the government, though a part of these may be offset by development in the agricultural sector. Also the lifecycle GHGs from bio-fuels vary considerable depending on the feedstock.

- Thailand has in place a number of measures to promote bio-fuels e.g. reduced import tariffs for manufacturing components related to bio-fuel development, waivers for corporate tax for 'green' companies and support for bio-fuels in the Alternative Energy Development Plan.
- The UN has an ongoing project on the development and implementation of a monitoring and assessment tool for CO2 emissions in inland transport to facilitate climate change mitigation (funded by UNDA). This is being implemented through the regional commissions. The expected output will be a standards emissions assessment tool for calculating transport emissions.
- UNESCAP (Transport division) is focusing on issues of modal shift and efficiency of logistics. UNESCAP (Environment and Development Division and Transport Division) held an expert group meeting on eco-efficiency in freight transport and logistics in 2010 as part of the joint project of UNESCAP and UNELAC entitled "Eco-efficient and Sustainable Urban Infrastructure in Asia and Latin America", the project is at its final stage where the guideline for developing eco-efficient and social inclusive infrastructure is expected to be published in July this year.
- Credits obtained from CDM projects are exempt from tax in Thailand.

C. Discussion related to forestry and sequestration

- FAO have three relevant ongoing projects:
    - Participation of tree plantation farmers in sustainable forest management in conjunction with the Royal Forest Department (RFD)
    - A project looking at voluntary carbon markets and their applicability to local communities (Linking communities to forestry-related voluntary carbon markets)
    - A project looking at assisted natural regeneration (Applying assisted natural regeneration for restoring forest ecosystem services)

D. Boundaries of the study

- Overall, the proposed study boundaries were accepted by the stakeholders consulted.

E. Data requirements

- The UNESCAP Asian Highway Database maintains information on traffic flow by road – the EWEC is also included.
- For data on traffic flow, the Department of Highways compiles AADT data for different roads across the country at regular intervals (every 3 years). The latest data from Thailand is for 2008, collected and compiled in 2010. The database can be purchased from the Department of Highways.
- The study should consider the methodology being used to develop MRVs for transport projects.
- The Thai government produces an annual report on vehicle registration (Department of Land Transport).
- Data on energy consumption for the transport sector can be obtained from the Ministry of Energy.
- The second national communication for Thailand is being prepared by ONEP – the inventory has been compiled and approved by TGO.

- The Provincial Electricity Authority (PEA) maintains disaggregated energy consumption data for provinces.

Consultation on the 'Carbon Neutral Transport Corridors' concept and scope of the feasibility study (EWEC), Ha Noi, Viet Nam

2nd of March 2011

I. PARTICIPANTS

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II. INTRODUCTION

1. The first consultation on the Carbon Neutral Transport Corridors (CNTC) concept and scope of the feasibility study (focusing on the East-West Economic Corridor EWEC) was held in Ha Noi, Viet Nam on the 2nd March 2011. The meeting aimed to bring key stakeholders from Viet Nam together to discuss the CNTC concept and the activities planned under the CNTC feasibility study.

2. The meeting was chaired by Dr. Nguyen Van Tai, Director of the Director of the Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE). Dr. Tai opened the meeting with a short introduction of the key issues related to climate change and low carbon development in Viet Nam. He then introduced the proposed activity and introduced the Environment Operations Center (EOC) team.

3. Mr. Sumit Pokhrel, Energy and Climate Change Coordinator at the EOC, briefly introduced the background to the activity. Ms. Naeeda Crishna, Carbon Footprint Specialist at the EOC, presented the background and rationale and explained why the CNTC concept was needed. This was followed by an introduction of the concept and an explanation of how the key ideas within the concept would be investigated during the feasibility study. Key study stages were also introduced and the proposed boundaries of the study introduced to the group.

4. The presentation was followed by a scoping consultation during which time the participants discussed key issues including observations / comments on the proposed concept and study, ongoing transport and sequestration initiatives in Viet Nam, engagement with the private sector, spatial and temporal boundaries of the feasibility study and the study plan.

5. A short description of the discussion is given in the following sections.

III. DISCUSSION

A. Comments / observations on proposed concept and study

- One possible addition to the focus of the study that should be considered is low carbon production and trading in the areas around the corridors.
- The Ministry of Transport conducts work / studies on the EWEC and SEC with a focus on assessing the environmental impacts and transport modalities. Other transport options (railroad) with lower carbon emissions has so far not been sufficiently looked into.
- In terms of transport, a lack of coordination significant is a contributor to GHG emissions (fleets, logistics, and fuel efficiency). To this end cooperation with neighboring countries has to be fostered.
- There is a need for coordinated awareness raising in the GMS in specific sectors. For example, a change in fuel efficiency will not have the optimum impact if driver efficiency and behavior is not considered as well.

- It is important that this initiative is linked to the overall development strategy of the transport sector in Viet Nam. The CNTC study should look at how to apply / embed these CNTC initiatives in transport sector planning processes.
- In terms of afforestation in remote areas it is very important to consult with and provide for local people. Forest based livelihoods have suffered from reduced income and living standard due to outside demand and large scale resource extraction / forest degradation.
- Urban areas are greater sources of GHGs than rural areas or highways – maybe the CNTC concept should take account of this.
- Possible initiatives to pilot in order to increase fuel efficiency of HGVs – capacity building for drivers (eco-efficient driving) and vehicle maintenance.
- Framework should consider the following with respect to cleaner vehicles – changing to cleaner fuels, improve vehicle technologies (upgrade of engines / fleets), improving infrastructure (quality and maintenance of roads) and improving driver behavior (reduce idling, eco-efficient driving etc.).
- The study should consider links with current policy development in Viet Nam e.g. current revision of EIA legislation, new PES degree.
- With respect to the development of bio-fuels, some issues need to be overcome. Current fleets would require dual fuel capacity as the supply of bio-fuels in remote areas is poor. Also, uphill driving requires petrol to start the vehicle.

B. Discussion related to clean transport

1. Ongoing transport initiatives and gaps

- Swiss-Vietnamese clean air pilot for trucks was conducted by VCAP. The pilots implemented training on “eco-driving” for an urban waste management company which resulted in significant reductions in the use of fuel (between 7-20% per vehicle). Some challenges faced during the pilots included the lack of an emissions database (vehicle types, travel distance, technology available) and poor information sharing between stakeholders (often resulting in repeated collection of primary data).
- VCAP also maintains a maintenance system for vehicles in Ha Noi. This system monitors vehicles (cars, trucks, vans, buses – motorcycles are excluded) through a network of over 100 inspection stations. These stations are under the Standards and Inspection Directorate.
- The MoT has a subsection that trains drivers on eco-driving as part of a three year project (currently the first year has been implemented).
- The MoT is also conducting a pilot project on controlling overloading of freight vehicles as a way of reducing fuel and safety costs.

2. Policy framework and gaps

- Law on environmental protection tax (tax on fuel consumption) – to be enforced from 2011
- EURO 2 is only applied to new vehicles, older cars follow older Vietnamese standards.

- Road map for EURO 3,4,5 has been drafted and is to be submitted to the Prime Minister for endorsement in the third quarter of 2011.
- In 2010 a decree on road traffic management was issued based on the Road Traffic Law
- In 2010 a decree on age limit for vehicles was also issued (20 years for private cars, 25 years for freight vehicles)
- MoT is developing a strategy to promote bio-fuels from 2011 – 2015, with a vision to 2020.

3. Private Sector Engagement

- In order to engage with private and state owned companies, the International Cooperation Division of the MoT can help make contact with individual companies.
- In order to begin engagement with these companies, a local consultant will be required to identify the required stakeholders and facilitate initial meetings

C. Discussion related to forestry and sequestration

- The Government of Viet Nam has given a lot of attention to reforestation in recent years. The overall target for the country is to achieve 5 million ha of reforestation; so far 3.5 million ha has been achieved.
- The Payment for Ecosystem Services policy that has recently been issued in Viet Nam has been piloted successfully in Lam Dong province. However, nationwide application still remains a big challenge.
- One issue with reforestation projects is that the benefits from these can only be seen over a long time period 10-15 years at least.
- The status of REDD+ in Viet Nam at the moment is preparedness stage, though the country is moving towards demonstration and piloting (these will begin implementation in 2011-15). The national REDD office is based at MARD.
- The government also has in place guidelines for the planting of trees – priority is given to a) species that can be used to generate bio-fuels b) optimum species for sequestration c) species that can survive in the context of climate change and d) species of higher economic value.
- In terms of land use planning the General Department of Land Administration (MNRE) is responsible for land planning and how much land is allocated to each of the land classes.

D. Boundaries of the study

- Overall the proposed study boundaries were accepted by the stakeholders consulted.

E. Data requirements

- Viet Nam's Road Traffic law can be accessed online through the MoT website
- General traffic flow data is maintained by the Department of Planning and Investment (MoT), information on the road network in Viet Nam is maintained by the Directorate of Road Maintenance / General Department of Road Administration (MoT).
- Vehicle registration statistics and data are maintained by Vietnam Register and annual publications can be accessed from their website.

- Another source of statistical information (energy consumption etc.) is the General Statistics Office (GSO)
- Land use classification data is maintained by MNRE
- Forest cover assessment is conducted every 5 years (Department of Forestry, MARD)
- Information on land ownership / concessions can be obtained from MONRE and DONRE

APPENDIX 2 WHAT IS A CARBON NEUTRAL TRANSPORT CORRIDOR?

A. Introduction

Climate change poses a major threat to economic and social development. Southeast Asia has been identified as particularly vulnerable to climate change due to the nature of its geography and natural resources – a recent ADB study has shown that the cost of climate change in Southeast Asia could be equivalent to over 6% of annual GDP by 2100[1].

In the Greater Mekong Subregion (GMS)[2], 'economic corridors' have been established to enhance investments in transport, energy, and telecommunications in the region[3]. These are areas where increased development is expected – development that is likely be accompanied by negative environmental impacts, including an increase in carbon emissions from the use of fossil fuels.

This paper proposes an approach to manage direct and induced carbon emissions arising from transport projects in these economic corridors through the implementation of 'Carbon Neutral Transport Corridors'. The concept of 'corridor level' initiatives to reduce environmental impacts is well established[4]. In the GMS, the Core Environment Programme - Biodiversity Corridors Initiative (CEP-BCI) has piloted a conservation landscape corridor approach to reduce fragmentation of fragile ecosystems across the region. Building on these concepts, a carbon neutral transport corridor would include systems to both reduce carbon emissions from transport (by increasing transport and logistics efficiency) and deforestation (by addressing the drivers of deforestation) and offset carbon emissions (through sequestration and reforestation projects), seeking no net gains in the amount of carbon released into the atmosphere from a baseline year.

Due to the complexity in the nature of carbon accounting, and uncertainty in data collection, current projects around the world that aim to achieve 'carbon neutral' status only take into account the emissions resulting as a direct result of the operations of the infrastructure i.e. emissions arising due to the use of fossil fuels 'on site'. The considerable emissions 'embodied' in the construction or demolition of such infrastructure or the emissions that may arise as an indirect result of the project (e.g. induced impact such as fewer emissions being sequestered due to deforestation) are rarely considered. In order to tackle GHGs arising from regional initiatives in the GMS, where GHG reduction targets are not mandatory as yet, a more holistic approach to carbon neutral projects is required. While 'Carbon Neutral' may seem ambitious and perhaps 'improbable' in long range transport development for a

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[1] Asian Development Bank, 2009. The Economics of Climate Change in Southeast Asia: A Regional Review. ADB: Manila.

[2] The Greater Mekong Subregion (GMS) comprises Cambodia, the People's Republic of China, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam.

[3] The GMS countries adopted the economic corridor approach to development during the 8th GMS Ministerial Meeting held in Manila in 1998. The approach aims to improve and enhance investments in transport, energy, and telecommunications in the region (ADB, 1998).

[4] The 'greenway' approach to highway and road development adopted by some countries is an example of a corridor level initiative which addresses a road project. In a greenway landscape around road projects is protected so as to maximize on the value of non-monetary benefits of the landscape - i.e. recreation, ecotourism, ecosystem conservation etc.

foreseeable period of time, setting a high, ambitious goal signals policy resolution to ultimately reach that goal. Low carbon development is a step towards that goal.

1. Direct and induced carbon emissions from transport corridors in the GMS

Globally, transport was responsible for 12% of greenhouse gas emissions (GHGs) in 2007[5]. Transport infrastructure has a direct carbon impact in that it facilitates an increase in traffic, and (particularly in developing countries), it has an additional induced carbon impact in that it facilitates land use change by providing access to previously inaccessible landscapes.

As illustrated in Figure 1, a profile of the GHG emissions from GMS countries compared to the global average for 2005 shows that though average transport related GHGs are slightly lower than the global average, deforestation and land use change is a significant source of emissions in the GMS.

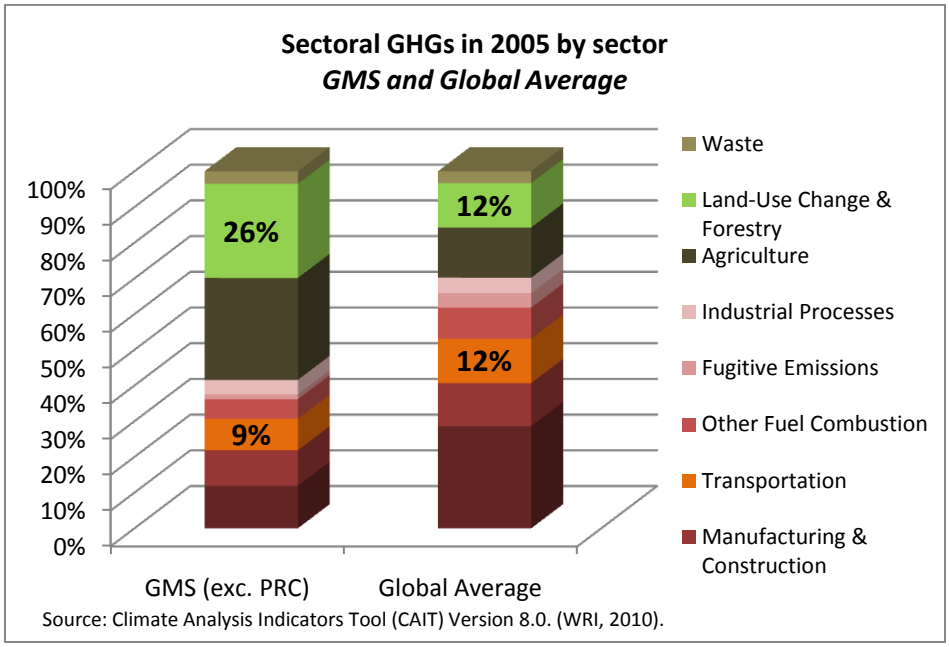

Figure 1: Comparison of greenhouse gas emissions between the GMS and the global average by sector

Further, Figure 2 illustrates that emissions from transport have been increasing year on year in the GMS, at an even high rate than Asia as a whole or the global average. This trend is expected to continue - various projections of future transport related emissions show that within South and Southeast Asia these emissions will see a three to five fold increase by 2030 (if no new policies are introduced to tackle these emissions), making Asia responsible for 31% of global transport emissions by 2030[6]. This increase in transport emissions has been attributed mainly to increasing numbers of light

[5] Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2010).

[6] Schipper, L., Fabian, H., and Leather, J., 2009. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation. ADB Sustainable Development Working Paper Series. ADB: Manila.

duty vehicles (passenger cars and smaller road freight vehicles) and heavy goods vehicles (larger road freight vehicles).

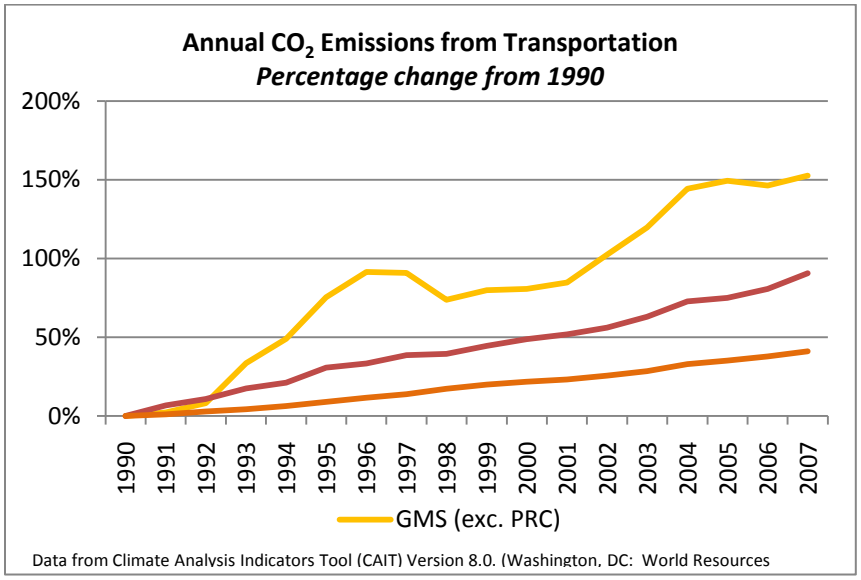

Figure 2: Trends in GHG emissions from the transport sector in GMS countries

As a benefit of the peace emerging after the end of the Viet Nam war and the ceasing of hostilities, the GMS Economic Cooperation Program facilitated by the ADB has initially focused on the economic corridors that improve transport links along certain routes so as to create continuous land access connecting key development and commercial hubs in the region. Each of the GMS transport corridors, therefore, includes a number of road and highway development projects to upgrade and consolidate the continuous land routes. In addition, there has been an upgrading of airports and ports to improve connectivity, transfers and transit facilities for passengers and freight[7].

The impacts of the corridors are already being recorded – studies on the GMS East West Economic Corridor (EWEC) which is being established across Myanmar, Thailand, Lao PDR and Viet Nam have noted a 150% increase in passenger buses in the first five years of the corridor being established[8]. A CEP-BCI prefeasibility study of the EWEC shows that emissions from transport are estimated to be in the order of 1 million tonnes per year, of which just over half is attributable to freight traffic[9]. For illustration, this estimate of carbon emissions would be equivalent to 8% of Myanmar's and 67% of Laos' annual emissions. The CEP-BCI study found that in order to sequester these emissions 150,000

[7] The GMS Economic Cooperation Program (GMS ECP), as of December 2009, had implemented 44 investment projects with a total project cost of about $11 billion, involving subregional roads, airport and railway improvements, hydropower projects for cross-border power supply, tourism infrastructure development, and communicable disease control.

[8] Stone, S., and A. Strutt. 2009. Transport Infrastructure and Trade Facilitation in the Greater Mekong Subregion. ADBI Working Paper 130. Tokyo: Asian Development Bank Institute.
Available: http://www.adbi.org/workingpaper/2009/01/20/2809.transport.infrastructure.trade.facilitation.mekong/

[9] Fraser, A., Linde, L., Kityuttachai, K and Tantasirin, C., 2007. Report on a preliminary assessment of the scope for implementing a Carbon Neutral Transport Corridor in the GMS. Environment Operations Center: Bangkok.

ha of land would be required – the potential offset cost of these emissions would be around $10 Million[10].

The estimate for the East West Economic Corridor (EWEC) takes into account only the direct emissions arising from traffic, and not the induced emissions that would arise as a result of the development that would accompany better transport links in the area (changes to land use, more industry and production in the area, deforestation etc.) nor the emissions arising from construction activity. As shown in Figure 1, these are a major source of emissions in this region and factoring in these potential emissions sources could increase the forecast emissions from the corridor significantly[11].

The overall direct and induced carbon emissions from these transport corridors are likely to be considerable. There is a need for initiatives to address these.

2. Carbon emissions arising from a GMS transport corridor

In order to understand the relative magnitude of emissions that could arise as a result of a transport corridor and where potential carbon savings could be achieved, the GMS East West Economic Corridor (EWEC) being established across Myanmar, Thailand, Lao PDR and Viet Nam is considered. The EWEC consists of a number of transport projects being implemented in different areas to create a unified 'transport corridor'. This corridor has been chosen as the initial focus of this work as it is the furthest along in its development as an economic corridor in the region.

The simplified life cycle of each project would be as follows: the project's life would begin at the stage where the concept of the project was first developed and the technical design for the project was completed. The next stages in the life-cycle would include construction and use of the road transport infrastructure. Finally, the road and related infrastructure would be upgraded or replaced with newer or different infrastructure. Accounting for and measuring all the various sources of carbon that may be emitted as a result of one project may not be necessary. For the GMS, it is important to consider all the *significant* sources of emissions within the boundaries of a Carbon Neutral Transport Corridor and to understand which areas should be targeted in order to achieve the greatest reduction in carbon emissions. Figure 3 lists some of the main sources of direct and induced GHGs at each stage in the life-cycle of a road transport project and highlights the difference in the magnitude of these emissions.

[10] This estimate is based on the average price of forestry related offsets on the voluntary carbon market in 2010 (http://www.carbonpositive.net/viewarticle.aspx?articleID=2143).

[11] For example, a recent study of the carbon impacts across a selected portfolio of ADB funded transport projects highlighted that carbon emissions from construction activity can vary between 1% and 24% of the construction and operational emissions for a project. (Asian Development Bank, 2010. Reducing Carbon Emissions from Transport Projects. ADB: Manila.).

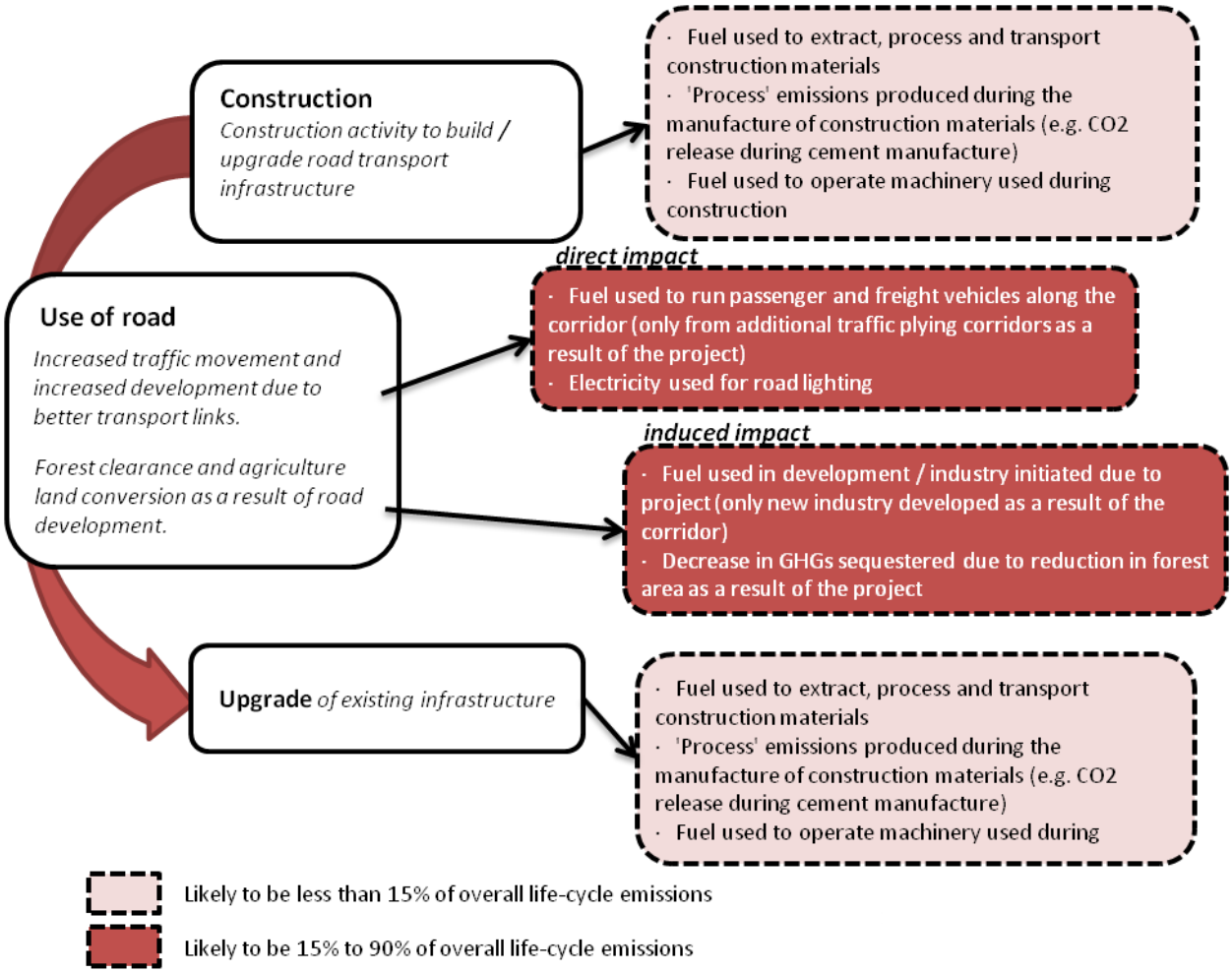

Figure 1: Sources of greenhouses gases throughout the life-cycle of a road project12

The map of emissions sources given in Figure 3 is not exhaustive but serves to highlight the major sources of emissions that are likely to arise as a result of the EWEC and where the main initial focus of a 'Carbon Neutral Transport Corridor' project should be[13]:

I. Emissions from increasing traffic along the corridor (both passenger and freight)

II. Carbon debit resulting from deforestation and land use change in the area

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[12] Based on information from 1) Asian Development Bank, 2010. Reducing Carbon Emissions from Transport Projects. ADB: Manila. 2) Fraser, A., Linde, L., Kityuttachai, K and Tantasirin, C., 2007. Report on a preliminary assessment of the scope for implementing a Carbon Neutral Transport Corridor in the GMS. Environment Operations Center: Bangkok. And 3) Switalski, A., 2005. The Ecological Effects of Roads in the Brazilian Amazon: Current Status and Prospects for the Future. Road-RIPorter, Volume 10:3. http://www.wildlandscpr.org/road-riporter/autumn-equinox-2005-volume-10-3 . Accessed on 07.10.10.

[13] Emissions from construction activity, and particularly from the use of imported construction materials or those that have been transported long distances, are also important across transport projects in general, but may not be in the case of road upgrade projects as are currently included in the GMS transport corridors. As demonstrated by ADB (2010), these emissions are often greater in projects involving elevated structures or tunnels which typically require large volumes of concrete, steel and excavation.

Future phases of the CNTC could focus on downstream emissions from the development of industry / production along the corridor and development of urban areas (ribbon development) in the EWEC provinces. Also, upstream initiatives like the development of offset mechanisms to capture the cost of reforestation and biodiversity conservation from road users and developers, and reducing emissions during construction activities could also be investigated.

B. What is a Carbon Neutral Transport Corridor?

The UN defines climate neutrality as 'a way of living' that produces zero net greenhouse gas emissions. UN (2008) specifies that climate neutrality can be achieved by first **reducing** emissions resulting from an activity and then **offsetting** any residual emissions. An extension of the climate or carbon neutral concept is that of 'carbon neutral infrastructure' or 'zero carbon infrastructure', where energy efficiency measures are used to reduce the emissions from an infrastructure project, and remaining energy demand is met using renewable energy.

The UN recommends a five step approach to achieve climate neutrality – measure, act, reduce, offset and evaluate[14]. Though all these are important, reduce and offset are the two areas of activity that will result in the most emissions reductions and should be prioritized when developing initiatives to tackle emissions from a GMS transport corridor. Within this context, this paper proposes a definition for a GMS Carbon Neutral Transport Corridor:

> *A Carbon Neutral Transport Corridor is the area surrounding a transport network that realizes net zero greenhouse gas emissions through a parallel process of reducing emissions through increasing efficiency, and offsetting unavoidable emissions through protection and enhancement of forest ecosystems and increased natural sequestration.*

As discussed in UN (2008), it is essential to understand the baseline conditions and the scale of emissions expected over the lifetime of the transport corridor in order to develop effective initiatives to reduce GHGs. Measurement and analysis of the magnitude of these emissions, i.e. a detailed feasibility study, is expected to be the first step in the development of a Carbon Neutral Transport Corridor.

In order to further scope the initiatives that could be used to reduce and offset emissions in order to achieve a Carbon Neutral Transport Corridor; the following sections consider a selection of fiscal and other policy measures.

1. Reducing transport emissions

The main aim of establishing an economic corridor is to increase trade and connectivity, with the larger goals of increased economic development and reduced poverty in the region[15]. In order to reduce emissions from such a corridor, therefore, there is a need to focus on mitigating or improving expected carbon emissions, rather than trying to reduce the source of such emissions i.e. increased development.

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[14] United Nations, 2008. Kick the habit – the UN Guide to Climate Neutrality. GRID-Arendal: Norway.
[15] Asian Development Bank, 1998. Proceedings of the Eighth Ministerial Conference on Subregional Cooperation. ADB: Manila.

There are a number of strategies being adopted across the world to reduce the carbon impact of transport. These include measures to introduce better traffic management with the aim of influencing more fuel efficient driver behaviour, encouraging better management of freight operations (e.g. minimising empty freight truck movements through better coordination among companies), replacement / upgrade of freight fleets and encouraging the uptake of more fuel efficient passenger vehicles. A selection of strategies that could be applied to a GMS Carbon Neutral Transport Corridor includes (but is not limited to) the following:

Strategy	**How could this be implemented**
Corridor traffic management (e.g. congestion management, speed management, traffic flow smoothening etc.)	• Initial pilot to demonstrate / test out effectiveness of approaches followed by capacity building in national traffic / transport departments
Logistics management i.e. initiatives to increase efficiency of freight operations	• Adoption of voluntary / mandatory target by freight industry, alongside capacity building in logistics management to increase efficiency
Regular road maintenance	• Capacity building in national traffic / transport departments
Freight fleet modernisation and upgrade	• Fiscal policy e.g. incentives to reduce energy use, subsidies / grants for fleet modernisation and adoption of cleaner technologies
Deployment of alternative fuels in the region	• National policy / strategy to increase energy generated from renewable sources
Incentivise increased fuel efficiency across passenger fleets	• Fiscal policy e.g. carbon tax for more polluting vehicles • National legislation e.g. introduction of a fuel economy standard / emissions standard for new vehicles

It is worth noting that national level measures like increasing the modal shift towards more carbon efficient transport (e.g. rail) have not been included here due to the road based nature of the economic corridors in the GMS. However, these strategies have been seen to be very effective in reducing national transport emissions and are being considered elsewhere in the GMS program.

Of the policies shown above, many have been found to be efficient in reducing carbon emissions. ADB (2010) estimates that traffic management techniques can cut up to 20% of expected traffic emissions, and that better road maintenance would yield significant carbon and energy savings. Vehicle scrappage (i.e. a scheme that incentivises the replacement of older, less efficient vehicles in a fleet) has been seen to have important co-benefits in that it reduces the emissions of other air pollutants like particulates, nitrous oxide and sulphur dioxide[16].

[16] Center of Clean Air Policy, 2005. Transportation Emissions Guidebook: Land Use, Transit & Transportation Demand Management. www.ccap.org/safe/guidebook/guide_complete.html. Accessed on 6.10.10.

Targeting the reduction of greenhouse gas emissions needs to be seen in the larger context of environmental and health issues in the GMS. It is generally acknowledged that policies to reduce greenhouse gas emissions are likely to reduce air pollutant emissions and vice versa, though the extent of this will vary with the specific policy in question. Air pollution is a major source of concern in the GMS and the rest of Asia, with many Asian cities reported as failing to meet WHO air quality standards and 6.8 million people affected in the region[17]. In order to maximise the benefits of initiatives in a Carbon Neutral Transport Corridor for GMS countries, this report proposes that the choice of policy instruments should prioritise those that have an impact on both air pollutant and carbon emissions.

2. Reducing emissions from development and production

Initiatives to mitigate emissions from expected development in the region, including those from changes to current land-use, would need to support more efficient supply chains for industry and production and identify areas where changes to processes could help reduce costs and add value. One possible strategy to implement this would be to conduct a value chain analysis to optimise existing production chains in the area with the aim of decreasing energy use and transport movements. This could be implemented through an initial pilot to demonstrate the impact of the intervention on traffic and emissions in the corridor.

3. Reducing and offsetting emissions from deforestation

Due to the existence of widespread natural forest in the region, natural carbon sequestration projects are a logical way to offset emissions from transport and development in the Carbon Neutral Transport Corridor. The CEP-BCI study conducted in 2007 estimated that for the EWEC, 50,000 ha of plantations would be required to offset carbon emissions from current traffic and around 150,000 ha to sequester the likely emissions in 2015, if no other policy were in place to tackle emissions. However, the amount of carbon that could be offset would depend on the suitability and ownership of land for reforestation and on the type of vegetation that would be used in sequestration projects.

Many of the GMS countries have conservation and forest protection legislation in place already and, in line with the definition proposed in this paper, a CNTC approach should also focus on strengthening the implementation of current legislation in order to reduce forest clearance activities arising due to the development of a transport corridor. As a result, a combined approach of strengthening current policy, introducing policies to protect overall existing forest resources and the implementation of new plantation projects in suitable areas would be necessary to protect and enhance carbon stocks.

Some possible policy measures to reduce deforestation are as below:

Strategy	How could this be implemented
Strengthen implementation of forest protection	• Capacity building at national, provincial and local levels, improvement of implementation framework

[17] Asian Development Bank, 2003. Reducing Vehicle Emissions in Asia. ADB: Manila.

Increase forest protection areas	• Plantation projects strengthened by provincial / national legislation
Incentivize local protection of forest area	• Positive fiscal instruments e.g. Payment for Ecosystem Services
Promotion of Sustainable Forest Management (SFM)	• Provincial / national policy alongside extensive capacity building and guidance development about SFM

One way of funding such initiatives could be through an upstream mechanism like biodiversity offsets[18] where the users or developers of the corridor build costs of offsetting deforestation and associated species loss into project development. These funds could then be used in conservation projects that demonstrate additional, measurable conservation outcomes i.e. strengthening ineffective protected areas or addressing the underlying drivers of deforestation.

C. How is implementing a Carbon Neutral Transport Corridor beneficial to the GMS?

Implementing a CNTC will have multiple benefits to GMS nations.

First, by aiming to reduce carbon emissions, the Carbon Neutral Transport Corridor will help maintain the economic progress that GMS countries are making now by averting even greater impacts of climate change over the next hundred years. As established in the initial sections of this paper, climate change is a major threat to the GMS countries, and has the potential to negatively impact on the livelihoods and well-being of people in the region.

Second, by aiming to introduce initiatives that will have a dual impact in terms of air pollution and carbon reduction, the Carbon Neutral Transport Corridor will have an impact much wider than its spatial boundaries. Reducing outdoor air pollution, specifically pollution driven by older polluting vehicles, will have an invaluable impact on health and social well-being in the area. A lower number of people falling sick will also reduce the wider economic costs of such hazards, which is an important benefit when seen in the wider context of poverty reduction and socio-economic progress objectives and policies that GMS countries have in place.

Third, through the protection of forest areas, the Carbon Neutral Transport Corridor will help GMS governments with established goals of biodiversity conservation and environmental protection while achieving important development objectives. Forests provide invaluable ecosystem services to the region and are the key to maintaining healthy water resources, water regulating functions and dry season flows, and a regulated climate. They are also an important natural resource for GMS countries and are the main source of income for many local communities in the region.

[18] Forest Trends, 2011. Business and Biodiversity Offsets Program. Available at http://bbop.forest-trends.org/index.php.

APPENDIX 3 PHD THESIS PROPOSAL

A. Title

Assessment of above ground biomass and carbon stock of land use change using multi-temporal landsat data

B. Objectives

- To monitor land use change
- To survey the plants species, diameter at breast height (DBH), height (H) for assessing above ground biomass
- To assess biomass in wet and dry season
- To develop model for estimating above ground biomass from Landsat data
- To improve accuracy of above ground biomass and carbon stock estimation using object based classification technique
- To assess above ground biomass and carbon stock from land use change

C. Methodology

1. Research Design and Methodology

This chapter presents the research framework of this study as shown in Figure 3 and detailed description of each step is also provided in the following sessions.

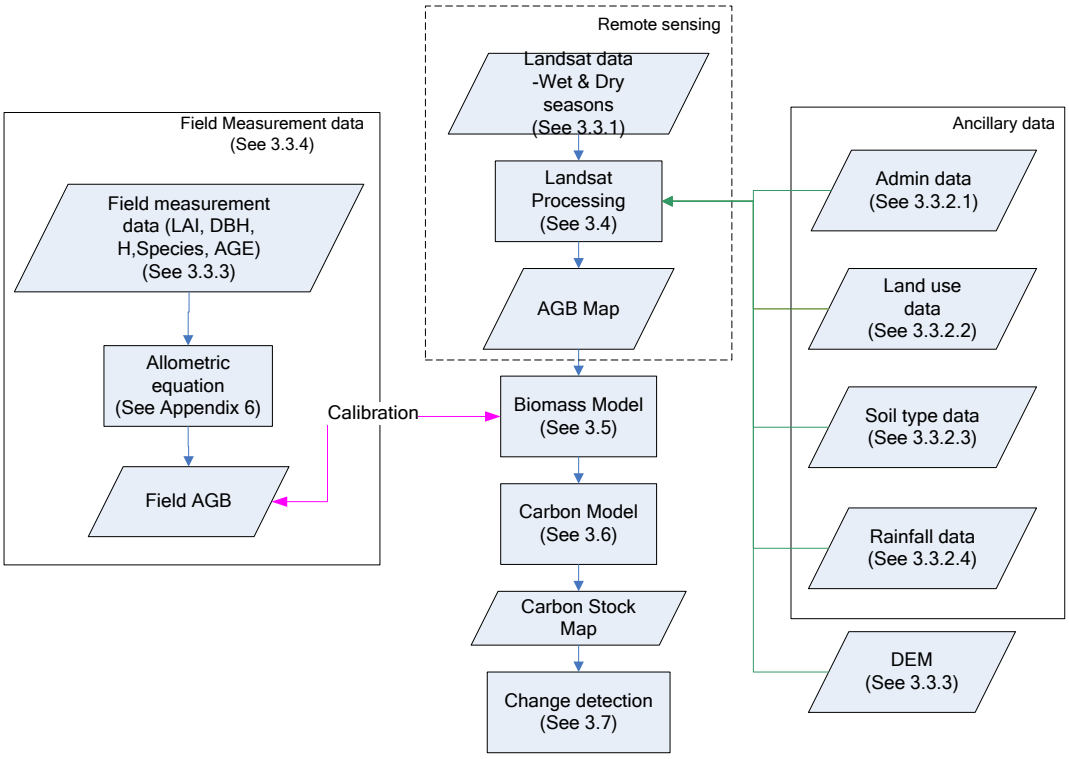


Figure 3: Research framework

2. Remote sensing part

In remote sensing part, 3 year of satellite image in wet and dry season will be used for assessing biomass and carbon stock. So 2 scene of satellite image per one season per year will be used for each classification. In summary, 12 scene of land sat image will be used for this study.

First, land use classification will be applied. This phase, shapefile of land use will be tool for first supervised classification. After that, field work need to be done in order to check with the image classified. After that accuracy assessment need to be processed. In this phase, 2 or 3 days of field visit can be obtained.

Biomass classification will be applied. In this step, different types of data such as soil type, DEM, rainfall data, land use data will be used for classification. This process will use knowledge base of these data as tool for classification. In this phase, plot biomass need to be done. The plot size should be approximately about 90*90 meter and all the trees DBH greater than 10 cm need to be measured and calculated biomass using suitable allometric equation. Sub-sampling plot is also applied inside the sample plot. The minimum plots for assessing biomass could be about 10 plots for each type of land use. This phase will take approximately of 1 month to collect data for different types of land use. The number of days for field visit depends on the number of people work on each plot. If higher amount of people, it takes less than a month.

3. Field work part

This part relevant to assessing data which will be used for correcting ground information for remote sensing classification, also for accuracy checking of remote sensing part.

4. Analysis part

- Accuracy check with data obtained from remote sensing and field work.
- Find correlation between remote sensing and data obtained from field work, after that model will be developed from this correlation.
- Convert biomass calculated from remote sensing to carbon stock by multiplying 50%.

D. Timeline

ID	Task name	Time	Job	Total	Expert Required
1	**Image Classification**	20 days (for 1 season per year)	6 times of classification (3 year with 2 season)	4 month	-
3	**Field work (for type of land use)**	2-3 days	2 time	4-6 days	Forestry
4	**Field work (Plot biomass)**	1 month	2 times (Wet and dry season)	2 months	Forestry (with remote sensing background)
5	**Image analysis**	1 month	**-**	**-**	**-**
6	**Report**	1 month	**-**	**-**	**-**

E. Review of literature

1. Above ground biomass (AGB) estimation

The AGB carbon sequestration comprises of all living vegetation above the soil, containing stems, branches, bark, stumps, seeds, and foliage. Above ground tree biomass is the mass, expressed as oven-dry weight (including or excluding bark), of the woody parts (stem, bark, branches and twigs) of all living trees excluding stump and roots (FAO, 2005).

There are 2 methods for estimating above-ground biomass:

1) Destructive method: It is done by felling the sample tree and then weighing it. Direct weighing can only be done for small trees; however, for bigger trees, partitioning is needed so that the partitions can fit into the weighing scale. In cases where the tree is huge, volume of the stem is measured. This method determines biomass through actual weight of all components (stem, branches, and foliage). This is the most precise method within a small unit area, but it is expensive, time consuming, damaging to the environment and impracticable at large scale. It is mostly used to calibrate allometric equations.

2) Non-destructive method. It does not need the trees to be cut down. It is an allometric method. It is a field inventory, where data are collected at plot level on species or site-specific factors (species, stem density, DBH, height etc.). Moreover, they are applied suitable equations or model to convert these measurements into biomass estimates. Generally, the more site-specific variables that are measured at site, the more precise the biomass estimate will be. It is good way to cross-check conversion equation with sampling from the first method. Allometric equations developed base on the basis of few measurement from destructive sampling such as diameter at breast height (DBH) and height (H). **Carbon stock assessment from this method is usually derived from above-ground biomass**. However, the biomass calculation from these techniques cannot be validated except the sample tree is felled and measured. Once sample tree variables and biomass data are gotten, and the biomass equation is developed, it is then applied to each tree in the sample plots to obtain the plot biomass. The forest biomass is then predicted by the corresponding sampling scheme formula for the mean and total estimator or by predictive modeling using remotely sensed spectral data.

2. Forest carbon stock measurements

The main carbon pools in tropical forest ecosystems are the living biomass of trees and understory vegetation and the dead mass of litter, woody debris and soil organic matter. The carbon stored in the aboveground living biomass of trees is typically the largest pool and the most directly impacted by deforestation and degradation. Thus, estimating aboveground forest biomass carbon is the most critical step in quantifying carbon stocks and fluxes from tropical forests.

In many cases widely used values from look-up tables and correlations with aboveground biomass will be adequated to estimate carbon stocks in other pools. For example, root biomass is typically estimated to be 20% of the aboveground forest carbon stocks (e.g. Houghton et al 2001, Achard et al 2002, Ramankutty et al 2007) based on a predictive relationship established from extensive literature reviews (Cairns et al 1997, Mokany et al 2006). Similarly dead wood or litter carbon stocks (down trees,

standing dead, broken branches, leaves, etc) are generally assumed to be equivalent to ~10-20% of the aboveground forest carbon estimate in mature forests (Harmon and Sexton 1996, Delaney et al 1998, Houghton et al 2001, Achard et al 2002). Soil is critical to consider for regions such as Southeast Asia's peat-swamp forests where soils are a massive source of carbon emissions following deforestation (Page et al 2002).

However, no methodology can yet directly measure forest carbon stocks across a landscape. Consequently, much effort has gone into developing tools and models that can scale up or extrapolate destructive harvest data points to larger scales based on proxies measured in the field or from remote sensing instruments (e.g. Brown et al 1993, Waring et al 1995, Brown 1997, Chave et al 2005, Saatchi et al 2007).

F. Ground-based forest inventory data

Forest inventory is the systematic collection of data and forest information for assessment or analysis. It is also commonly known as timber cruising. Forest inventory can be achieved utilizing a set of random or permanent plots, or both (Ross Miller, 2006). Sample plot selections should be represented for those forest types. Each plot should contain information i.e. species, spacing, size classes, diameter at breast height (DBH), height (H), site quality, age, and defects. Moreover, forest inventory can be used to estimate the forest values such as wood volumes, and forest stocking rate.

Estimation of above-ground biomass (AGB) is an essential aspect of studies of carbon stocks and the effects of deforestation and carbon sequestration on the global carbon balance and also provides valuable information for many global issues. Estimating AGB is a useful measure for comparing structural and functional attributes of forest ecosystems across a wide range of environmental conditions. Permanent sampling plots have long been used in ecological studies for assessing how much biomass is held in ecosystem. So far different studies have been conducted to estimate AGB and they mostly used diameter, height and wood specific gravity. Many factors can influence the accuracy of biomass estimation in tropical forests and are known to vary with soil type, soil nutrients, climate and, disturbance regime, successional status, topographic position, landscape scale and human impacts. Variation in environmental factors such as topography, hydrology, and edaphic characteristics (e.g. soil nutrient availability) may also complicate attempts to generalize stand density and AGB over regional or landscape scale.

According to forest inventory, AGB estimation can be estimated using information collected from field e.g DBH, and height. The average AGB (Mg ha-1) for each land cover types of tropical region can be estimated using the relationships between tree diameter (DBH) and tree height (D-H relation).

G. The details of forest inventory include:

1. Sample site selection

The sampling site should be representative of the whole area. It should be accessible by foot or by car. Moreover, the sampling site should have recent remote sensing data, maps and other secondary data available. Support staff or labor should be available during the field measurement. It is very important that number of sampling site should be enough. Also, the cost should be effectively.

2. Sampling methods

The best sampling method is the sampling method that can meet the exacting objectives of the study effectively. The best sampling method is difficult to define because it depends on many factors interacting in complicated ways. In tropical forest, a random or stratified sampling can be applied for sampling methods. The advantage of these sampling methods is that sampling error can be calculated. Sampling error is the sampling that differs from population. When deducing from the population, results are shown plus or minus the sampling error.

Systematic and random sampling designs are the two broad types of schemes used to estimate forest carbon stocks at the country level (Paciomik and Rypdal, 2003). Systematic sampling uses a regularly spaced grid to identify plot locations across an entire region, while random sampling chooses plot locations by chance. Without stratification, both schemes may over-or under-sample because patterns in nature are inherently clumpy and not likely to be randomly distributed. Stratification of systematic and random sampling schemes by broad forest types greatly increases survey efficiency by reducing unnecessary sampling and ensuring that major variation has been captured. It is important to assess how forest carbon stocks vary across a country before designing a stratified sampling scheme (Brown 2002). This information is used to define sampling strata or broad forest categories with similar forest carbon stocks. Information on soil types, drainage class, elevation, topography and land-use history are likely universally important to understanding the spatial distribution of carbon stocks.

3. Plot Size

Depending on the heterogeneity of a population, increase in plot size generally decreases the sample variance. At the same scale of measurement, small plots will almost always be more variable than large ones (Freese, 1984). If for example, quarter hectare plots are measured and the results are to be extrapolated to hectare level, then the hectare variance is the plot variance times 16. If the variable χ has variance s P2P and this variable is multiplied by a constant (say k), the product (k χ) will have a variance of kP2PsP 2P (Freece 1984). Thus, estimating biomass using big plot sizes is expected to reduce on the sample variance.

4. Optimum number of plots

The optimum number of plots depends on cost and time which is relevant to survey precision as equation below:

Individual plot CV, overall survey precision and number of plots are linked by the equation

$$E = \frac{t\,\mathrm{CV}}{n^{1/2}}$$

where E is the precision and t is the appropriate Student's t statistic.

It follows that the number of plots required to produce a given precision is

$$n = \left(\frac{t\,\mathrm{CV}}{E}\right)^2$$

Substituting the Eq. (1) into Eq. (3) gives Eq. (4), an expression for n in terms of plot size.

$$n = \left(\frac{t[\exp\{-0.292 - 0.263\log(\mathrm{area})\}]}{E}\right)^2$$

5. Inventory plot

There are many plots design for forest inventory such as

simple inventory plot, point quadrant plot, etc. General measurements used for forest inventory in each plot are diameter at breast height (DBH) of individual trees, tree height, and basal area.

Simple inventory plot

Simple inventory plot is simple. The size of each inventory plot commonly varies in size from 0.1 to 1 hectare. The plots can be a linear (such as a transect), circular or rectangular (Ross Miller, 2006). The key to set the plot is the size of plot area should be corrected because the variation in plot size represents a big difference over the forest. Examples of plot sizes are shown in Figure 4. Normally, all of trees in the plot with DBH greater than 10 centimeters are measured.

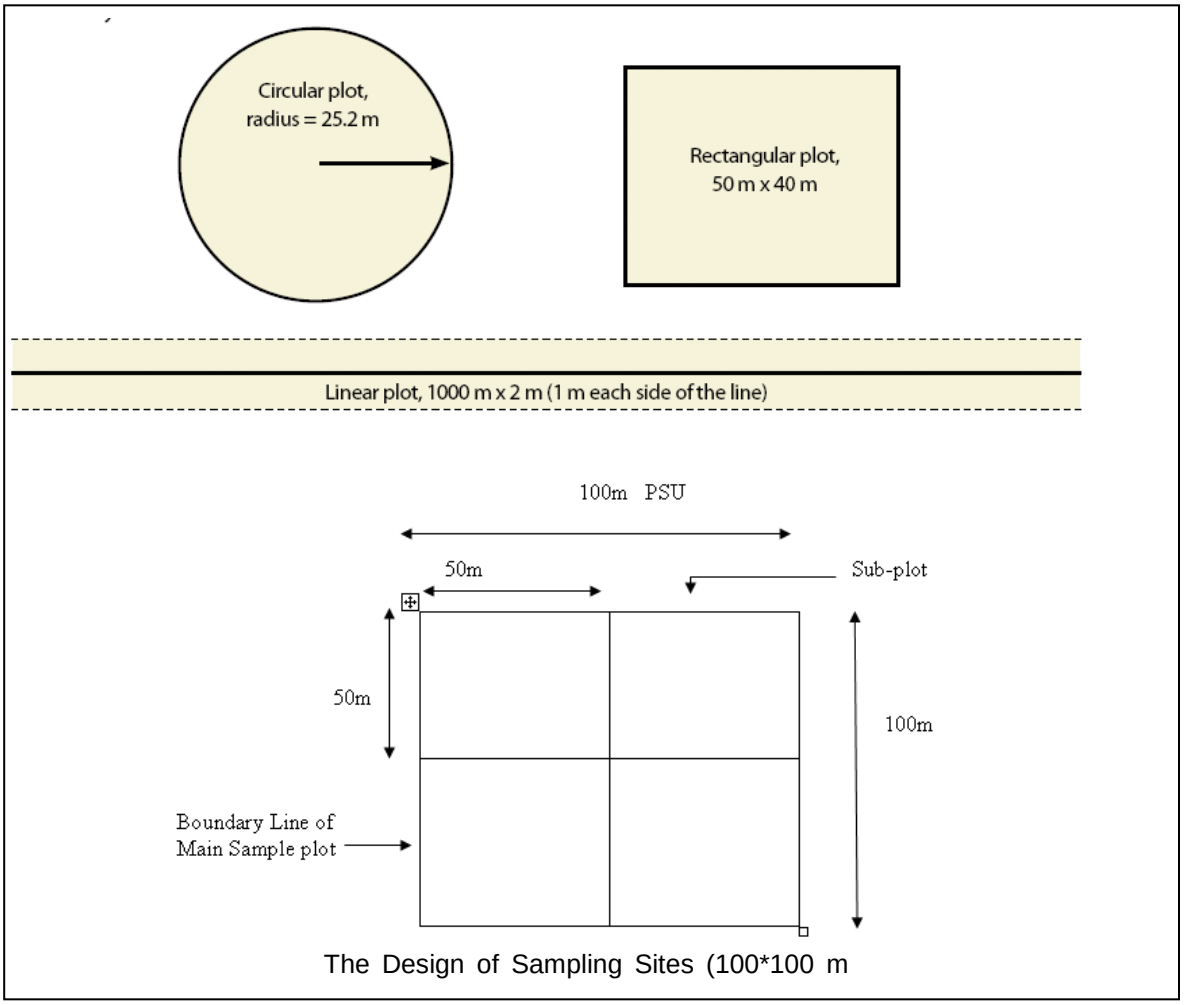


Figure 4: The Sample Inventory Plots Design

Permanently plot identified in the bush with some positions, or simply set up for the measure, and after that removed. Permanently plots are mostly excellent for measuring individual trees growth rates.

The advantages of simple inventory method is more precise and more detail of species per plot. However, this method is time consumed, less sampling plot distributed and cost.

Point-quarter inventory plot

Simple inventory plot may be difficult to be represented for large area with diverse types and/or species of forests. It is better to use pointless technique instead. Plotless techniques are very efficient with static organisms because they associate with measuring distances to organisms.

The most popular sampling technique of pointless technique is the point-quarter technique (Pollard 1971). Each sample is selected randomly point along transect with or without any randomization technique. The area close to each random point is divided into four quadrants as shown in Figure 2.12. The nearest distance from random point to closet point in each quadrant is selected. There are four quadrants, thus four trees will be measured. Figure 5 shows point A illustrates a random point and the letters b c d e f g and h illustrate trees. The distance from A to the center of b, d, e, and h will be measured. Moreover, the species name, its basal area, DBH and height are recorded individually.

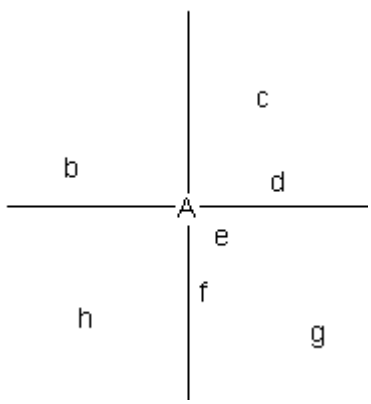


Figure 5: Point Quarter Diagram

The advantage of point-quarter inventory plot is timeless comparing with simple inventory method. Moreover, there is more sampling plot distributed. However, there is less precise and less detail of species per a plot.

The appropriate unbiased estimate of population density for the point -quarter method is from Pollard (1971):

$$Distance Error(De) = \sqrt{(\hat{x}_i - x_i)^2 + (\hat{y}_i - y_i)^2}$$

$$Average Distance Error(AvgDe) = \frac{\sum_{i=1}^{n} \sqrt{(\hat{x}_i - x_i)^2 + (\hat{y}_i - y_i)^2}}{n}$$

$$\hat{x}_i = estimatedX$$

$$x_i = TrueX$$

$$\hat{y}_i = estimatedY$$

$$y_i = TrueY$$

6. Equipment

- GPS: It is used to identify location of the site.

- Diameter tape: It is used to measure tree bole at breast height.
- Clinometer: It is used to measure tree height.
- Nylon measuring tape: It is used to measure the plot.
- Compass: It is used to find the direction.

Figure 6: Equipment for Forest Inventory

7. Inventory measurement

Tree parameters (see Figure 7) such as diameter at breast height (dbh), tree height, bole height, and crown width for each individual tree in the sample plot are measured.

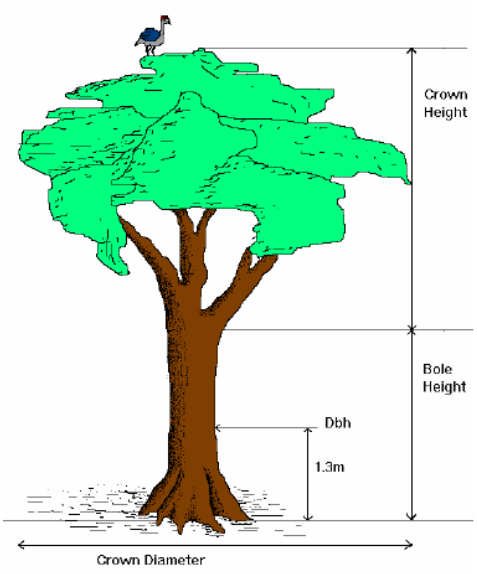


Figure 7: Tree Parameters

<u>Diameter at breast height (DBH)</u>

The DBH is the most general measurement in forest inventory because it can be used to predict forest stocking, volume, growth, distribution, and dominance. DBH is normally measured in centimeters using a diameter tape with measuring around the bole at breast height (approximately 1.3 meter). There are various types of DBH measurement according to the shape of the trees as shown in Figure 8.

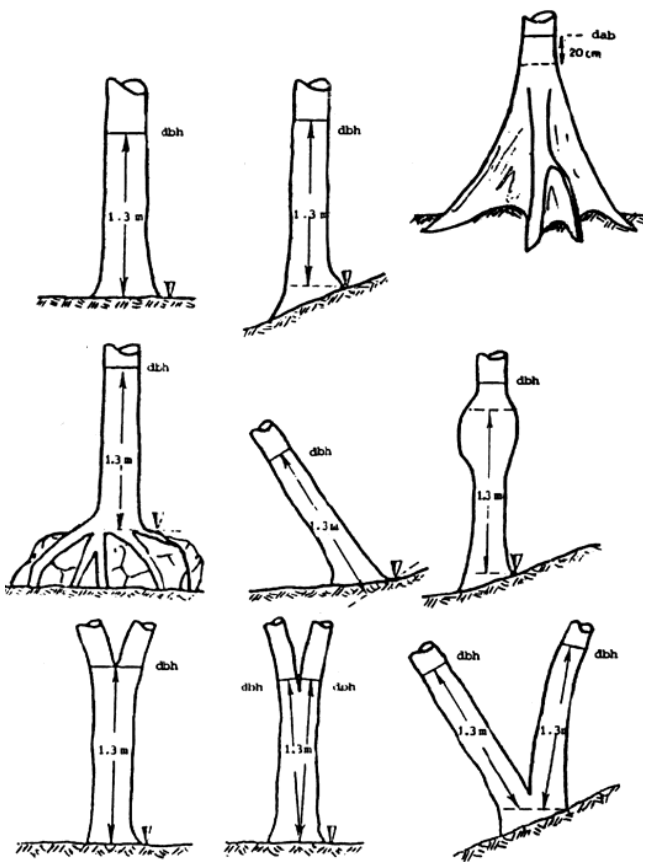


Figure 8: Types of DBH Measurements

<u>Basal area</u>

Basal area is a key measurement of tree stocking. Basal area presents the area, normally in a hectare, where the stems are covered over given area. Basal area illustrates many stocking rates, certainly optimal growth densities, and harvesting. However, basal area can be calculated from tree DBH as shown in equation below:

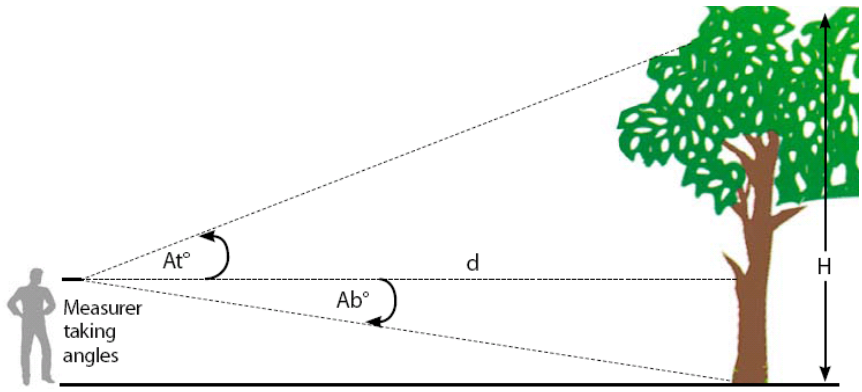
$$TBA = [\{(dbh/100)/2\}^2]\pi$$

Where TBA= tree basal area m^2

dbh= Diameter at breast height (over bark) (cm)

Tree height measurement

Clinometer and trigonometry is used for measuring tree height. The height of the tree is determined to the highest growing point of the tree as shown in figure 2.12. The best practical method to calculate the height is to take the measurements in the bush and after that calculate the height in the office. Not all of the trees in the plot are required to measure if the potential log length for the trees has been measured. The potential log length is the most precise approach to measure wood volume. Nevertheless determining the height of a mature or some mature trees in the plot will provide an evidence of the potential productivity of the site, which can be mostly valuable in measuring productive potential of any forest.



H=d[(tan(At)+tan(-Ab)]
Where: H = height (m)
d = distance (m)
At = angle to top of tree or potential log (degrees)
Ab = angle to bottom (degrees)
(hint: be sure that the calculator, or computer program is set to the 'Degrees' setting, if it is set on 'Radians' or 'Grads', the height given will be incorrect)

Figure 9: Calculating Tree Height/ Potential log Length using Trigonometry

Species

Species is also important for forest inventory. Species composition in the plot will show a snap shot of what the forest is presently composed of. This is mostly important for monitoring forest dynamics.

APPENDIX 4 TERMS OF REFERENCE FOR KEY STUDY PERSONNEL

A. CARBON FOOTPRINT SPECIALIST

1. Background

The Greater Mekong Subregion (GMS) Core Environment Program Biodiversity Conservation Corridors Initiative (CEP-BCI) Phase 1 has begun assessing the feasibility of climate change interventions that could lead to substantial investments in subsequent phases of the program. In order to look at the impacts of GMS transport corridors being developed across the region, the program is now embarking on a feasibility study to investigate the suitability of establishing a 'Carbon Neutral Transport Corridor' along the GMS East-West Economic Corridor (EWEC).

2. Objective/Purpose of the Assignment

The Carbon Footprint Specialist is responsible for coordinating and implementing the GMS CEP activity on "Carbon Neutral Transport Corridor".

3. Scope of Work

The Carbon Footprint Specialist will work closely with the Chief Technical Advisor (CTA) and Energy/Climate Change Coordinator at the EOC in the planning, design and implementation of the overall CNTC feasibility study and will provide technical input in establishing the baseline carbon footprint and projections. As the coordinator for CNTC, s/he will be coordinating the activities of international and national consultants, providing inputs to and carrying out studies and working closely with relevant stakeholders including private sector. S/he will coordinate the outputs of the team and will be responsible for developing the CNTC report.

4. Tasks and Activities

The Carbon Footprint Specialist, with the support from national consultants, will be carrying out the following activities:

1. Provide overall coordination support to the consultant team, and produce detailed work plans for the team members (national consultants) with timetables and deliverables.
2. Organize and carry out country consultation to define temporal and geographic coverage scoping and the sequencing of CNTC feasibility study with support from relevant EOC staff.
3. Coordinate scoping workshop for identifying regulatory, institutional and technical gaps to implement CNTC activities and develop overall methodological framework including individual elements of the baseline assessment, policy / freight study and carbon sequestration study.
4. Provide technical expertise to the CNTC carbon footprint baseline assessment including boundary setting, data collection, data compilation, analysis and reporting. This should include working with relevant partners and individually to establish baseline emissions, project these emissions over a specific time period and quantify the carbon emissions reduction and savings targets to be achieved by CNTC.
5. Conduct a desk-based policy review of GHG reduction initiatives globally, and a detailed review of regulatory and legislative frameworks in GMS countries with regard to reducing carbon emissions

from land-use change (e.g. sequestration) and freight traffic (e.g. adoption of cleaner vehicles, emission standards and acceleration of bio fuels in transport sector). Identify gaps in the current GMS institutional framework and recommend a policy / incentive framework to introduce cleaner technologies and a road map for introducing more stringent vehicle emission standards on both new and in-use vehicles.

6. Coordinate and implement the freight business climate assessment focusing on in order to understand operational issues faced and the appetite for reducing GHG and vehicle emissions from freight transport. Conduct a desk based review of freight business climate in the GMS, a survey of private sector freight stakeholders and coordinate engagement with freight companies along with national consultants. Support the identification of financing options for a possible CNTC freight pilot program to be implemented in CEP-BCI Phase 2.
7. Coordinate and the support the development of the carbon sequestration feasibility study including providing input to the study methodology and framework development, recruiting required national team for field work, supporting the collection of data and development to criteria tree for spatial analysis, coordinating the development of written outputs.
8. Coordinate and develop the overall CNTC feasibility study report including technical, policy and financial aspects of possible freight and sequestration pilots, and detailed recommendations on institutional frameworks and capacity.

5. Deliverables

All written deliverables are to be produced in English.

i. Detailed work plans including TORs for national consultants, interns and other resources as required by the GMS CEP.
ii. Progress reports along with any other technical documents for reporting to ADB and the GMS Working Group on Environment.
iii. Scoping workshop and report including CNTC concept paper, project methodology and timescales;
iv. Carbon footprint baseline and projections assessment report including assessment of the emissions arising from the development of the corridor over a particular time period and carbon reduction targets for the CNTC;
v. Policy assessment paper including identification of gaps in the existing institutional framework and recommendations for the development of policies on vehicle emission standards
vi. Freight business climate report including identification of stakeholders to be engaged in CNTC pilots and recommendations on technical and financial aspects of pilots;
vii. Support to carbon sequestration feasibility study report including identification of suitable sites for sequestration activity and defined financial and benefit sharing recommendations;
viii. Overall CNTC report compiling baseline assessment, freight study, policy review and sequestration study recommendations;
ix. Final reports and power point presentation for delivery at the WGE, SOM, EMM and GMS Summit meetings.

6. Reporting Arrangement and Time Commitment

The Carbon Footprint Specialist will serve as the **coordinator** of CNTC activities. S/he will coordinate closely with the Chief Technical Advisor (CTA) and Energy/Environment Coordinator at the EOC and will be responsible for providing technical backstopping and coordination support.

The work will include field trip(s) and consultations with coordinating organizations in the GMS countries, especially Lao PDR, Thailand and Viet Nam.

7. Qualifications

The specialist should have a background in carbon footprint assessment form sector development and, environment, climate change planning; have at least 4 years of experience in project management, freight planning and management, environment and climate change. Related experience in the GMS countries is preferable. The consultant should hold a Masters level degree in environmental sciences and be expected to be proficient in written and spoken English.

8. Consultant Recruitment

The specialist will be recruited by the Asian Development Bank (ADB) on an individual basis as required under the Regional Technical Assistance (RETA 6289). Consulting firms can submit applications for consideration.

B. FOREST CARBON SPECIALIST

1. Background

The Core Environment Program and Biodiversity Conservation Initiative (CEP-BCI) is a regional technical assistance program (TA 6289-REG) (GMS) to enhance environmental sustainability and social equity of the Greater Mekong Subregion (GMS) Economic Cooperation Program. The outcome of the TA is sound environmental management systems and institutions that mainstream environmental and biodiversity protection in the GMS Economic Cooperation Program. The TA consists of five components which are (i) environmental assessment of economic sector strategies and corridors; (ii) biodiversity conservation in key conservation landscapes; (iii) environmental performance assessments; (iv)development and institutionalization of GMS capacity for environmental management; and (v) program development and sustainable financing.

A CEP-BCI study in 2007 assessed the preliminary scope for implementing a Carbon Neutral Transport Corridor (CNTC) in the GMS and recommended a twofold approach: carbon offset through sequestration, and reduction of emissions through freight traffic management. As follow on to this work, a concept paper on a GMS based CNTC developed by EOC has proposed that the aim of establishing a CNTC should be to reduce and offset GHG emissions with the long term aim of moving towards net zero carbon emissions.

2. Activities to be carried out under CNTC

In order to establish the feasibility of a CNTC within the GMS two parallel sets of activity have been planned:

- The first will focus on reducing emissions from the transport corridor with an emphasis on freight and passenger traffic.
- The second will focus on the types of measures that could be applied to reduce emissions from deforestation and the feasibility of offsetting emissions through reforestation / sequestration projects

The sequestration feasibility study is expected to incorporate the following:

- Technical feasibility - identification and description of possible sequestration sites and potential
- Financial feasibility – identification of the main funding streams and sustainable financing mechanisms (e.g. REDD, PES) that could be deployed to facilitate such sequestration projects
- Policy environment - identification of policy level initiatives that could be implemented to reduce emissions from deforestation

3. Scope of work

The EOC is seeking the services of a qualified consultant to support CNTC activities. The specific tasks of the Consultant will include the following:

CNTC Sequestration study (33 days):

- Provide input to the definition of temporal and geographic coverage scoping. Support the development of the baseline assessment and impact assessment framework for conservation landscapes
- Support the development of the CNTC policy review by providing inputs on current policy and institutional set up in the GMS countries with respect to deforestation and sequestration
- Design and establish the sequestration study methodology building on REDD+ REL and MRV systems (provide input to GIS team on spatial analysis models to be used; identify field resources needed to complete work)
- Supervise the collection and documentation of information on forest cover, land use and land ownership; analyze land availability for sequestration and reforestation; provide input to spatial analysis; identify sequestration sites
- Supervise the execution of field surveys to assess the suitability of specific sequestration sites and to identify suitable vegetation and sequestration potential
- Identify and make recommendations on local/community based mechanism to ensure peoples participation and benefit sharing mechanisms for selected sites
- Report on financial instruments available for sequestration (e.g. REDD+) and current status of sequestration projects in the area. Include recommendations for the investment plan of carbon sequestration for selected sites with costs and benefits, and institutional set up for implementation, maintenance and monitoring with a tentative implementation schedule.

4. Duration and reporting requirement

The Consultant is expected to provide intermittent input over a period of six months from February to July 2011.

The Consultant will report to the Chief Technical Advisor (CTA) of the EOC and work in coordination with Energy/Climate Change Coordinator and Carbon Footprint Specialist

C. TRANSPORT PRIVATE SECTOR SPECIALIST

1. Background

The Greater Mekong Subregion (GMS) Core Environment Program Biodiversity Conservation Corridors Initiative (CEP-BCI) Phase 1 has begun assessing the feasibility of climate change interventions that could lead to substantial investments in the subsequent phases of the program. In order to look at the impacts of GMS transport corridors being developed across the region, the program is now embarking on a feasibility study to investigate the suitability of establishing a 'Carbon Neutral Transport Corridor (CNTC)' along the GMS East-West Economic Corridor (EWEC).

The CNTC concept includes two elements: reducing emissions from transport (i.e. freight) and reducing and offsetting emissions through reforestation / sequestration.

The main aim of the CNTC feasibility study is to identify how to implement a CNTC in line with the concept i.e. the study will identify the technical, policy and financial feasibility of implementing defined initiatives to reduce emissions from freight traffic and increase carbon sequestration under the CNTC umbrella. The main output of the study is recommendations for pilot projects to be driven by national governments and private sector companies in the region.

2. Objective/Purpose of the Assignment

The purpose of this assignment is to implement activity under the CNTC feasibility study along with the CNTC study team at the EOC, particularly to carry out a review of the business climate among larger freight companies in the GMS with the aim of understanding the willingness for initiatives to reduce energy use and vehicle GHG emissions. The assessment should target the main companies that use / will use the economic corridors being developed in the GMS.

3. Scope of Work

The Consultant will work closely with the Energy/Climate Change Coordinator and Carbon Footprint Specialist at the EOC. S/he will primarily be responsible for the study to assess the business climate in the freight sector in the GMS, identify the major companies that operate across the region, understand the main business drivers and incentives, understand the state of play in terms of age of vehicles currently used across the sector and feasibility of upgrading these, identify the appetite for energy reduction and the adoption of cleaner technologies and describe the operational and other barriers to the uptake of these. Specifically, the consultant will:

- Identify the major companies that operate across the region, particularly those that may use the EWEC
- Conduct interviews with the main companies operating in the region (both transport and logistics companies and possibly their supply chains i.e. engine manufacturers etc.)
- Identify willingness to participate in feasibility study (in terms of data collection on vehicle types are driver behaviours)

- Assess current and anticipated business drivers and obstacles and nature of industry across the GMS (i.e. size, turnover, structure etc.)
- Identify the demand for the adoption of modern fleets, new engine technologies and initiatives to encourage fuel efficiency and carbon reduction.
- Collate recommendations from businesses on enabling policy conditions required to reduce the carbon intensity of their sector and to identify possible obstacles / drivers for these.
- Identify and understand whether there is scope for freight engine manufacturers and suppliers in Southeast Asia to adopt / commit to carbon partnerships (cleaner engines and cleaner fuels, carbon targets etc.).
- Conduct the scoping workshop for main freight industry businesses and trade associations to identify major barriers to the uptake of possible initiatives to reduce carbon and air pollutant vehicle emissions.

4. Deliverables

All written deliverables are to be produced in English unless otherwise specified:

i. Identification of transport companies to engage;

ii. Freight business assessment interview results;

iii. Participatory workshops with freight companies;

iv. Progress updates for the EOC team as required.

6. Reporting Arrangement and Time Commitment

The Consultant will work with Energy/Climate Change Coordinator and Carbon Footprint Specialist at the EOC and will be responsible for the implementation and completion of the assignment.

The expected level of effort to complete this task is up to 20 working days, subject to possible extension, intermittently from April 2011 to October 2011. The work will include field trip(s) and consultations with freight companies in the region.

7. Qualifications

The specialist should have a background in transportation or environment; have at least 10 years of experience in or engaging with private sector companies in the transport sector. Related experience in the GMS / Southeast Asian countries is preferable. The consultant should hold a Masters level degree and be expected to be proficient in written and spoken English.

8. Consultant Recruitment

The specialist will be recruited by the Asian Development Bank (ADB) on an individual basis as required under the Regional Technical Assistance (RETA 6289). Consulting firms can submit applications for consideration.

D. TRANSPORT SPECIALIST (NATIONAL)

1. Background

The Greater Mekong Subregion (GMS) Core Environment Program Biodiversity Conservation Corridors Initiative (CEP-BCI) Phase 1 has begun assessing the feasibility of climate change interventions that could lead to substantial investments in the subsequent phases of the program. In order to look at the impacts of GMS transport corridors being developed across the region, the program is now embarking on a feasibility study to investigate the suitability of establishing a 'Carbon Neutral Transport Corridor (CNTC)' along the GMS East-West Economic Corridor (EWEC).

The CNTC concept includes two elements: reducing emissions from transport (i.e. freight) and reducing and offsetting emissions through reforestation / sequestration. The main aim of the CNTC feasibility study is to identify how to implement a CNTC in line with the concept i.e. the study will identify the technical, policy and financial feasibility of implementing defined initiatives to reduce emissions from freight traffic and increase carbon sequestration under the CNTC umbrella. The main output of the study is recommendations for pilot projects to be driven by national governments and private sector companies in the region.

2. Objective/Purpose of the Assignment

The purpose of this assignment is to implement activity under the CNTC feasibility study along with the CNTC study team at the EOC, particularly on the transport policy and freight assessment and carbon footprint assessment.

3. Scope of Work

The Consultant will work closely with the Energy/Climate Change Coordinator and Carbon Footprint Specialist at the EOC. S/he will carry out a review of freight private sector companies in Lao PDR, and collect and analyze transport data in order to develop a carbon footprint of the CNTC. S/he will be responsible for identifying and facilitating engagement with transport associations and individual companies based in Vientiane and Savannakhet, and assisting the study team in data collection and collation. Specifically, the consultant will:

<u>Data collection and collation</u>

i. Review key sources of information required for the carbon footprint assessment (including traffic flow data for the EWEC, vehicle registration statistics for Lao PDR and Savannakhet province, fuel consumption data, other traffic and transport statistics) and identify data sources and potential gaps

ii. Collect secondary data from relevant line agencies and organizations (e.g. WREA, Ministry of Transport, national Statistics Bureau) and translate relevant information into English

iii. Organize collection of any primary traffic / transport data necessary from sub section of EWEC in order to validate secondary data

Freight sector engagement and review

iv. Facilitate engagement with the freight private sector in Lao PDR, specifically associations and companies based in Vientiane or operating in Savannakhet province

v. Identify relevant private sector businesses, associations and chambers of commerce, and other relevant stakeholders for interview

vi. Work with EOC study team to develop freight survey questionnaire and approach

vii. Conduct a freight assessment survey among private sector transport and logistics companies, and collate results

viii. Assist in facilitating participatory workshops with freight private sector

4. Deliverables

All written deliverables are to be produced in English unless otherwise specified:

i. Primary and secondary transport and traffic data for the carbon footprint assessment;

ii. Identification of transport companies to engage;

iii. Freight assessment survey data and results;

iv. Participatory workshops with freight companies;

v. Progress updates for the EOC team as required.

5. Reporting Arrangement and Time Commitment

The Consultant will report to the Energy/Climate Change Coordinator and Carbon Footprint Specialist at the EOC and will be responsible for the implementation and completion of the assignment.

The expected level of effort to complete this task is up to 40 working days, subject to possible extension, intermittently from April 2011 to October 2011. The work will include field trip(s) and consultations with government agencies, provincial authorities in Savannakhet and freight businesses in Lao PDR.

6. Qualifications

The specialist should have a background in transportation or environment; have at least 5 years of experience in or engaging with private sector companies in the transport sector, and of engaging with Government of Lao PDR. Related experience in the GMS / Southeast Asian countries is preferable. The consultant should hold a Masters level degree and be expected to be proficient in written and spoken English.

7. Consultant Recruitment

The specialist will be recruited by the Asian Development Bank (ADB) on an individual basis as required under the Regional Technical Assistance (RETA 6289). Consulting firms can submit applications for consideration.