DRAFT GRAND DESIGN FOR INDONESIA'S NATIONAL CARBON ACCOUNTING SYSTEM (NCASI)

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1.0 Executive summary

Indonesia's National Carbon Accounting System (NCASI) will be modeled off Australia's National Carbon Accounting System but tailored to Indonesia's unique circumstances.

The NCASI will provide a comprehensive and credible account of Indonesia's land-based GHG emissions profile and C uptake. It will support Indonesia's reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC) and the Reduced Emissions from Deforestation and Forest Degradation post-Kyoto global climate protection regime.

The NCASI will contribute significantly to Indonesia's reputation in the area of carbon accounting, resulting in positive implications both domestically and internationally. It will allow Indonesia to develop a robust modeling and projections capacity for land based GHG accounting, and therefore robust emissions and C uptake estimates.

Why is an NCAS needed in Indonesia?
Deforestation, land use and land-use change are the second leading source of greenhouse gas emissions worldwide. Land use change accounts for 19% of global carbon emissions and over a third of emissions from developing countries (Figure 1). The bulk of emissions arise when forested land is converted to agricultural production, especially if forests are first cleared and burnt. Mature forests contain large stocks of carbon locked up within vegetation, debris and soils. Dense tropical forests have especially high carbon stocks per hectare. In recent years, maintaining existing forest has been promoted as one of the least expensive climate mitigation options.

Figure 1: Global greenhouse gas emissions in 2000, by source

Sector	MtCO2	%
Energy	24,722.3	60.6
Electricity & Heat	10,276.9	25.2
Manufacturing & Construction	4,317.7	10.6
Transportation	4,841.9	11.9
Other Fuel Combustion	3,656.5	9.0
Fugitive Emissions	1,629.3	4.0
Industrial Processes	1,406.3	3.4
Agriculture	5,603.2	13.7
Land-Use Change & Forestry	7,618.6	18.7
Waste	1,465.7	3.6
Total	**40,816.2**	

Source: CAIT, 2007.

In Indonesia, deforestation and land-use changes were estimated to account for 74% of Indonesia's carbon emissions in 1994 according to Indonesia's first National Communication on Climate Change. Indonesia's energy sector was the second largest emitter of greenhouse gas emissions and estimated to account for 23% of total emissions for that same year. Together these two sectors were responsible for 97% of Indonesia's carbon emissions.

Indonesia's is currently preparing its Second National Communication on Climate Change for the UNFCCC and it will make use of data and analysis compiled by the NCASI to provide robust estimates of emissions resulting from land use change.

Objectives

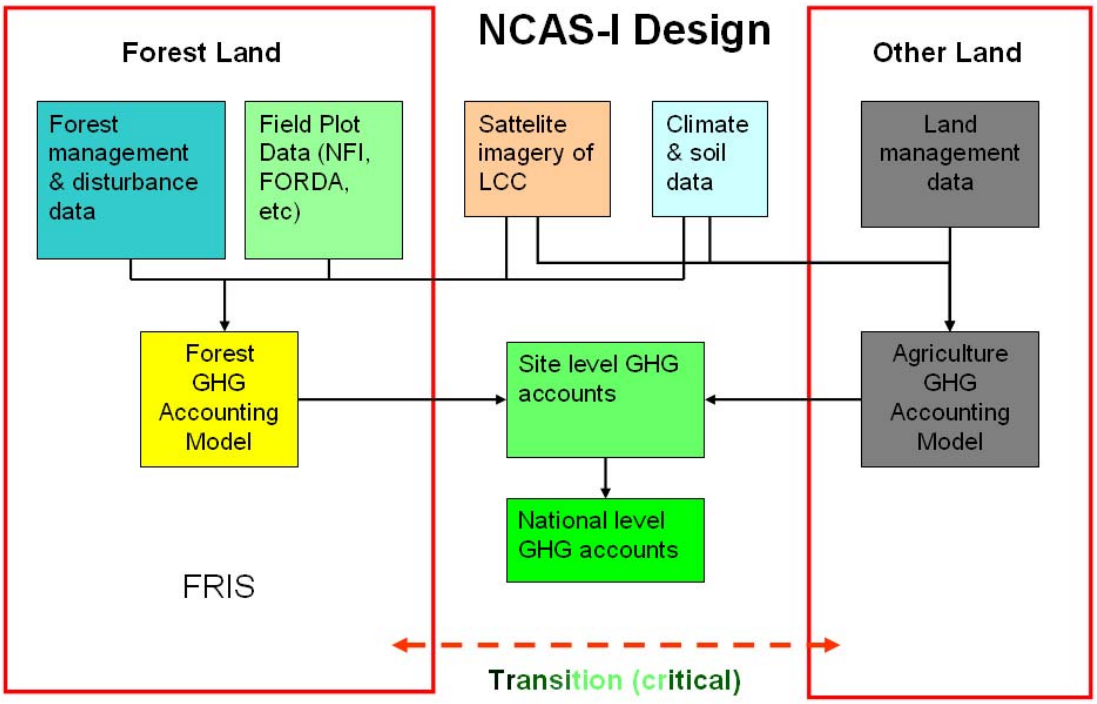
The NCASI will pull together information on deforestation, land use change and land use from Indonesia's forest lands and other lands (primarily agricultural lands) to:

- support Indonesia's position in the international development of policy and guidelines on sinks activity and greenhouse gas emissions and their mitigation from land based systems.
- reduce the scientific uncertainties (particularly about emissions from peat) that surround estimates of emissions and removals of both CO_2 and non-CO_2 greenhouse gases from land use change.
- provide monitoring capabilities for existing emissions and sinks.
- provide the scientific and technical basis to international negotiations and promote Indonesia's interests in international fora.
- develop a comprehensive GIS that includes digital map-based information such as soil maps, remotely sensed images covering the whole of Indonesia and climate and vegetation data.
- Predict future GHG emissions and sinks.
- support Indonesia's negotiations on REDD and provide the necessary inputs required for establishing a credible Reference Emission Level.

NCASI information components

The NCASI will be a highly integrated system that will compile information from Indonesia's forestry and agricultural sectors on:

- Remotely sensed land cover change data
- Land use and management data
- Climate and soil data
- Growth and biomass data; and
- Spatial and temporal ecosystem modeling relevant to estimating GHG flux.



NCASI development

Over the next six months, a number of high level meetings will be held to determine which agency will be responsible for coordinating development of, and housing of the NCASI. The Coordinating agency will be responsible for reporting and making data accessible to the general public. The coordinating agency will also be responsible for coordinating inputs from multiple government agencies that collect and analyze relevant information. These agencies may include: the Ministry of Forestry, the National Climate Change Board (DNPI), the Ministry of Environment, Ministry of Agriculture, the National Institute of Aeronautics and Space, Bureau of Meteorology, the National Development Planning Agency, Ministry of Labor and Transmigration, the National Survey and Mapping Agency (Bakosurtanal), the Ministry of Public Works, the National Land Agency (BPN), the Agency for the Assessment and Application of Technology (BPPT), and Indonesia's Scientific and Research Agency (LIPI). Inputs from non-government organizations, the broader scientific community and district and provincial Government offices will also need to be coordinated.

A scientific support group will also be formed to guide strategy development and implementation, review progress, ensure transparency, technical rigor and policy relevance. Members may include representatives from non-government organizations and the scientific community.

A number of activities will also be initiated over the next year by the Forest Resource Information System to allow Indonesia to prepare a Reference Emission Level for REDD before the Copenhagen UNFCCC COP due to be held in December 2009.

2.0 Introduction

Deforestation, land use and land-use change are the second leading causes of global warming. They account for 19% of global carbon emissions and over a third of emissions from developing countries. The bulk of emissions from land use change arise when land is converted to agricultural production, especially if forests are first cleared with burning. Mature forests contain large stocks of carbon locked up within trees, vegetation and soils. Dense tropical forests have especially high carbon stocks per hectare. In recent years, maintaining existing forest has been promoted as one of the least expensive climate mitigation options.

The international community has formed the United Nations Convention on Climate Change and the Kyoto Protocol to tackle the challenge posed by climate change and the contribution of land use change to global warming. It is also considering forming a post-Kyoto mechanism, known as Reducing Emissions from Deforestation and Degradation (REDD), to recognize the significance of carbon stored in forest ecosystems.

The National Carbon Accounting System of Indonesia (NCASI) will support Indonesia's reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC). It will also support Indonesia's efforts to establish a Reference Emission Level for REDD and to monitor credible reductions in greenhouse gas emissions resulting from reduced deforestation and forest degradation.

The aim of the NCASI is to provide a comprehensive and credible account of Indonesia's land based emissions profile and sinks capacity.

Indonesia's National Carbon Accounting System (NCASI) is based on Australia's National Carbon Accounting System, but tailored to Indonesia's specific circumstances. New remote sensing methods will be developed to account for the fact that a combination of remote sensing sources will be required to monitor land use change in cloudy regions; and new soil carbon models will be developed to estimate emissions from peat soils—soils that are not dominant in Australia.

The NCASI is expected to contribute significantly to Indonesia's reputation in the area of carbon accounting, resulting in positive implications both domestically and internationally. It will allow Indonesia to develop a robust modeling and projections capacity for land based carbon accounting, and therefore robust emissions and removal estimates. A credible accounting system, such as the NCASI, is fundamental to facilitating market confidence in REDD and it will provide initial information about emissions from land use change.

3.0 Indonesia's international obligations and commitments

United Nations Framework Convention on Climate Change

Indonesia strongly supports the objective of the UNFCCC to prevent the anthropogenic gas concentration in the atmosphere exceeding a level that would endanger the existence of life on earth. Its position is in line with the IPCC findings that global warming is a real threat to human welfare in many ways.

To indicate its firm decision and serious concern regarding global warming, Indonesia signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 5, 1992. The President of the Republic of Indonesia then ratified the UNFCCC by signing a regulation on August 1, 1994—(*Undang-undang tentang Pengesahan Konvensi Kerangka Kerja PBB tentang Perubahan Iklim Nomor* 6/1994). This regulation was submitted to the Secretary General of the UN on August 23, 1994 and Indonesia was consequently included as a Party of the Conference. It is therefore bound to the rights and obligations stipulated in the Convention.

As a Party to the UNFCCC, Indonesia is obliged to prepare annually an inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol and submit any necessary supplementary information.

Article 4.1(a) of the UNFCCC commits Indonesia to produce an annual inventory of national greenhouse gas emissions according to the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The inventory reports human induced greenhouse gas emissions by sources and removals by sinks, not controlled by the Montreal Protocol in six sectors: Energy, Industrial Processes, Solvent and other Product Use, Agriculture, Land Use Change and Forestry (LUCF), and Waste.

Indonesia submitted its first National Communication on Climate Change to the UNFCCC in 1999 and is currently preparing its second National Communication, which it expects to submit in 2009. The NCASI will provide critical inputs for this Communication and assist Indonesia to improve its reporting of greenhouse gas emissions resulting from land use change

<u>The Kyoto Protocol</u>
Indonesia ratified the Kyoto Protocol in July 1998. Article 3.7 of the Kyoto Protocol requires Parties with net emissions from the LUCF sector in 1990 to include net emissions due to Land Use Change in their 1990 baseline.

The Kyoto Protocol also specifies that each country must develop and have "a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol."

Three main information requirements are outlined:
- an estimate of carbon stock and flux in 1990, known as the 1990 Baseline;
- an estimate of emissions during the commitment period 2008-2012, to be matched against the assigned annual amount;
- estimates of sinks resulting from direct human-induced land use change and forestry activities can be used to offset the emission estimates in the commitment period, if they can be shown to be initiated after 1990 - hence the term 'Kyoto forest' referring to forests established since 1990.

Indonesia is presently unable to establish a 1990 baseline due to a lack of spatial data that can be used to detect land use change, however the NCASI will assist Indonesia to establish this capacity.

REDD

Reduced Emissions from Deforestation and Forest Degradation (REDD) emerged at the UNFCCC COP 13 in Bali as a component of the post-Kyoto global climate protection regime. The Indonesian president has expressed a strong willingness to reduce GHG emissions through strategies that avoid deforestation and Indonesia's yellow book on climate change featured REDD as its first priority.

On 17th July 2008, the Ministry of Forestry presented a draft Ministerial Regulation (Permenhut) on the "Implementation Procedures for Reducing Emissions from Deforestation and Forest Degradation" in a public hearing involving major stakeholders. The Ministry is currently revising the draft after reviewing comments and proposals submitted by multiple stakeholders and expects to release a final regulation before the end of 2008. This regulation will provide policy guidance on where REDD pilots can be carried out, the recipients of REDD credits, implementation procedures, monitoring and reporting, incentive distribution and guidelines for setting reference emissions levels.

A REDD commission will also be established in the near future. This commission is expected to be a clearing house for all REDD activities. The REDD commission will review and recommend or reject REDD proposals, guide overall REDD implementation, issue REDD certificates, manage the national registry, and manage the reserve of 30% of REDD credits.

5.0 Indonesia's lands and management arrangements

Indonesia's total area is estimated to be 187.913 million ha. These lands are essentially divided into two: forest lands and lands used for other purposes such as agriculture, settlement, transmigration and other land uses.

Indonesia's designated forestland (*kawasan hutan*) are administered and managed by the Ministry of Forestry. These lands cover around 133.694 million ha or 71% of the total land area. According to Landsat analysis undertaken in 2003, 85.97 million ha of forest lands was forested, while 39.091 million ha were classified as non forest (8.517 million ha of no data/clouds)[1]. Lands falling outside the forest estate are administered by other government departments, such as the Ministry of Agriculture (and estate crops), as well as district and provincial governments. The National Land Administration Agency (*Badan Pertanahan Nasional*) is responsible for land tenure, surveying and allocating freehold land entitlements.

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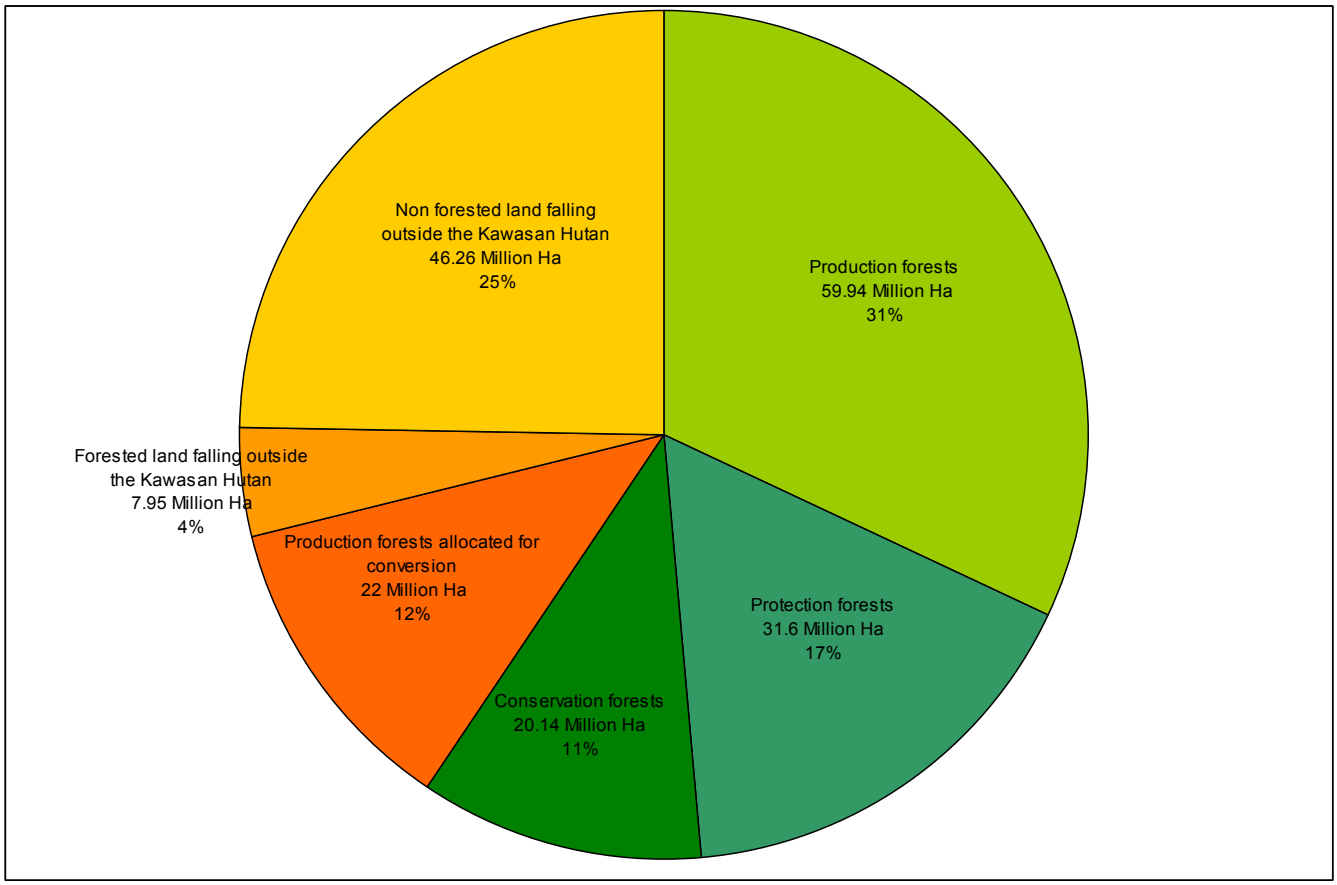
[1] Departemen Kehutanan, 2007. Statistik Planologi Kehutanan Tahun 2006, Badan Planologi Kehutanan, Jakarta.

Indonesia's forest lands are divided into three categories: Production forests (81.948 million ha), conservation forests ((20.142 million ha), and protection forests (31.604 million ha) million ha). Production forests are primarily allocated for sustainable forest management and can be utilized for logging and industrial forest plantations, however, over 22 million hectares of production forest have been allocated for conversion to other land uses, such as estate crops, agriculture and settlement. These lands will eventually be excised from the designated forestland (Kawasan Hutan). Conservation forests are allocated for biodiversity and wildlife conservation and protection forests have been set aside for protecting environmental services, such as watersheds, carbon stocks, steep slopes, rivers and beaches.

Outside the forest estate, approximately 7.959 million ha of land is forested (Landsat interpretation, 2003). These forested lands can also be allocated for conversion to agriculture and are under the jurisdiction of district and provincial governments.

The NCASI will monitor land use change and estimate GHG emissions and sinks in all of these lands, particularly those lands where deforestation is expected to be rapid over the next few decades: conversion forests and forests falling outside the forest estate.

Figure X: Land cover and land use categories in Indonesia



6.0 Objectives

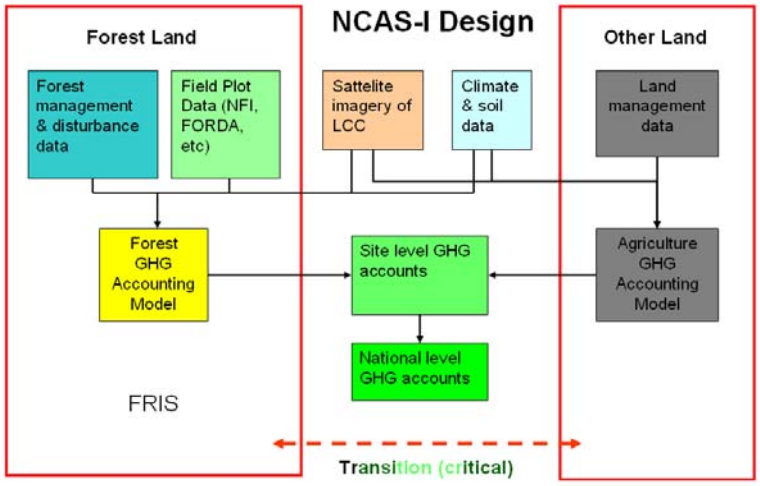
Specific objectives of the NCAS are to:

- support Indonesia's position in the international development of policy and guidelines on sinks activity and greenhouse gas emissions and their mitigation from land based systems.
- reduce the scientific uncertainties that surround estimates of emissions and sinks in the Indonesian context.
- provide monitoring capabilities for existing emissions and sinks
- provide the scientific and technical basis to international negotiations and promote Indonesia's national interests in international fora.
- develop a comprehensive GIS that includes digital map-based information such as soil maps, remotely sensed images covering the whole of Indonesia and climate and vegetation data.
- support Indonesia's negotiations on REDD and provide the necessary inputs required for establishing a credible Reference Emission Level.

7.0 Scope

The NCASI will establish a robust system to account for land-based emissions of greenhouse gases by sources and removals by sinks both within Indonesia's forest lands and outside the forest lands. It will have the capability to estimate emissions from:

- Forest management (e.g. harvesting, silviculture)
- Disturbance (e.g. Fire)
- Conversion (natural forest to agriculture, estate crops or timber plantations)
- Deforestation and forest degradation; and
- Afforestation



8.0 Operating environment

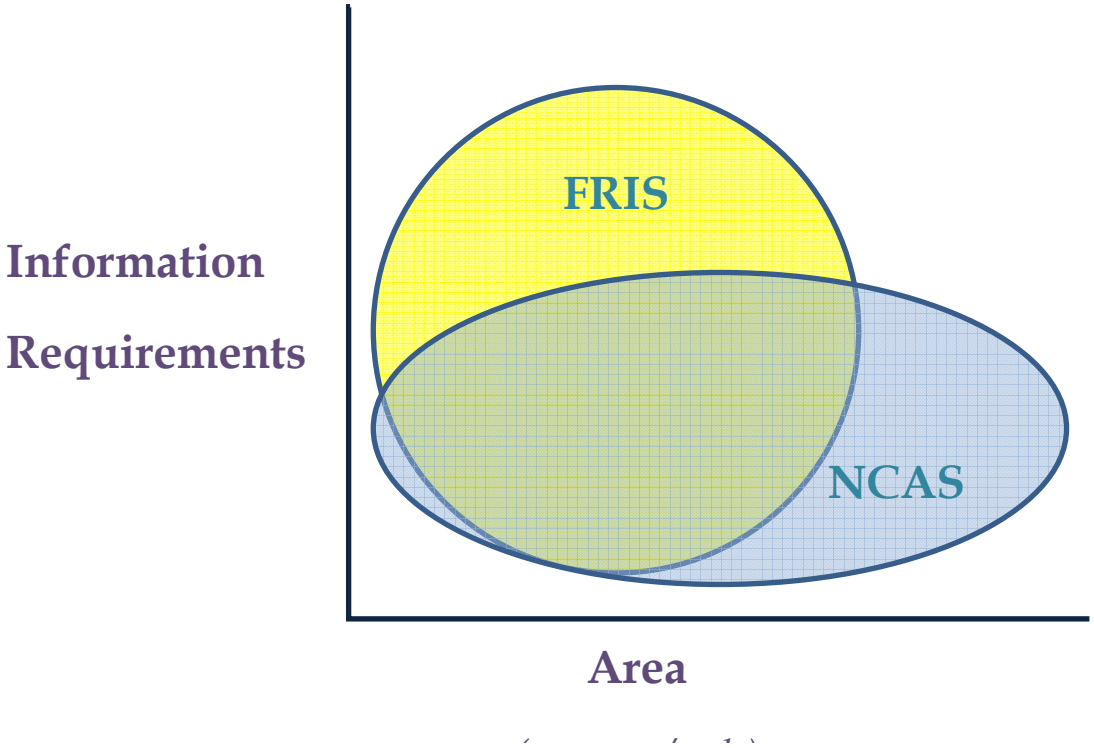
Over the next six months, a number of high level meetings will be held to determine which agency will be responsible for coordinating and housing the NCASI. The Coordinating agency will be responsible for reporting and making data accessible to the general public. The coordinating agency will also be responsible for coordinating inputs from multiple government agencies that collect and analyze relevant information. These agencies may include: the Ministry of Forestry, the National Climate Change Board (DNPI), the Ministry of Environment, Ministry of Agriculture, the National Institute of Aeronautics and Space, Bureau of Meteorology, the National Development Planning Agency, Ministry of Labor and Transmigration, the National Survey and Mapping Agency (Bakosurtanal), the Ministry of Public Works, the National Land Agency (BPN), the Agency for the Assessment and Application of Technology (BPPT), and Indonesia's Scientific and Research Agency (LIPI). Inputs from non-government organizations, scientific community and district and provincial Government offices may also need to be coordinated.

A scientific support group will also be formed to guide strategy development and implementation, review progress, ensure transparency, technical rigor and policy relevance. Members may include representatives from non-government organizations and the scientific community.

In the meantime, a number of activities will be initiated by the Forest Resource Information System to allow Indonesia to prepare a Reference Emissions Level for REDD before the Copenhagen UNFCCC Cop due to be held in December 2009.

9.0 Relationship between the NCASI and the Forest Resource Information System (FRIS)

The NCASI will draw upon forest sector information that is compiled, archived and analyzed by the Forest Resource Information System (FRIS) being developed by the Ministry of Forestry. 70% of Indonesia's lands fall within the forest estate (*kawasan hutan*) which is administered by the Ministry of Forestry, so these lands are set to be a major part of the National Carbon Account when it is operating and reporting. However, the National Carbon Accounting System for Indonesia (NCASI) needs institutional input beyond the forests including agriculture and other land use sectors.



10.0 NCASI Information components

The NCASI information components are influenced by the Revised 1996 IPCC Guidelines for the Land Use Change and Forestry sector and are defined as:

Land cover change
- Area cleared
- Method of clearing
- Rate of clearing
- New land use

Land Use and Management
- Crop, forest or pasture type
- Management information

Climate input
- For example, rainfall, temperature (min, mean, max), evaporation, frost days, vapour pressure deficit
- Solar radiation

Crop Growth and Plant Parameters
- Crop growth rates
- Above ground and below ground biomass
- Carbon content
- Litter mass and decomposition rates of crops

Forest Biomass Stock and Growth Increment
- Above and below ground biomass
- Carbon content of biomass
- Regrowth increment over time for natural forests
- Plantation growth rates
- Turnover and decomposition rates for forests
- Post-clearing replacement biomass (regrowth rate)

Soil Carbon
- Pre-clearing soil carbon content
- Loss from clearance and land use
- Rate of decay/accrual
- Non-CO2 GHG emissions from soils and forest fires

Forest Products
- Total carbon content of products/by-products
- Rates of decay of products/by-products

11.0 Key actions

Land cover change

Relevance

Assessment of changes in forest cover (land cover change[2]) is a fundamental component of accounting for greenhouse gas emissions and removals by land systems. The NCASI will strive to provide annual accounts of greenhouse gas emissions occurring since the baseline reference year (1990, as specified by the Kyoto Protocol). It will also be able to estimate lagged emissions

[2] Land Cover Change refers to a change in forested to non-forested (or visa versa) vegetation cover.

occurring from deforested or degraded lands (i.e. from the degradation of formally forested peat soils).

The land clearing rates for 1990 and the preceding years are needed to estimate carbon fluxes in 1990 attributable to losses from soils and biomass decay from those earlier years. The method used to estimate clearing rates will be based on a combination of satellite data, including LANDSAT, Modis, SPOT Vegetation, Alos Palsar and JERS. Both optical and radar sources of spatial data are required for this analysis because much of Indonesia has high cloud cover which limits the use of LANDSAT and other optical sources to detect land use change. New spatial data (radar—Alos Palsar) and methods are also needed to detect forest degradation.

Objectives

- To provide long term annual monitoring of land cover change commencing from 1990.
- To provide a multi-temporal, fine resolution data series identifying through time, for any land unit, land cover change (removal of forest cover and forest regrowth) that is attributable to direct human actions.

Tasks

- Identify the most appropriate remote sensing options (radar and optical) to provide a comprehensive account of land cover change since 1990 and a comprehensive account of land cover change in the future.
- Acquire the most appropriate remote sensing data to support the design of a time series analysis of land cover change since 1990 (likely to be a combination of LANDSAT, NOAA/AVHRR, MODIS, SPOT Vegetation, JERS and ALOS Palsar data).
- Catalogue scene availability, scene quality and purchase cost to support a time series review of land clearing rates.
- Calibrate and refine methods using LANDSAT, MODIS, NOAA/AVHRR, JERS and Alos PALSAR images taken at different times.
- Conduct pilot study of time series optical/radar processing to produce NCAS land-cover change time series
- Identify a frequency distribution of land clearing noting any changes over time.
- Establish a test site for new technologies emerging with remote sensing and modeling.

Land use and management

Relevance

Land use (for pasture and crops etc) and management practices (use of fire, swidden agriculture, grazing etc) following land use change events, affect ongoing carbon stock and the rate of carbon stock change of that land. Both the IPCC Inventory Guidelines and the Kyoto Protocol require continued accounting for lagged emissions following both current and past land cover change events.

Changing land use and management on an area of land over time will produce associated temporal patters of variation in carbon stock change, especially if these lands are dominated by peat soils. Information on agricultural land use and management practices over time is fundamental to accurate accounting of the temporal patterns of variation in GHG change, and is therefore a requisite input to modeling of land use change emissions.

Objectives

- To identify the land use and management practices that affect GHG balances following land cover change events.

Tasks

- Identify the nature, effect and possible mapping of land uses and land management techniques which impact on GHG flux.
- Develop a time series analysis of the primary social, economic and regulatory drivers of land use change (particularly land clearing).
- Investigate methods for mapping land use and land management that affect GHG flux.
- Provide a land tenure map which can help identify agents of deforestation and forest degradation.
- Determine GHG balances for production forest, conservation forest and protection forest.

Climate inputs

Relevance

In Australia, model sensitivity testing identified that inter-annual climate variability has a significant effect on both soil and forest carbon stock change. The use of long-term (temporal) average and regionally (spatial) averaged climate data was shown to be inadequate to support spatially and temporally disaggregated carbon modeling, frequently generating spurious results when tested. This is also expected to be the case in Indonesia.

To provide spatially mapped monthly climate data, the NCASI will obtain weather station data from the Bureau of Meteorology for rainfall, solar radiation, minimum and maximum temperature and evaporation. Monthly climate surfaces (maps) for each attribute will also be derived.

Objective

- To provide monthly climate maps for rainfall, temperature, evaporation, frost and solar radiation to support the GHG modeling program.

Tasks

- Obtain weather station data from the Bureau of Meteorology for rainfall, minimum and maximum temperature, solar radiation, frost and evaporation.
- Derive monthly climate surface (maps) for each attribute.

Crop growth and plant parameters

Relevance

Studies conducted for the Australian NCAS showed that the plant residue input to soil carbon modeling was a strong determinant of model outcome. Reliable crop growth information (supported by management practice as it affects residue generation and management) is important to robust soil carbon estimation. Plant residue input to litter and soil carbon pools are a significant determinant of total site carbon and trends in soil carbon over time. The allocation of total plant productivity (growth) to various plant components, decomposition rates and the turnover rates of each component affect ongoing plant input and residue amounts to both plant litter and soil carbon pools.

Both the IPCC Inventory Guidelines and the Kyoto Protocol require ongoing accounting for lagged emissions from soils following land cover change events. Therefore, ongoing data on crop growth and plant parameters is required for the soil carbon modeling.

Objectives

- To provide spatially and temporally referenced data on crop growth rates.
- To provide data to support the allocation of:
  - Crop biomass to various above-and-below ground plant components
  - Turnover rates of the various plant components and
  - Carbon content of plant components

Tasks:

- Develop sampling and measurement protocols for systematic collection of new biomass and litter data
- Compile and generate data on the biomass of main crops, such as rubber, oil palm, sugar cane, rice etc.
- Compile and generate data on the carbon content of main crop species.
- Compile and generate data on the litter production, standing mass and decomposition rates of main crop species.

Biomass stock and growth increment

Relevance

Both sinks and sources of biomass carbon on units of land subsequent to relevant land cover change events must be accounted for under both the IPCC Inventory Guidelines and the Kyoto Protocol. It is, therefore, necessary to determine the stock of forest biomass carbon for a land unit at any point in time. This requires an understanding of the potential site biomass at maturity, the temporal pattern of biomass accumulation, disturbance history of the site and forest age.

Following land cover change events, ongoing land use change emissions accounting includes accumulation of C in regrowth and continuing decomposition of residual tree biomass. For above-ground biomass after land cover change events, it is necessary to account for any vegetation (i.e. crops or pasture) that replaces the original forest.

Indonesia already holds a large database (2400 sample points) of forest biomass estimates which have been obtained from its National Forest Inventory (NFI). However, there is a need for a critical review of the methods used to make these estimates of biomass. These revised estimates can be combined with new information to refine estimates of forest biomass and the carbon stored in this biomass.

Objectives

- To provide a methodology for estimating biomass at maturity (undisturbed condition), biomass in forests in relation to disturbance history (age determined from the land cover change program), and rates of regrowth post-disturbance.
- In estimating biomass, to establish a method to take into account process factors that constrain and promote growth including soil fertility, temperature and soil water content.

Tasks

- Review biomass estimates obtained from Indonesia's National Forest Inventory.
- Develop methods to distinguish areas of regrowth using remote sensing techniques.
- Develop survey techniques to access local knowledge on the relevant proportions of areas allowed to regrow.
- Identify the different decay rates, including release from combustion by fire, for carbon release from biomass with different clearing technique.
- Identify the proportion of clearing by different techniques.
- Develop predictive methods for establishing likely biomass removed with previous land clearing.
- Develop a suite of growth models for annual increments in biomass accumulation.
- Develop a method for estimating the carbon content of below ground woody biomass.
- Review published and unpublished studies to derive a representative suite of allometric equations for Indonesian tree species.
- Develop a suite of aboveground and belowground biomass decay rates which relate to climate and wood properties.
- Identify a series of possible environmental classifications which can potentially explain variations in biomass accumulation and plant biomass partitioning.
- Identify the proportional allocations and track the life cycle of wood products within each pool.

Tree parameters

Relevance

In order to estimate both above ground and below ground biomass (as required by both the IPCC Inventory Guidelines and the Kyoto Protocol) there is a need to be able to convert the modeled above-ground biomass estimate to a total (above and below ground) biomass estimate.

Partitioning of above-ground biomass is also important to determine the fate of material (particularly on and offsite transfers) as each tree component may be treated differently under different management systems. Different tree components also turnover (natural shedding, e.g. leaf drop, root slough) at different rates.

Wood density estimates are used to derive stem volume estimates form the mass based growth estimates. This provides for comparison with the available stem volume estimates more commonly collected in commercial inventories. More likely to be the other way round, i.e. biomass is estimated from volume estimates that are more commonly available.

Objectives:

- To understand partitioning of tree biomass into different components to allow for differential rates of growth, turnover and decomposition, and management impact.
- To derive estimates of stem volume for comparison to available stem volume based plot (measured) data.

Tasks:

- Develop sampling and measurement protocols for systematic tree biomass estimation
- Review available information, identify gaps, and then initiate a range of studies on partitioning of growth, tree carbon content and wood density to provide a consolidated understanding..

Forest parameters

Relevance

The structural characteristics of various forest types may either determine or be associated with a range of forest values such as root-shoot ratios, above-ground partitioning to various tree components, turnover rates, decomposition rates and initial (pre-land cover change) masses of coarse woody debris and fine litter. Each of these factors is important in accounting for all carbon pools, as required for Land Use Change estimates and for Deforestation under the Kyoto Protocol.

Objectives

- To estimate the amount of carbon stored in forest litter and roots.
- To associate land cover change events with relevant forest types (i.e. primary, secondary lowland forests, mangrove forests, peat swamp forests etc).

Tasks

- Establish a National Vegetation Information System that collates and provides, in a consistent taxonomy and classification, the best available vegetation maps from all available sources.
- Develop a model to estimate carbon stored in the forest litter of different vegetation types.
- Calibrate and test models to estimate rates of decomposition and accumulation of different vegetation types.

Soil carbon

Relevance

Soil carbon change (typically losses) after land use change and with subsequent crop/pasture management needs to be estimated over time on land that has undergone relevant land cover change at some point in time. This is particularly important for peat soils that store large quantities of carbon and emit carbon and other greenhouse gases over an extended period of time when disturbed.

The extent of soil disturbance, and therefore the loss of soil carbon following clearing will be affected by whether trees are pushed over, burned, windowed and stick raked or poisoned or left standing. Carbon loss from peat soils is also likely to be affected by draining, burning, compression and oxidation. Little is currently known in Indonesia about the impacts of different land uses on soil carbon stocks, particularly peat carbon stocks, and how these techniques affect emissions.

Because there is a high level of uncertainty about the loss of organic soil carbon post clearing or disturbance, soils contribute a large source of variation for a 1990 baseline. Consequently, there is a need to define both the pre-clearing soil carbon levels, the time course (rate) of loss of soil carbon post clearing and the equilibrium level of soil carbon post clearing for different land uses. There is also a dire need to improve understanding about GHG fluxes (both CO_2 and non-CO_2 GHGs) from tropical peat soils.

Objectives

- To provide mapped estimates of 'pre-disturbance' soil carbon contents.
- To improve understanding of GHG fluxes from tropical peat soils after disturbance.
- To develop a calibrated and verified soil carbon model capable of fine-scale temporal and spatial application on peat and mineral soils.

Tasks

- Compile and improve spatial data on all soil types (including peat soils) and develop soil type maps for the archipelago.
- Compile data on the properties and depth of peat soils.
- Calibrate and verify a robust and widely applicable soil carbon model to perform spatially and temporally disaggregated estimation for soil carbon.
- Identify any difference in the rates or total change in soil carbon content with method of land clearing or land use (i.e. use of fire, compressing peat, draining peat etc).

- Calibrate and verify a robust and widely applicable soil carbon model to estimate CO_2, N_2O and CH^4 emissions arising from peat fires, oxidation or other types of disturbance.
- Establish a program of 'paired' plot measures of the time course of soil carbon loss, the time to equilibrium and the residual soil carbon contents. This should also provide additional samples to support estimates of pre clearing soil carbon contents in areas affected by deforestation.

Modeling

Relevance

In Australia, it was early recognized that carbon accounting would need to rely on both the collation and synthesis of resource information and the calibration and verification of a model framework. This was primarily because the vast areas in Australia under extensive forest and agricultural management demand an approach founded on modeling – measurement approaches were not found to be practical.

A number of models were developed in Australia as components of the NCAS including: a physiological growth model for forests, 3PG (Landsberg and Waring, 1997; Landsberg et al. 2000: Coops et al, 1998; Richards and Brack (2004); Waterworth et al (2008); the carbon accounting model for forests developed by the Australian Greenhouse Office (AGO), CAMFor (Richards and Evans, 2000a), the carbon accounting model for cropping and grazing systems—CAMAg (Richards and Evans, 2000b), the microbial decomposition model GENDEC (Moorhead and Reynolds, 1991; Moorhead et al. 1999) and the Rothamsted Soil Carbon Model—Roth C (Jenkinson, et al. 1987; Jenkinson et al. 1991).

These models were independently developed for various purposes of predicting and accounting for:

- Soil carbon change in agriculture and forest activities (in the case of Roth C).
- The determination of rates of decomposition of litter (in the case of GENDEC); and
- The calculation of a 'forest productivity surface' that was used for the spatial and temporal scaling of many forest parameters.

CAMFor and CAMAg are carbon accounting tools developed by the Australian Greenhouse Office through which it is possible to apply management impacts such as fire, decomposition, harvest, cropping and grazing to externally generated growth and decomposition rate inputs.

All of the above models were integrated in one model, known as FullCAM, which provides a linkage between the various sub-models used to develop the Australian NCAS. FullCAM has components that deal with the biological and management processes which affect carbon pools and the transfers between pools in forest, agriculture, transitional (afforestation, reforestation, deforestation) and mixed (e.g. agroforestry) systems. The exchanges of carbon, loss and uptake between the terrestrial biological system and the atmosphere are also accounted for. FullCAM aims to take a holistic approach, with modeling and measurement continuous across all carbon pools and cognizant of the transfers between pools. The FullCAM model was developed in Australia to establish estimates and

predictions of carbon flows associated with all biomass, litter and soil carbon pools in forest and agricultural systems. It can also estimate non-CO2 pools and gases. The FullCAM model can be used to provide guidance to development of a similar model for Indonesia.

Objectives

- To provide a suite of calibrated and verified models for biomass, litter and soil carbon modeling in a spatial GIS framework which includes multi-temporal remotely sensed land cover change data.
- To provide an integrated yet flexible model capable of accepting a range of available inputs (and input types) and able to perform both point-based, aspatial area-based estimation and full spatial accounting.

Tasks

- Develop a Carbon Accounting Model for Agriculture to provide capacity for both project and continental scale carbon accounting.
- Develop a Carbon Accounting Model for Forestry to provide capacity for both project and continental scale carbon accounting.
- Calibrate and test a microbal decomposition model to consider the environmental and biological drivers of microbial activity, namely temperature, moisture and substrate quality.
- Develop a soil carbon model for peat and mineral soils.
- Develop a forest productivity index for Indonesia to predict indices of forest growth, potential biomass at maturity and rates for biomass increment.
- Develop models to predict future planned and unplanned deforestation.
- Review and utilize the Full Carbon Accounting Model developed in Australia to deal with both the biological and management processes which affect carbon pools and the transfers between pools in forest, agricultural, transitional (afforestation, reforestation and deforestation) and mixed (e.g. agroforestry) systems.

12.0 Information management

The 1990 baseline will be subject to verification by the international community. This will require transparency in methods of analysis and the sourcing and availability of data. In refining methods and obtaining new data, the NCASI needs to be able to document and track sources of data, information and impact of their introduction. The system will also need to be capable of being extended to provide decision support for the choice of implementation options for the NCASI. Many of the datasets and methods needed for the development of the NCASI will be of common interest to district and provincial government agencies and standard protocols will be developed to store, archive and share information among central government departments and with provincial and district government agencies.

Objectives

- To facilitate multi-agency cooperation and sharing of information.
- To facilitate systematic collection and storage of information from multiple agencies.

Tasks:

- Develop standard protocols to store, archive and share information among central government departments and with provincial and district government departments.
- Develop relationships with national, provincial and district agencies to ensure that the NCASI is able to compile and analyse all relevant information.
- Work with other central, district and provincial agencies to identify possible datasets and projects of interest to NCASI.
- Construct a dynamic, robust and flexible geodatabase to store information in a systematic fashion. Ensure that the geodatabase compatible with the FRIS geodatabase and geodatabases developed by other government departments and able to accommodate changes in method, data format and structure.
- Develop a disclosure policy in line with Indonesia's Freedom of Information Act
- Release spatial and statistical data deemed appropriate for public consumption on CDs and websites.

13.0 Capacity building

On going training and capacity building is needed to keep government staff and their provincial and district colleagues abreast of recent developments and to have the capacity in-house to take advantage of the latest technologies. Training should incorporate a range of technical skills, including GIS/remote sensing analysis, database management, web-based mapping, reporting, research methodologies, data analysis, designing and implementing systems, greenhouse gas modeling and field inventories. Instruction at district and regional levels will be crucial to improve information flow and ensure frequent updates. Guidance will be needed for government officials and other stakeholders for decision support to take best advantage of information at hand in a transparent decision environment.

14.0 Communication strategy

The UNFCCC under Article 4.2 (b) requires Parties:

> *'to communicate information on polices and measures and on its projected anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, with the aim of returning to their 1990 levels of these emissions'.*

The NCASI will be designed in such a way that it can communicate this information in a systematic, credible and transparent way.

A comprehensive communication strategy will also be developed to ensure that the NCASI can be understood by a range of stakeholders including local communities, scientists and government. The strategy will ensure that the NCASI is able to:

- Increase understanding about greenhouse gas emissions resulting from land use change.
- Increase understanding about REDD.
- Develop communication and understanding between central government departments and district and provincial agencies.
- Raise awareness about the need for a NCAS and its objectives.
- Publish material in NCASI technical reports, external newsletters and journals.

15.0 Research

Because Indonesia is vastly different from Australia, significant research will need to be undertake to provide valuable inputs to the NCAS and allow Indonesia to provide credible estimates of GHG emissions and sinks. Research topics identified to date include the following:

- Improve understanding about emissions release from forest degradation.
- Improve understanding about the carbon balance of industrial timber plantations and how they compare to natural forests in Indonesia.
- Evaluate potential of Alos Palsar to provide disturbance and degradation information.
- Carry out a pilot for optical/radar time series covering a range of forest types to determine what Alos Palsar and optical can and can not do with land use change.
- Evaluate integration of Alos Palsar with time-series Modis and SPOT vegetation.
- Evaluate integration of Modis with Landsat.
- Improve understanding about GHG fluxes from tropical peat soils.
- Improve methods for estimating GHG emissions from managed and wildfires.
- Determine if remote sensing can be used to estimate peat depth and its change following disturbance.

16.0 Mechanisms for system improvement

Overtime, the NCAS will be expanded, improved reviewed and evaluated so that it can provide a robust, credible and comprehensive account of emissions resulting from land use change and land management in Indonesia.

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Appendix 1: NCASI Activity Table

1. Establish operating environment

Objectives:

- To identify an institution that has a mandate for coordinating inputs and housing the NCASI
- To provide a support team that can guide strategic development and implementation, and provide advice and scientific rigor.

	Task	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS	Budget shortfall US$
1.1	Hold high level meetings to agree upon which agency will be primarily responsible for coordinating NCASI inputs and housing the NCASI	MoF to lead discussion and host meetings	H	$5,000	No	$5,000
1.2	Form a scientific support team that can guide NCASI development and implementation, provide advice and scientific rigor, ensure transparency and credibility.		H	$300,000	Yes	0
1.3	Identify detailed system requirements for establishing a credible NCASI		H	$5,000	Yes	0
	Total			**$310,000**		**$5,000**

2. Land cover change

Objectives:

- To provide long-term monitoring of land cover change commencing from 1990.
- To provide a multi-temporal, fine resolution data series identifying through time, for any land unit, land cover change (removal of forest cover and forest regrowth) that is attributable to direct human actions.

	Task	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS	Budget shortfall US$

2.1	Identify the most appropriate remote sensing data options to provide a comprehensive account of land cover change since 1990 and a comprehensive account of land cover change in the future.	Lead agency: MoF Collaborating agencies: Lapan, Agriculture, Environment	H	$10,000	YES	0
2.2	Acquire the most appropriate remote sensing data to support the design of a time series analysis of land cover change since 1990 (likely to be a combination of Landsat, NOAA/AVHRR, Modis, JERS and Alos Palsar data)	Lead agency: MoF Collaborating agencies: Laplan, Environment	H	$4,000,000	YES	0
2.3	Identify best cloud free scenes to support time series analysis of land clearing rates	Lead agency: MoF Collaborating agencies: Laplan, Environment		$10,000	YES	0
2.4	Calibrate and refine methods for processing Landsat, Modis, NOAA/AVRR, and Alos Palsar images taken at different times.	Lead agency: MoF Collaborating agencies: Laplan, Environment		$180,000	YES	0
2.5	Form a multi-temporal classification of time series of landcover maps to detect land cover change.	Lead agency: MoF Collaborating agencies: Laplan, Environment		$200,000	YES	0
2.6	Conduct pilot study of time series optical/radar processing to produce NCAS land-cover change time series.	Lead agency: MoF		$100,000	YES	0

		Collaborating agencies: Laplan, Environment				
2.7	Develop a frequency distribution of land clearing sizes noting any changes over time.	Lead agency: MoF Collaborating agencies: Laplan		$50,000	NO	$50,000
2.8	Establish a test site for new technologies emerging with remote sensing and modeling.			$50,000	YES	0
	Total budget			**$4,600,000**		**$50,000**

3. Land use and management

Objectives

- To describe the land use and management practices that affect soil and biomass C stocks.

	Task	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS**	**Budget shortfall US$**
3.1	Identify the nature, effect and possible mapping of land uses and land management techniques which impact on terrestrial carbon cycles.	Ministry of Forestry and Ministry of Agriculture	H	$400,000	N	$400,000
3.2	Develop a time series analysis of the primary social, economic and regulatory drivers of land use change (particularly land clearing)	Ministry of Forestry		$50,000	N	$50,000
3.3	Investigate methods for mapping land use and land management techniques that impact on terrestrial carbon cycles.	Ministry of Forestry and Ministry of	H	$100,000	N	$100,000

		Agriculture				
3.4	Provide land tenure map which can identify agents of deforestation and forest degradation.	Ministry of Forestry and Ministry of Agriculture		$200,000	N	$200.000
	Total budget			**$750,000**		**$750,000**

4. Climate inputs

Objective

- To provide monthly continental climate maps for rainfall, temperature, evaporation, frost days and solar radiation to support the carbon modeling program

	Task	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS**	**Budget shortfall US$**
4.1	Obtain weather station data from the Bureau of Meteorology and Ministry of Agriculture for rainfall, solar radiation, minimum and maximum temperature, frost and evaporation	Bureau of Meteorology and Ministry of Agriculture		$50,000	Y	0
4.2	Develop a basis for deriving monthly climate surface (maps) for each attribute.	Bureau of Meteorology and Ministry of Agriculture		$50,000	N	$50,000
	Total budget			**$100,000**		**$50,000**

5. Crop growth and plant parameters

Objectives

- To provide spatially and temporally referenced data on crop growth rates.
- To provide data to support the allocation of:
  - Crop biomass to various above-and-below ground plant components
  - Turnover rates of the various plant components and
  - Carbon content of plant components

	Tasks	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS	Budget shortfall US$
5.1	Develop sampling and measurement protocols for systematic biomass collection	Ministry of Agriculture		20,000	Y	0
5.2	Compile and generate data on the biomass of main crops, such as rubber, oil palm, sugar cane, rice etc.	Ministry of Agriculture		100,000	N	100,000
5.3	Compile and generate data on the carbon content of main crop species.	Ministry of Agriculture		100.000	N	100,000
5.4	Compile and generate data on the litter mass and decomposition rates of main crop species.	Ministry of Agriculture		100,000	N	100.000
	Total budget			**$320,000**		**$300,000**

6. Biomass stock and growth increment

Objectives

- To provide mapped estimates of biomass at maturity (undisturbed condition), biomass given disturbance history (age determined from the land cover change program) and rates of regrowth post disturbance.
- In mapping biomass estimates, to take into account process factors that constrain and promote growth including soil fertility, temperature and soil water content.

	Tasks	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS	Budget shortfall US$
6.1	Review biomass measurements obtained from Indonesia's National Forest Inventory	Ministry of Forestry		20,000	Y	0
6.2	Develop methods to distinguish areas of regrowth using remote sensing techniques	Ministry of Forestry and		100,000	N	100,000

		Ministry of Agriculture				
6.3	Develop survey techniques to access local knowledge on the relevant proportions of areas allowed to regrow or are regrowth that is recleared	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.4	Identify the different decay rates for carbon release from biomass with different clearing techniques.			50,000	N	50,000
6.5	Identify the proportion of clearing by different techniques	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.6	Develop predictive methods for establishing likely biomass removed with previous land clearing	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.7	Develop a suite of growth models for annual increments in biomass accumulation	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.8	Measure the carbon content of below ground woody biomass	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.9	Derive a regional and representative suite of allometric equations to develop GHG emission estimates from biomass measurements.	Ministry of Forestry and Ministry of Agriculture		300,000	Y	0
6.10	Develop a suite of aboveground and belowground biomass decay rates which relate to climate and wood properties	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
6.11	Identify a series of possible environmental classifications which	Ministry of		50,000	N	50,000

	can potentially explain variations in biomass accumulation and plant biomass partitioning.	Forestry and Ministry of Agriculture				
6.12	Identify the proportional allocations and track the life cycle of wood products within each pool.	Ministry of Forestry and Ministry of Agriculture		50,000	N	50,000
	Total budget			**$870,000**		**$550,000**

7. Tree parameters

Objectives

- To understand partitioning of tree biomass into different components to allow for differential rates of growth, turnover and decomposition and management impact.
- To derive estimates of stem volume for comparison to available stem volume based plot (measured) data.

	Tasks	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS**	**Budget shortfall US$**
7.1	Develop sampling and measurement protocols for systematic tree biomass collection	Ministry of Forestry		$20,000	Y	0
7.2	Initiate a range of studies on partitioning of growth, tree carbon content and wood density to consolidate information and identify information gaps	Ministry of Forestry		$50,000	N	$50,000
7.3	Initiate a range of studies to fill information gaps.	Ministry of Forestry		$50,000	N	$50,000
	Total budget			**$120,000**		**$100,000**

8. Forest parameters

Objectives

- To estimate the amount of carbon stored in forest litter, including rates of decomposition and accumulation
- To associate land cover change events with relevant forest types.

	Tasks	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS	Budget shortfall US$
8.1	Establish a National Vegetation Information System that collates and provides, in a consistent taxonomy and classification, the best available vegetation maps from all available sources.	Ministry of Forestry		$50,000	N	$50,000
8.2	Develop a model to estimate carbon stored in the forest litter of different vegetation types.	Ministry of Forestry		$50,000	N	$50,000
8.3	Develop a model to estimate rates of decomposition and accumulation of different vegetation types.	Ministry of Forestry		$50,000	N	$50,000
	Total budget			**$150,000**		**$150,000**

9. Soil carbon

Objectives

- To provide mapped estimates of 'pre-disturbance' soil carbon contents using standardized research and inventory data.
- To improve understanding about GHG fluxes from tropical peat soils after disturbance.
- To develop a calibrated and verified soil carbon model capable of fine-scale temporal and spatial application.

	Tasks	Responsible agency	Priority	Estimated Cost US$	Overlap with FRIS and KFCP	Budget shortfall US$
9.1	Compile and improve spatial data on all soil types (including peat soils) and develop soil type maps for the archipelago.	Ministry of Agriculture, Forestry and Transmigration		$300,000	Yes	$200,000
9.2	Compile data on the properties and depth of peat soils.			$300,000	Yes	0
9.3	Calibrate and verify a robust and widely applicable soil carbon models to perform spatially and temporally disaggregated	Ministry of Agriculture,		$200,000	Yes	$50,000

	accounting for soil carbon	Forestry and Transmigration				
9.4	Identify any difference in the rates or total change in soil carbon content with method of land clearing or land use (i.e. use of fire, compressing peat, draining peat etc)	Ministry of Agriculture, Forestry and Transmigration		$200,000	No	$200,000
9.5	Calibrate and verify robust and widely applicable soil carbon models to estimate CO^2 N^2O and CH^4 emissions arising from peat fires, oxidation or other types of disturbance.	Ministry of Agriculture, Forestry and Transmigration		$300,000	Yes	0
9.6	Establish a program of paired measures to plot the time course of soil carbon loss, the time to equilibrium and the residual soil carbon contents. This should also provide additional samples to support estimates of pre-clearing soil carbon contents in areas affected by land clearing.	Ministry of Agriculture, Forestry and Transmigration		$100,000	No	0
	Total budget			**$1,400,000**		**$450,000**

10. Modeling

Objectives

- To provide a suite of calibrated and verified models for biomass, litter and soil carbon modeling in a spatial GIS framework which includes multi-temporal remotely sensed land cover change data.
- To provide an integrated yet flexible model capable of accepting a range of available inputs (and input types) and able to perform both point-based, aspatial area-based estimate and full spatial accounting.

	Tasks	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS /KFCP**	**Budget shortfall US$**
10.1	Develop a Carbon Accounting Model for Agriculture to provide	Ministry of		$100,000	N	$100,000

	capacity for both project and nation-wide scale carbon accounting for agriculture.	Agriculture				
10.2	Develop a Carbon Accounting Model for Forestry to provide capacity for both project and nation-wide scale carbon accounting for forestry.	Ministry of Forestry		$100,000	Y	0
10.3	Develop a microbial decomposition model to consider the environmental and biological drivers of microbial activity, namely temperature, moisture and substrate quality.			$100,000	N	$100,000
10.4	Develop a soil carbon model for mineral and peat soils.			$100,000	Y	0
10.5	Develop a forest productivity index to predict indices of forest growth, potential biomass at maturity and rates for biomass increment.			$100,000	N	$100,000
10.6	Develop models to predict future planned and unplanned deforestation.			$100,000	Y	0
10.7	Develop a Full Carbon Accounting Model that can deal with both the biological and management processes which affect carbon pools and the transfers between pools in forest, agricultural, transitional (afforestation, reforestation and deforestation) and mixed (e.g. agroforestry) systems.			$150,000	Y	$50,000
	Total budget			**$750,000**		**$350,000**

11. Information management

Objectives

- To facilitate multi-agency cooperation and sharing of information.
- To facilitate systematic collection and storage of information from multiple agencies.

	Tasks	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS /KFCP**	**Budget shortfall US$**
11.1	Develop standard protocols to store, archive and share information about central government departments and with			$200,000	Y	0

	provincial and district government departments.					
11.2	Develop relationships with national, provincial and district agencies to ensure that the NCASI is able to compile and analyse all relevant information.			$50,000	N	0
11.3	Work with other central, district and provincial agencies to identify possible datasets and projects of interest to NCASI.			$50,000	N	0
11.4	Construct a dynamic, robust and flexible geodatabase to store information in a systematic fashion. Ensure that the geodatabase is compatible with the FRIS geodatabase and geodatabases developed by other government departments and able to accommodate changes in method, data format and structure.			$200,000	Y	$150,000
11.5	Develop a disclosure policy in line with Indonesia's Freedom of Information Act			$100,000	Y	$80,000
11.6	Release spatial and statistical data deemed appropriate for public consumption on CDs and websites.			$100,000	Y	$80,000
	Total budget			**$700,000**		**$310,000**

12. Communication

Objectives

- To raise awareness about climate change and REDD.
- To raise awareness about the NCASI and its outputs.

	Tasks	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS /KFCP**	**Budget shortfall US$**
12.1	Report to the UNFCCC GHG emissions resulting from land use change and efforts to reduce emissions via REDD initiatives.			$30,000	Y	$30,000
12.2	Increase understanding about greenhouse gas emissions resulting from land use change.			$100,000	N	$100,000
	Increase understanding about REDD.			$100,000	N	$100,000

12.3	Develop communication and understanding between central government departments and district and provincial agencies.			$200,000	Y	0
12.4	Raise awareness about the need for a NCAS and its objectives among the general public.			$100,000	N	$100,000
12.5	Publish material in external newsletters and journals			$100,000	N	$100,000
	Total budget			**$730,000**		**$430,000**

13. Research

Objectives

- To improve Indonesia's capacity to develop credible estimates of land based emissions and sinks

	Tasks	**Responsible agency**	**Priority**	**Estimated Cost US$**	**Overlap with FRIS /KFCP**	**Budget shortfall US$**
13.1	Improve understanding about GHG emissions released from forest degradation			$200,000	Y	$200,000
13.2	Improve understanding about the carbon balance of industrial timber plantations and how they compare to natural forests in Indonesia			$100,000	N	$100,000
13.3	Evaluate the potential of Alos Palsar to provide disturbance and degradation information			$200,000	Y	$200,000
13.4	Carry out a pilot for optical/radar time series covering a range of forest types to determine what Alos Palsar and optical can and can not do with land use change			$200,000	Y	0
13.5	Evaluate integration of Alos Palsar with time-series Modis and SPOT vegetation			$200,000	N	$200,000
13.6	Evaluate integration of Modis with Landsat			$200,000	N	$200,000
13.7	Determine if remote sensing can be used to estimate peat depth			$100,000	Y	0
	Total budget			**1,200,000**		**$900,000**

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Total budget for the NCAS: $US12,000,000

Total budget shortfall for activities covered by the FRIS: $US4,395,000