Document No.:

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

PROJECT DOCUMENT

Improving capacities towards reducing greenhouse gas emissions from peat swamp forest fires in Indonesia (2018P5-IND)

[Supervisory Agency Ministry of Environment and Forestry]

Forest Research and Development Center, Forestry and Environment Research Development and Innovation Agency, Ministry of Environment and Forestry

01 January 2019 -20 December 2021

Basic Information

Project title(ID)	Improving capacities towards reducing greenhouse gas emissions from peat swamp forest fires in Indonesia (Project ID 2018P5-IND)
Supervisory agency	Ministry of Environment and Forestry
Executing agency	Forest Research and Development Center, Forestry and Environment Research Development and Innovation Agency, Ministry of Environment and Forestry
Implementation agency(ies)	The University of Melbourne
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Target area(s) Indonesia. The project will provide both an improved empirical basis (experimental sites in Kalimantan) for reducing greenhouse gas emissions from degraded peat swamp forest areas and an increased capacity from local village scale through to government agency level for reducing emissions.	
Project implementation duration: 01/2019 to 12/2021, 36 months	
Total budget(USD)	**498,170**
APFNet grant(USD)	**199,990**
Counterpart contribution (USD)	**298,180** **(made up of Cash AUD 100,000 and In-kind USD 228,180)**

Project summary:

(1) Problems/issues to be addressed:

Tropical peatland is an area of high carbon density and plays an important role in carbon-gas land-atmosphere interactions. Indonesia has by far the largest share of the tropical peat forest carbon pool (estimated at 57 Gt or 65% of the total), yet it also experiences the most rapid degradation of its peat swamp forests due to strong economic and social pressures for timber and land for agriculture and plantations. Clearance and drainage of peat swamp forests over recent decades has resulted in an unprecedented increase in peat fires, with smoke and pollution affecting not only Indonesia but all south-eastern Asia. Indonesian peat fires in 1997-98 released about 1 Gt carbon (C), which was equivalent to about 15% of global fossil fuel emissions at the time. Currently, emissions from drained and burnt peatlands contribute 2 Billion tCO_2 per year and account for 5% of the global carbon budget. It is obvious that peat fires have the potential to contribute significantly to global emissions of greenhouse gases (GHG). Peat fires are generally dominated by smoldering combustion, a flameless form of combustion that occurs more readily than flaming combustion. Smoldering fires can persist under low temperatures, high moisture content and low oxygen concentrations and as a result can burn for weeks or months despite rain events or changes in fire weather. Smoke produced by smoldering leads to regional haze and greater emission of methane, volatile organic compounds and particulate matter than flaming combustion. Smoldering of peat fires has significant ramifications for human health and for regional economies through disruptive smoke and haze. Despite strong international commitments to address emission from peat fires, the quantity of peat fire derived emissions, the amounts emitted under different flaming and smoldering phases are poorly understood. Our previous study found that emission estimates can be of threefold difference if smoldering and flaming phases are accounted separately. Fuel loads, burning efficiency of those fuels and emission factors (i.e. amount of gas emitted per amount of fuel burnt) are the main components of the emission estimation. Currently only a handful of studies exist on fuel loads for peat swamp forests making emission estimates highly uncertain. Lack of knowledge on how different fuels contribute to the emission and smoke production makes it very difficult for the Agencies to address the issue of GHG emissions and develop well-targeted policy for emission reduction. In a carbon sensitive environment, when economies and local communities can be financially rewarded for reducing GHG emissions, accounting for C redistribution can become critical for ecosystem service payments.

(2) Goal(s) and objectives:

The main goal of this project is to improve the capacity of forest managers, local communities and policy makers in Indonesia to develop robust strategies to reduce GHG emission from fires in peat swamp forests. The objectives are to:

1. Develop a baseline of GHG emissions from peat swamp forests of different degradation stages by empirically measuring fuel loads in fine and coarse size categories and determining combustion factors for each size class;
2. Identify drivers of emissions from PSF fires;
3. Develop the methodology for reducing GHG emissions based on the knowledge accrued in the project.

(3) Expected outputs/outcomes and key activities:

Expected outputs/outcomes:

1. Improved estimates of GHG emissions (CO_2 and non-CO_2) from peat swamp forest fires based on comprehensive field measurements;
2. An updated methodology on estimating GHG emissions from PSF for Indonesia's international reporting;
3. A set of recommendations for reducing GHG emissions from forest fires;
4. High quality peer-reviewed publications making results of the project transparent and readily available for international reporting and verification under the UNFCCC requirements for the result-based payments on emission reduction.

Key activities:

1. Comprehensive literature review, development of a statistically robust experimental design, measurement of fuel loads and pyrogenic carbon in the field;
2. Data analysis of the relationship between fire intensity and fuel consumption and emission release;
3. Development of policy recommendations for emission reduction in PSFs based on the results of the field study.

(4) Target group:

Forest management units, Ministry of Environment and Forestry and other land management agencies

(5) Potential beneficiaries and main stakeholders:

The main stakeholders are the Indonesian Ministry of Environment and Forestry, the local communities and the land management units where the project will be conducted. Direct beneficiaries will potentially include all the people negatively impacted by smoke and haze from peat fires in the region and indirectly people in similar ecosystems globally that benefit from new knowledge generated in this project.

(6) Methodology and approaches:

This project will establish well-replicated field experiments that include intact peat swamp forest (PSF) and degraded PSFs at various stages of degradation on one major island of Indonesia – Borneo (Central Kalimantan). Measured site characteristics will include biomass above and below ground to derive heavy (coarse) and fine fuel mass and careful sampling of residues after fire to determine conversion to gaseous emissions and the production of pyrogenic carbon. Overall the objective is to derive a more detailed picture of biomass transformation, the creation of pyrogenic carbon and losses of carbon from PSF sites throughout advancing stages of their conversion from intact forest to developed agricultural land use. The project will also determine the burning efficiency of coarse and fine fuel types and emission factors in flaming and smoldering combustion. The smoldering and flaming emission will be measured opportunistically during fires as well as in the laboratory environment. These measurements will enable more accurate estimations of fire impacts on carbon cycling and emissions in these PSF systems.

(7) How the project could be sustained:

The interaction between researchers, forest managers, local communities and government agencies through this project will increase understanding of the key drivers of emissions from peat swamp forest degradation and improve the science that will lead to better formulation of policies effective in reducing emissions. This, in turn, will result in changes to policy and legislation, may enhance the adoption of best practices, and foster better forest law enforcement and governance.

Abbreviations and acronyms

GHG – Greenhouse gas
CO_2 – Carbon dioxide
MoEF – Ministry of Environment and Forestry, Indonesia
PSF – Peat swamp forest
UoM – the University of Melbourne, Australia
SEFS- School of Ecosystem and Forest Sciences of The University of Melbourne
FREL - Forest Reference Emission Level
INCAS- Indonesian National Carbon Accounting System, http://www.incas-indonesia.org/

Project details

1. Background and Rationale

Indonesia has the largest share of the tropical peat forest carbon pool (estimated at 57 Gt or 65% of the total), yet it also experiences the most rapid degradation of its peat swamp forests (PSFs) due to strong economic and social pressures for timber and land for agriculture and plantations. Clearance and drainage of PSFs over recent decades has resulted in an unprecedented increase in peat fires, with smoke and pollution affecting not only Indonesia but all south-eastern Asia. Indonesia has developed a National Carbon Accounting System (INCAS) for estimating GHG emissions from forests and peatlands, including peat swamp forest fires. A particular challenge with PSFs is determining fuel loads and fuel type (coarse and fine) available for combustion. To make progress with emissions estimates the INCAS has adopted fuel load estimates that are calculated from peat bulk density and peat depth. This method does not allow for the presence of heavy fuels in the calculation of emissions. Heavy fuels, such as woody debris and uplifted tree roots are left on the ground after clearance of PSFs. These heavy fuels are considered to be critical to the development of deeper peat fires that smolder for weeks or months; they also release more potent gases than fine fuels and produce heavy smoke. Field data of heavy fuel loads in PSFs in Indonesia is limited to a few studies with only the small diameter heavy fuel category (<4 cm diameter) accounted, or with estimates only of volumes of heavy fuels. The combustion of heavy fuels directly relates to fire severity such that lower intensity fires will combust a smaller proportion of heavy fuels and will create greater loads of pyrogenic carbon (char) that will remain in the peat soil for many years. Understanding how fire intensity affects combustion of heavy fuels and production of char will help to develop policy incentives for more appropriate burning regimes to reduce emissions.

Emissions from biomass burning are calculated as the product of area burnt (Area), fuel load (Fuel Load), a combustion factor (CF) and the emission factor specific for each gas (EF): *Emission i = Area x Fuel Load x CF x EFi (Eq.1).*

Fuel Load and ***CF*** remain highly uncertain for Indonesian PSFs and directly influence emission estimates. By addressing this knowledge gap this project will help to improve our understanding of GHG emission from peat swamp forests and the actions needed to reduce GHG emissions and smoke haze.

Kalimantan on the island of Borneo, with about 4.78 million ha (32%) of Indonesian peatlands area, is selected for potential study sites in Indonesia. Currently, emissions from drained and burnt peatlands contribute 2 Billion tCO_2 per year and account for 5% of global carbon budget. Understanding what parameters contribute the most to the

emissions and developing methodologies for reducing GHG emission from peatland fires will have a strong impact on people's health and on regional economies.

At present, Indonesia doesn't report emissions from PSF fires due to high levels of uncertainty and low quality of the data. Being a Tier 1 economy for biomass burning emission reporting it's assumed that all carbon stocks will be emitted, making emissions estimated from PSF fires unrealistically high. Recent research indicates that a proportion of carbon stock that is otherwise assumed to be released into the atmosphere is transferred from biomass to residue pools. In addition, current emission estimates from fires report only CO_2. The contribution of the high global warming potential methane (CH_4) and nitrous oxide (N_2O) also need to be accounted for developing a reliable baseline of PSF emissions.

The proposed project addresses the significant problem of smoke and GHG emissions from fires in degraded PSFs and aims at developing robust methodologies for estimating GHG emissions and improved and more realistic emissions estimates that will then improve policy for reduction of emissions from PSF fires. The project will build the capacity of forest managers, local communities and policy makers to understand the drivers of GHG emissions that is crucial for developing best practices and policies for emission reduction.

This project addresses the APFNet priority and objective "to promote sustainable forest management to enhance ecological functions and ecosystem security of forests". The clearing, draining and burning of peat swamp forests is a major form of forest degradation and contributor to GHG emissions to the atmosphere. There are serious gaps in knowledge of fire impacts on peat swamp forest carbon pools so that emission estimates are highly uncertain and as such are not included in Indonesian reporting to UNFCCC. This project will measure and describe PSF above- and below-ground carbon pools in accordance with IPCC recommendations. Peat swamp forests that are intact, degraded and burnt once, and degraded and burnt several times will be assessed for above- and below-ground fuels according to size class including heavy or coarse (logs left after clearing), fine (litter) and soil peat. The project will estimate forest and peat-fire emissions of CO_2 and the non-CO_2 gases methane and nitrous oxide, providing more accurate emission estimates for these forests than have been attempted to date. A further objective of this project is to describe the GHG emissions resulting from burning practices at different stages of PSF conversion to plantation or other land use and different fire intensities. By better describing the risks of GHG emissions associated with the burning applied at different stages of forest conversion and fire intensities, forestry policies and management actions can be targeted to reduce carbon losses.

The project will be a natural evolution in the development of more accurate reporting under Indonesian's international requirements and in the development of policies to reduce GHG emissions from peat forest fires, thus providing a basis for interventions to improve air quality at local and regional scales.

2. Goal(s) and Objectives

The main goal of this project is to improve the capacity of forest managers, local communities and policy makers in Indonesia to develop robust strategies to reduce GHG emissions from fires in peat swamp forests.

Specific objectives of this project include:

- Improve the knowledge base of fuel loads (fine and heavy) and their characteristics in peat swamp forests at different stages of degradation;
- Further develop the knowledge base of peat soil carbon and char production during fires;
- Develop parameters for better and more accurate estimates of GHG emissions (CO_2 and non-CO_2) from peat-fires for inclusion in Indonesia's reporting of Forest Reference Emission Level (FREL) to the UNFCCC;
- Build and extend the scientific basis for developing adaptive management options and enhance the capacity in decision making for GHG emission reduction from peat-fires;
- Expanding network and capacity building through workshops, communications and policy notes to further enhance the information sharing and technology transfer.

3. Outputs and Activities

Output 1: Developing a baseline of GHG emissions from peat swamp forest fires

Accurate estimates of fuel loads (fine and heavy) and their burning efficiency are required to develop a baseline of current GHG emissions released from PSFs fires. At present, Indonesia doesn't include emissions from PSF fires in its international reporting of GHG emissions due to the low quality of the data and high levels of uncertainty.

Activity 1.1: Comprehensive literature review

Scientific publications and gray literature (i.e. industry, project and research reports) related to fire emission measurements from PSF fires will be reviewed to establish knowledge gaps.

Activity 1.2: Establishment of field sites and data processing

Plots representing four treatments (intact, degraded-not burnt, degraded and burnt once and degraded and burnt multiple times) with 3 replicates and 10 plots each (120 plots total) will be established for field activities in Kalimantan after consultation with the local representatives. Fire and site history data will be accessed using governmental resources and remote sensing information (MODIS, Landsat).

Sampling design will be adopted from the Working Paper # 221 "Protocols for the measurement, monitoring, and reporting of structure, biomass, carbon stocks and greenhouse gas emissions in tropical peat swamp forests". In brief, a circular sampling plot 0.03 ha will be established along a 250 m transect, all trees with diameter at breast height >5 cm will be measured within a 10m radius plot and identified for tree species; two 12 m line transects will be established for measurements of coarse woody debris [CWD] - heavy fuels and 0.1 m^2 frames will be used for destructive sampling of fine fuels (litter and twigs); soil samples will be extracted using soil cores after collecting fine fuels from the ground. Peat soils, fine and heavy fuels and tree core samples will be processed in the laboratory for estimation of fuel dry mass, carbon content, peat bulk density, mass of char and tree density.

Activity 1.3: Developing the baseline of emissions from PSFs fires

Findings from the field measurements will form a dataset to develop a baseline of the GHG emissions from PSF fires. Stock difference between fuels (fine and heavy) will be used to estimate burning efficiency of fuels at different fire regimes and forest degradation. Major GHG emissions including CO_2 and non-CO_2 gases will be estimated.

Output 2: Understanding the main sources of GHG emissions from PSFs fires

Activity 2.1: Analysis of the sources of GHG emissions by fuel type and forest degradation stage

Findings from the field measurements and different treatments will be assessed for the sources of GHG emissions in PSFs fires. Emission from each fuel type at all forest degradation stages will be analyzed and the most significant sources will be identified using robust statistical techniques.

Data analysis and modelling of the main sources of GHG emissions will be developed i.e: the contribution of major gases (CO_2, CH_4, N_2O) to GHG emissions; the biomass source of these emissions (fine or coarse fuels); how does fire intensity and fuel moisture influence GHG emission estimates and char production; how does forest degradation affect GHG emission estimates; and how does carbon re-distribution and char production affect both GHG emission and ecosystem carbon sequestration.

Activity 2.2: Identification of possible strategies for emission reduction

Findings will be presented and discussed with the relevant stakeholders (MoEF, local government) for capacity building first in terms of understanding the results and their implications for management, and second to develop strategies to reduce GHG emissions in discussion with the relevant stakeholders.

Output 3: Analysis of the proposed changes and development of policy recommendations

One of the ultimate objectives of this project is to facilitate the scientifically credible evaluation of change in management strategies for reducing GHG emission from PSFs fires. This will be achieved by comparing the impact of changes to forest management and business as usual scenarios on emission estimates (a trade-off analysis).

Activity 3.1: Assessing the impact of changes

Changes in emission estimates will be assessed through model integration (comparing various scenarios of peatland emissions) and trade-off analysis. Findings will be presented and discussed with the MoEF and local government for capacity building in

understanding the results and steps to implementation of changes in forest management. Once possible strategies for emission reduction are identified (for instance, modelling showed that coarse fuels produce more emission than fine fuels and it's recommended to avoid ignition of coarse woody fuels), this recommendation will be discussed with local foresters in the peatland areas and with the policy decision makers at the Ministry for feasibility of implementation. Cost analysis will be performed to identify if resources (human, time, finances) involved in emission reduction actions are greater than benefits for emission reduction under REDD+ agreement.

Activity 3.2: Developing policy recommendations

Based on the outcomes of the discussions with relevant stakeholders, most appropriate and practically feasible recommendations for emission reduction from PSF fires will be developed.

Model integration and trade-off analysis will allow MoEF staff to understand the consequences of moving to a higher Tier in reporting emissions from peat fires (currently Indonesia uses Tier 1, the IPCC default parameters, for reporting GHG emissions from forest fires, while the data from this project will allow Indonesia to move to a higher Tier in reporting emissions using economy-specific data, [i.e. Tier 2]). Based on the results of trade off analysis, and after consultation with staff at peat land locations and the Ministry (capacity building element of the project), policy recommendations will be developed for reduction of GHG emissions from PSFs fires.

Output 4: Capacity building

A comprehensive network involving scientists, policymakers and stakeholders will be extended and the capacity of the stakeholders will be enhanced through a set of approaches in this project. In particular, the capacity of government officials and local forest managers will be enhanced in the area of policy making related to emission reduction using the methods described below.

Discussions with local government and forestry representatives are included in each 10-day field trip and the employment of local people is included in the field trip budget as a "local staff support" component. Employing and training local people for field measurements will provide them with general forest inventory skills and improve local community knowledge and capacity for understanding sources of GHG emissions. The project also includes laboratory analysis and sample preparation which will be carried out by local staff and included in the budget as "cost per sample".

Activity 4.1: Workshops

An inception workshop will be held at the beginning of the project. Two training workshops will be held for government officials and local forest managers on project progression and application of recommendations for emission reduction throughout the project duration. We anticipate the involvement of local government, local communities and forestry workers in the project from the project initiation stage, mid-stage and final stage through a series of meetings and briefings including the development of manuals for applying field sampling methodologies. Technical notes will be developed based on the outcomes of the training workshops and the networking activities.

Activity 4.2: Research Higher degree students training

This activity is designed to train next generation foresters who will be able to apply SFM knowledge to forest management practices. This project aims at supporting 1 PhD student to regularly visit Australia and to attend one international conference for ideas exchange and capacity building. The PhD student will be fully supported by the University of Melbourne via fee remission scholarships.

Activity 4.3: Conferences and publications

The project achievements will be presented at regional and international conferences. Scientific papers will be published in peer-reviewed journals to facilitate reporting and verification process for Indonesia reporting its GHG emissions from PSF fires under the international requirements.

Activity 4.4: Staff exchange

The project aims at hosting staff from the Indonesian MoEF at the UoM facilities for capacity building, data analysis and publication writing.

4. Risks and Assumptions

In general, this project is low to medium risk. The major objective of this project is to develop a robust dataset of fuel loads for the inclusion of GHG emissions from peat-fires into Indonesia's FREL. Accessibility of peatlands and potential risk of wildfires before or during project implementation may seriously affect completion of the project on time. We will access and summarize all previously collected data from economy inventory reports and unpublished sources as the first stage in building a database of emissions from prolonged fire.

5. Institutional Management and Communication

Dr Kirsfianti Ginoga will be the Project Director. Currently she is the Director at the Forest Research and Development Center, Indonesian Ministry of Environment and Forestry. Prior to this position, she acted as the Director of Research and Development Center for Climate Change and Policy and the Director of GHG Inventory and MRV within the Directorate General of the Climate Change, MoEF.

Dr Haruni Krisnawati will be the Project Coordinator. Dr Haruni is a Senior Researcher at the Forest Research and Development Center, Indonesian Ministry of Environment and Forestry. She leads the research group on forest assessment and biometrics within the center. She is also leading the technical development of the Indonesian National Carbon Accounting System (INCAS) – a system for accounting GHG emissions and removals to support GHG Inventory and Measurement, Reporting and Verification (MRV) requirements for the forest sector in Indonesia.

Dr Liubov Volkova and **Dr Chris Weston** will be engaged as project international experts responsible for the capacity building and supporting MoEF throughout the project implementation. Dr Volkova is a Research Fellow at the UoM and has strong expertise in forest inventory, bushfire fuels, forest fire emissions and carbon accounting. Dr Weston is a Senior Lecturer at the UoM and has expertise in forest soils, greenhouse gas emissions and biomass sampling. He has over two decades of experience leading and

delivering on research projects funded by a range of national and international mechanisms. Dr Weston has close links with several forestry schools throughout the region and will draw on this network for the extension of results to a broader area within the region.

Dr Volkova will work closely with Dr Krisnawati (Project Coordinator) in the day to day supervision of all aspects of the project including pre-study and project design. Dr Volkova will be a supervisor of all field sampling and related activities including site selection, sampling of field sites, data curation and analysis, interpretation, preparation and write up of results for submitting to peer-reviewed journals. The consulting cost is split 1/3 to APFNet and 2/3 to counterpart cash contribution. Dr Weston will provide in-kind contribution to the project committing 0.35 FTE of his time.

To ensure efficient and effective project implementation, a project steering committee consists of multiple stakeholders, i.e. officials from MoEF, UoM, DoEE will be convened annually to provide supervision and recommendations.

Good communication with project stakeholders and other implementing partners will be kept over project implementation via series of workshops and meetings (online and face to face). The project management structure and communication mechanism are illustrated in Annex B and C.

6. Project resources and financial management

For the detailed budget, please refer to Annexes F and G. UoM would like to contribute USD170,000 in-kind to the research and AUD 100, 000 cash (equivalent to approximately USD 70,000) provided by the Australian Government. MoEF is contributing USD30,000 in kind to the research. Being very important to our Asian outreach and extension, UoM and MoEF fully support APFNet and its vision of sustainable forest management in the Asia Pacific region. UoM has a rigorous financial management system controlled centrally by professional accountancy staff, and an effective financial and research management control framework for the monitoring of the use of the funding. The project will follow systematic approaches to project management, including reporting, review, monitoring and evaluation, and these will be adopted by the collaborating agencies to ensure the successful implementation of the project. The project team will follow the established procedures of annual plans, bi-annual progress reports, quarterly review, and monthly project meetings and video conferencing to identify any gaps between the actual and the planned situations. Timely corrective actions will follow to ensure the efficiency and effectiveness of project implementation and to achieve the ultimate objectives of the project.

Throughout the project implementation, annual work plans will be developed to provide

detailed information about project planning and other issues. Biannual and Annual Progress Reports will be prepared covering the expenditures, progress, and achieved outputs according to the annual plan in the middle and at the end of each project year. A Financial Audit Report will be submitted by EA to APFNet to indicate the opening balance, expenditure incurred to date, and the closing balance for the project account. Upon completion of the project, EA will make a completion report to summarize the activities, inputs, expenditures, achieved outputs and objectives during the entire implementation phase and will identify any major differences between planned and realized budgets.

7. Monitoring and evaluation

When the project is initiated a systematic and comprehensive approach including reporting, review, monitoring, and evaluation will be developed and adopted by the Executing Agency (MoEF). These approaches will also be applied to the Implementing Agency (UoM) to ensure the successful conduct of the project.

A monitoring system will be adopted to identify any gaps between the actual situation and the planned situation following the indicators related to each activity listed in the Logical Framework Matrix (Annex B). Corrective actions may be required to ensure the efficiency of project implementation and to avoid encountering unexpected delays in such areas as output delivery.

A periodic progress review (after the completion of each output) will be conducted by the MoEF to guarantee that the project implementation is on track to achieve the anticipated objectives, using the associated Logical Framework Matrix and work plan (Annex B). By actively interacting with the project staff involved in the project implementation, and by assessing the progress of the project according to the annual plan, recommendations and changes in actions will be suggested in order to better support the success of the project.

8. Dissemination, duplicability and sustainability

The key activity of this project is to improve capacity towards reducing GHG emissions from peat swamp forest fires in Indonesia. This will be achieved through a wider demonstration such as workshops, conferences, journal articles, and the Internet to disseminate the project results.

The scientific and application results should be widely disseminated to all stakeholders especially to strategic and decision-making bodies. We aim to work closely with APFNet to provide scientific support to other APFNet economies in Asia Pacific Region where forests fire is a significant problem (e.g. Nepal and Cambodia). We aim at taking advantage of APFNet activities such as workshops, conferences, seminars and training to

promote the application of the outcomes from this project.

The project outcomes will be published in scientific peer-reviewed journals and presented at the conferences and workshops. Several workshops at each stage of the project will be held for relevant stakeholders. Forest professionals attending the workshops will be expected to increase their knowledge regarding GHG emissions from forest fires and related management actions to mitigate emissions.

Potential recommendations and solutions will be discussed amongst the different stakeholder groups during workshops. The interaction between researchers and government agencies through this project will increase understanding and will lead to better formulation of scientific outcomes in policy making, which is often seen as inadequate. This, in turn, will result in changes to policy and legislation, may enhance the adoption of best practices, and may foster better forest law enforcement and governance.