LEDS GLOBAL PARTNERSHIP | Agriculture, Forestry and Land Use (AFOLU) Working Group

Regional Workshop
"Moving on From Experimental Approaches to Advancing National Systems for Measuring and Monitoring Forest Degradation Across Asia"

Workshop Report

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Bangkok, THAILAND

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USAID FROM THE AMERICAN PEOPLE | LEAF Lowering Emissions in Asia's Forests | European Commission | UN-REDD Programme | SilvaCarbon | SERVIR MEKONG

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Acronyms

ALOS	Advanced Land Observing Satellite
CLASLite	Carnegie Landsat Analysis System "lite" software package
CO_2	Carbon Dioxide
EC JRC	European Commission's Joint Research Centre
FAO	Food and Agriculture Organization of the United Nations
FRA	Forest Resources Assessment
FRL/FREL	Forest Reference Level/ Forest Reference Emission Level
GHG	Greenhouse gas
GIS	Geographic Information Systems
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GOFI	Global Forest Observations Initiative
GtC	Giga-tons of Carbon
IPCC	Intergovernmental Panel on Climate Change
LIDAR	Light Detection and Ranging
NFI	National Forest Inventory
QA/QC	Quality Assurance/Quality Control
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PNG	Papua New Guinea
ReCaREDD	Strengthening National and Regional Capacities for Reporting on the Mitigation Actions of the Forest Sector
REDD+	Reduced Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RS	Remote Sensing
SAR	Synthetic Aperture Radar
SPOT	Satellite Pour l'Observation de la Terre ("Satellite for observation of Earth")
tCO_2	Tons of Carbon Dioxide
UN-REDD	United Nations Collaborative Programme on REDD+
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USAID LEAF	USAID Lowering Emissions in Asia's Forests Program
USFS	United States Forest Service

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Executive Summary

From 16 to 18 June 2015, over 70 delegates and resource persons attended the regional workshop on *"Moving on From Experimental Approaches to Advancing National Systems for Measuring and Monitoring Forest Degradation Across Asia"*. Delegates attended from thirteen Asian countries to share their knowledge and experience with international delegates from Europe, North America, Latin America and Asia. The aims of the workshop were to:

- Build common understanding of the rationale for measuring and monitoring forest degradation, and using this to examine forest degradation definitions and issues of cost-effectiveness;
- Exchange country information on methodologies and technical approaches, their current operational status and utility for estimating GHG-emissions at the national level;
- Review international developments in measuring and monitoring forest degradation and opportunities for advancing country led efforts; and
- Complete a degradation measuring and monitoring decision framework that considers critical decisions, key components and resourcing (human and technical) necessary in developing a functional plan for measuring and monitoring forest degradation at the national level.

The first day of the workshop focused on the key question of 'why measure forest degradation?' The presentations and discussion considered the question from the perspective of international guidance provided by the UNFCCC and the IPCC and how degradation measuring and monitoring interacts with the establishment of forest reference levels. Discussion also considered the national policy perspective and the critical issue of forest degradation from a biodiversity perspective, and not simply a reduction in forest carbon stocks. Case studies from India and Vietnam detailed achievements and on-going challenges in designing nationally robust systems – a key theme of discussion throughout the workshop. Determining the significance of degradation also provided context to the question of 'why measure?' and therefore appropriately defining degradation becomes essential in determining significance. A recommended definition for degradation presented at the workshop was:

"the reduction in the forest carbon stocks by at least 10% and persisting for 5 years or more[1]."

Day two focused on data needs and approaches to measuring and monitoring forest degradation. Land-based or activity-based accounting approaches were debated, with most delegates agreeing that the development of National Forest Inventories (NFI) (that emulated a land-based approach) were necessary. However there was some agreement that the difficulty in measuring and monitoring forest degradation meant specific activity-based approaches may also have to be designed and incorporated into the NFI. Concurrent workshop streams reviewed recent advances in the use of medium and high resolution imagery. The decision on which imagery source is the most appropriate is dependent on national circumstances and the 'significance' of the degradation problem. Day two concluded by exploring recent advances in estimating greenhouse gas (GHG) emissions from shifting cultivation, selective logging (planned and unplanned) and fire.

[1] Goslee, K. *et al* 2015. Technical Guidance Series for the Development of a National or Subnational Forest Monitoring System for REDD+: Forest Degradation Guidance and Decision Support Tool. Developed by Winrock International and the United States Forest Service for the USAID LEAF program. Available at: http://www.leafasia.org/library/forest-degradation-guidance-and-decision-support-tool

On day three, country delegates considered critical decisions that must be made for the measurement and monitoring of forest degradation to be included in a national REDD+ system. A framework was circulated to guide this process, with the critical decisions mirroring the workshop structure: Degradation definition; Assessment of condition, including estimation of significance for each type of degradation; Monitoring design, including land based or activity based accounting, monitoring objectives and capacity assessment; Monitoring system including emission factor and activity data information needs; Data analysis; and Implementation roles and responsibilities. Country delegates reported back on their work and from this a number of common challenge and next-steps were identified.

All presentations and group discussion summaries from the workshop are available at: http://www.leafasia.org/events/moving-experimental-approaches-advancing-national-systems-detecting-measuring-and-monitoring

Challenges and On-going Actions

- Perceptions of significance and motivations for measuring and monitoring degradation are strong across the region. But there are few examples of a systematic approach to establishing a comprehensive system that is integrated within a national forest monitoring system. The degradation framework presented during the workshop offers countries a means to work through a number of critical issues as they determine a robust, yet cost-effective approach to measuring and monitoring emissions from forest degradation.
- Drivers of forest degradation are generally well understood, but impacts tend to be localized, subtle and spatially and temporally erratic. Debate emerged during the workshop on how shifting cultivation should be characterized. Further guidance on this subject, based on evidence, should help countries make more informed decisions on how to classify shifting cultivation.
- Good 'first order' degradation estimates data based on available global data sets were presented during the workshop. But further capacity is needed for countries to generate their own 'first order' estimates through such software as Collect Earth or CLASlite.
- The accounting approach taken will have a significant impact on the design of any measuring and monitoring plan. The pros and cons of a land-based or activity-based approach were explored during the workshop. Further guidance, however, would help countries decide which approach best suits their context and how the selected approach can be integrated into their FRL/FREL.
- Operational definitions of degradation have not been developed (with the exception of Malaysia's draft definition). But defining thresholds for measurement are essential. Countries should consider their existing or emerging definitions to ensure that thresholds for a percentage loss of carbon stocks over a set time are defined and that these definitions are consistent with REDD+ guidelines and country measurement objectives.
- All countries are now considering a combination of medium- and high-resolution remote sensing data and field data to measure emissions from forest degradation. But certainty levels will ultimately define if the data collected is sufficiently accurate for inclusion within a UNFCCC approved FRL/FREL. Countries need to better define certainty levels against which accuracy of estimates can be reported.
- To assist in reaching a desired level of accuracy, countries must also establish a robust and systematic Quality Assurance/Quality Control (QA/QC) process across all data collection, processing, analysis and reporting process – both for field data and remote sensing data.
- As indicated, all countries are now developing their FRL/FREL. Without consideration of the above issues, it will be difficult to see how countries can include emissions from degradation in their

FRL/FREL. As countries can take a step-wise approach to building and expanding a FRL/FREL, countries should also consider a similar approach to measuring and monitoring forest degradation. Further capacity building and support will be required, and the partners of this workshop (except for the USAID LEAF project) are all in a position to provide this required support.

- As many drivers of degradation are cross-border in nature (i.e. unplanned, selective logging) or common across Asia (i.e. fuelwood collection or planned, selective logging) a regional forest degradation working group should be set up to facilitate the sharing of knowledge on these issues. Developing a common framework for comparing emissions and the impact of drivers across the region could be a useful first task for this working group. This working group could be established as a sub-working group under the auspices of the AFOLU Working Group of the LEDS Global Partnership[2].

Measuring and monitoring forest degradation is difficult, with the expectation that considerable resources, often outside the scope of country resources, are required to achieve nationally robust estimates of degradation emissions. However the workshop was able to provide guidance on what is significant, what critical decisions must be made, and how resources could most effectively be used to develop up a national forest degradation measuring and monitoring plan to support both a FRL/FREL and a national forest monitoring system.

[2] Agriculture, Forestry, and other Land Use Working Group details available at: http://ledsgp.org/sector/AFOLU.

Background

There is an increasing recognition of the scale of forest degradation across Asia's forests. Preliminary or 'first order' estimates suggest that approximately 129 million tons of CO_2, or 39% of the total emissions from deforestation and forest degradation, are emitted annually from selective logging, fuelwood collection and fire from the four lower Mekong countries[3]. Globally, it is estimated that approximately 100 million hectares of forest are disturbed annually, which is nearly 10 times greater than the area impacted by deforestation[4]. In countries with relatively low emissions from deforestation (e.g. Republic of Congo and Guyana) emissions from selective logging have been estimated to be about a third or more of those from deforestation[5].

The recognition of the scale of greenhouse gas (GHG) emissions from degradation and decline in the diversity of Asia's forests has seen a corresponding increase in efforts to test methodologies for detecting, measuring and monitoring forest degradation through remote sensing, field surveys, proxies and modeling. But the task is challenging. Lack of clarity and consistency in definitions, a diversity of drivers with different temporal and spatial patterns, technical challenges associated with each driver, limited historical information and inadequate resourcing (financial and human) are some of the key impediments for the systematic inclusion of forest degradation emissions in national GHG inventories.

While some National Forest Inventories (NFIs) (notably India and Vietnam) do include an assessment of change in forest 'quality', the majority of methods currently employed to measure and monitor degradation are still exploratory or limited in geographical size and scope. Discussion around these approaches also tends to be based on technical inputs and data accuracy and validity rather than issues of cost-effectiveness, a country's desire or rationale for measuring forest degradation and how degradation is operationally defined.

Nevertheless, these efforts are important and advances are being made. In November 2012, the USAID Lowering Emissions in Asia's Forest (USAID LEAF) project and the United States Forest Service (USFS) convened an international workshop[6] to take stock on approaches and on-going challenges to measuring forest degradation in Southeast Asia. Since then, there have been considerable developments in the science and practice of measuring and monitoring forest degradation. Yet there is much to be done before all Asian countries can critically evaluate the need for measuring forest degradation and designing and then resourcing a nationally appropriate forest degradation measuring and monitoring plan.

To overcome this challenge, exchange knowledge and information and identify critical issues in moving forward, the USAID LEAF program together with the United States Forest Service, the European Commission's Joint Research Centre's, the UN-REDD program, SilvaCarbon, and SERVIR Mekong organized a

[3] Goslee, K. *et al* 2015. Technical Guidance Series for the Development of a National or Subnational Forest Monitoring System for REDD+: Forest Degradation Guidance and Decision Support Tool. Developed by Winrock International and the United States Forest Service for the USAID LEAF program. Available at: http://www.leafasia.org/library/forest-degradation-guidance-and-decision-support-tool

[4] Herold, M., R.M. Roman-Cuesta, D. Mollicone, Y. Hirata, P. Van Laake, G.P. Asner, C. Souza, M. Skutsch, V. Avitabile, and K. MacDicken. 2011a. Options for monitoring and estimating historical carbon emissions from forest degradation in the context of REDD+. Carbon Balance and Management, 6:13. Available at http://www.cbmjournal.com/content/6/1/13

[5] Pearson, T.R.H., S. Brown and F.M. Casarim. 2014. Carbon emissions from tropical forest degradation caused by logging. Environmental Research Letters, 9. Available at http://iopscience.iop.org/1748-9326/9/3/034017

[6] The 2012 workshop report and presentations can be accessed at: http://www.leafasia.org/events/degradation-regional-workshop or http://www.treesearch.fs.fed.us/pubs/44752

regional workshop on *"Moving on From Experimental Approaches to Advancing National Systems for Measuring and Monitoring Forest Degradation Across Asia"* on June 16 to 18 2015 Bangkok, Thailand. The workshop brought together over 70 delegates from 13 Asian countries and international resource persons to discuss and debate current forest degradation measuring and monitoring approaches and their utility for cost-effectively reporting at a national level. The structure of the workshop encouraged consideration of this issue through both small group country work, expert presentation and the completion of a framework that could form the basis of a national degradation measuring and monitoring plan.

Workshop Objectives

The objectives of the workshop were to:

- Build common understanding of the rationale for measuring and monitoring forest degradation and using this to examine forest degradation definitions and issues of cost-effectiveness;
- Exchange country information on methodologies and technical approaches, their current operational status and utility for estimating GHG-emissions at the national level;
- Review international developments in measuring and monitoring forest degradation and opportunities for advancing country led efforts; and
- Complete a degradation measuring and monitoring decision framework that considers critical decisions, key components and resourcing (human and technical) necessary in developing a functional plan for measuring and monitoring forest degradation at the national level.

Key Findings

The following sections summarize key information and findings from the workshop.

Why Measure Forest Degradation?

In the context of the workshop, the question of why measure forest degradation was focused on national Greenhouse Gas (GHG) reporting requirements from the forest sector under the UNFCCC. GHG emissions from forest degradation are significant, accounting for 0.6–1.5 GtC per annum, equating to a range of 6-14% of all anthropogenic carbon releases, or 25-60% of all forest sector emissions (higher estimates have been reported)[7]. Combined with deforestation, the forest sector is contributing 14-21% of all carbon emissions to the global GHG balance.

However this single response ignores other equally valid reasons for considering forest degradation, including:

1. Management of nationally and locally significant natural resources and ecosystems and the current and future economic benefits that can gained from sustainable forest use.
2. Financial resources including: i) revenue and economic growth generated from legal log extraction, ii) revenue lost from illegal extraction and non-payment, or underpayment of permits, royalties and taxes, and iii) reduced revenue (for citizens) through emerging Payment for Environment Services schemes.

[7] Lawrence, Deborah., *Why Worry About Forest Degradation? Multiple Perspectives and Multiple Dimensions,* 2015 workshop presentation: http://www.leafasia.org/library/multiple-perspectives-and-multiple-dimensions

3. Management of localized climate effects through the evaporative (cooling) effect and rainfall patterns of large, intact forest estates.
4. Management of the global climate mitigation actions and by association, the potential for results-based payments.

"Why measure forest degradation?" was generally easily articulated by country delegates (see Table 1). The challenge is in the 'what' to measure and 'how' to measure. 'What' to measure is dictated by how degradation is defined. FAO have defined degradation as "The reduction of the capacity of a forest to provide goods and services", but over 50 definitions of forest degradation have been published[8]. Recent definitions allow for more objective measurements, including the IPCC definition of:

> *A direct human-induced long-term loss (persisting for X years or more) of at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation or an elected activity under Article 3.4 of the Kyoto Protocol.*

The workshop discussion continually touched on the importance of definitions, with agreement that countries must work towards a nationally consistent definition that responds to country circumstances. Therefore countries must determine their own 'X', 'Y%' and 'T'. Both Dr Lawrence[7] and Mr Vickers[8] also noted the importance of interpretation and context in that long-term, gradual removal of forest carbon stocks may be defined through a lens of sustainable forest management (as perceived by Malaysia) or degradation (as perceived by India or Vietnam). Table 5 provides further country information on definitions.

The UNFCCC and IPCC guidance is now relatively sophisticated and complete. Activity Data, Emission Factors, Carbon pools, Tiers and Approaches for 'forest remaining forest' guide the 'how' to measure. But challenges[9] still exist and include temporal thresholds, spatial scales, integration of field and satellite data, spatial impact and intensity of disturbance, and lack of data and limited capacity. While most countries in the region are including degradation in their Forest Reference Emission Level (FREL)/Forest Reference Level (FRL), the challenges outlined are resulting in simple, non-spatial proxy measures[10] being used to quantify emissions from forest degradation. Dr Fox concluded that the challenge is to develop robust, simple, and affordable methods for spatially measuring degradation that can be adapted and applied by countries intending to participate in REDD+ mechanisms. This generated a discussion on the relative merits of focusing on an activity based approach where the modelling of proxy measurements has produced robust and credible data (see Dr Brown's presentation on selective logging) or a land-based approach generally associated with the National Forest Inventory systems of countries like India, Vietnam and Malaysia. No immediate conclusion was reached, but agreement was made that country context and drivers of deforestation and degradation would determine approach.

Countries should measure degradation when:

- Degradation activities are a significant source of associated emissions;
- There is potential for mitigation of degradation activities; and

[8] Vickers, Ben. *Addressing Forest Degradation: The Policy Perspective*, 2015 workshop presentation: http://www.leafasia.org/library/addressing-forest-degradation

[9] Diloksumpun, Sapit. *UNFCCC and IPCC Guidance on Measuring and Monitoring Forest Degradation,* 2015 workshop presentation: http://www.leafasia.org/library/ipcc-guidance

[10] Fox, Julian. *Measuring Degradation for REDD+ Forest Reference Emission Levels/Forest Reference Levels (FRL/FREL)* 2015 workshop presentation: http://www.leafasia.org/library/measuring-degradation-redd

- There is sufficient technical capacity to measure degradation.

Case studies from Sri Lanka[11] and Vietnam[12] provided excellent insights into different development pathways toward an NFI and NFI data used in measuring and monitoring changes in forest carbon stocks and reporting against a FRL/FREL.

Session Discussion Points and Section Summary

Interest in Reducing Emissions from Deforestation and Degradation (REDD+) is again focusing attention on forest degradation. The question of 'why measure' is easily answered within this context and within broader discussions of natural resource management and resource economics. However difficulties arise in determining 'what' to measure and 'how' to measure.

- Degradation definitions are important, but many countries do not have an operational definition that link the 'why measure' to the 'what' and 'how'.
- There is complete, yet high level guidance issued by UNFCCC and IPCC for inclusion of degradation emissions in FRL/FRELs and monitoring, reporting and verification system. But substantial on-ground challenges remain.
- Approaches to measuring and monitoring were heavily debated. Delegates still retain some confusion over the relative merits of activity-based and land-based accounting. Further guidance is required.

[11] Kumar, Raushan. *Forest degradation in Sri Lanka,* 2015 workshop presentation: http://www.leafasia.org/library/forest-degradation-sri-lanka

[12] Vu Quang Hien, *Forest degradation monitoring in Vietnam,* 2015 workshop presentation: http://www.leafasia.org/library/forest-degradation-monitoring-vietnam

Table 1: Degradation Importance, Objectives and Degradation Drivers - Country Responses

Country	Is degradation important?	Monitoring Objectives	Current Condition	Drivers of Forest Degradation	Are resources being invested
Bangladesh	Yes	1) Bird monitoring, esp. in protected areas, at subnational level, (2) Wildlife monitoring, (3) Carbon & Redd+, (4) Data information about degradation and develop forest management planning	Across the country, severity differs. - Higher levels in midland, plain land, & some protected areas. - Medium level in Chittagong Hill tracts (forests already degraded). - Lower levels in Sunderbans, planted mangroves & some PAs	(1) industrialization, housing, infrastructure development (2) shifting cultivation (3) logging (legal and illegal) (4) encroachment into forested areas (5) conversion into plantation (6) fuelwood (7) grazing	
Bhutan	Unknown	(1) Maintain national forest policy objectives, (2) For national and international reporting (REDD+)	Degradation sources are known at general regional level but not explicitly at local level	(1) Legal logging, (2) Fuelwood, (3) Forest Fire, (4) Grazing	
Cambodia	Yes	Objectives not stated, but may be upgraded as better data becomes available in the future	Degradation occurs everywhere, but intensity related to development projects (hydropower, economic concessions) and population density. Insufficient data to determine specific locations.	(1) Illegal logging – Commercial species such as rosewood (2) Fuelwood collection (charcoal and cutting wood from trees in burned areas) (3) Legal timber harvesting for household use. (4) Fire (depends on forest type), but no data on significance.	No, still working on definition
Indonesia	Yes	1) Forest cover change in each forest management unit (2) the spread and pattern of forest degradation from illegal activity	Widespread	Planned degradation (oil palm, rubber, agriculture and road development) and unplanned degradation	Yes, detecting logging
Laos	Yes, but difficult to identify.	Not stated	Widespread	Logging, fire (typically from shifting cultivation), generating/gathering charcoal	No. Some donor funds for R&D
Malaysia	Yes	Monitor forest extent and composition changes	Pahang and Sabah	still being analyzed	No, still developing definition
Myanmar	Yes/Not sure. Little information available	1) Identify areas of high grading and biomass reduction (threshold and time frames unclear); (2) Identify impact of development on important timber species/ regeneration potential, (3) Possibly include non-timber values of forests	In general in all accessible areas of forests/ no spatially explicit information available; national level information not available but it is know that degradation an issue in dry forest areas (firewood cutting), productive forest areas (highgrading) and Kachin and Shan state (forest	(1) High grading, in legal forest management areas but also illegal logging! (2)Firewood cutting, mainly in dry forest areas (central part of MM) (3) Forest fire in connection with shifting cultivation or transformation of forests in rubber plantations (South and East) and oil palm (mainly in the South) (4) Shifting cultivation	Yes, through FRA and REDD+ national program

		(fodder, grazing, hunting, etc) (4) Identify area and impact of firewood extraction (5) Establish a real time fire detection system.	fire and shifting cultivation).	??	
Philippines	Yes, but there isn't data on extent	1) vegetation, (2) biomass	More information needed-currently based on 2013 and 2014 maps	Harvesting, fuelwood, NTFP, shifting cultivation	No. Current focus on reforestation and protection
PNG	Yes	Monitor degradation from commercial logging activities	Unknown	Logging, other, forest gardening and fire	
Sri Lanka	Yes	(1) To assess the change of forest condition/quality in order to take suitable measures for forest improvement, (2) To estimate the carbon stocks and emissions	1) Dry zone, (2) Low country wet zone, (3) Up country & (4) Arid zone.	(1) Dry zone - forest fires, illegal felling, cattle grazing, mining/gravel extraction, fuelwood collection, spreading of invasive species, elephant damages, forest fragmentation. (2) Low country wet zone - forest fires, illegal felling, mining/gravel extraction, spreading of invasive species, forest fragmentation (3) Up country - forest fires, mining/gravel extraction, fuelwood collection, spreading of invasive species, cardamom cultivation, forest dieback (4) Arid zone forest fires, cattle grazing, mining/gravel extraction, fuelwood collection, spreading of invasive species. - Activities listed in order of importance.	
Thailand	Yes, but issue in defining degradation	Rough cover change estimate	Anywhere with rosewood is present, northern Thailand, anywhere near borders.	Illegal logging	No
Vietnam	Yes, but variation in NFI protocols mean extent of degradation is unknown	(1) Better forest management and protection, (2) reduction of illegal logging, (3) meetings international requirements (REDD+, IPCC, etc.).	All around country but especially in the central highland and particularly in natural forest	Types of degradation-logging, conversion of natural forest to plantation forests, shifting cultivation (small scale) and road construction/mining.	No. But efforts to include degradation and enhancements in national REDD+ program

Why Measure? Significance and Critical Decisions

Significance

Estimating the significance of GHG emissions from degradation is highly important in allocating sufficient resources for on-going measuring, monitoring and reporting. The following definition of degradation was presented during the workshop[13]:

> *A reduction in the forest carbon stocks by at least 10% and persisting for 5 years or more.*

Emissions are significant and persistent if:

- Total annual emissions from degrading activities are more than 10% of the annual total forest-related emissions;
- Emissions from individual degrading activities represent at least 3% of total annual emissions;
- Resources exist to accurately measure, monitor and report emissions;
- Plausible policy and actions can be introduced and enforced to alter forest degradation activities; and
- Emissions may increase without intervention[13].

(Degrading activities include timber harvesting (legal and illegal), fuelwood and charcoal collection, fires, grazing, land use change and pollution and possibly shifting cultivation[14]).

Many countries have defined forest degradation (see Table 5), however these definitions are generally imprecise and difficult to operationalize. The definition presented advances a country's ability to develop an operational plan for measuring and monitoring degradation by defining both significance and persistence.

Determining significance is important. Justification must be provided if degradation, as a whole, or a degradation activity/activities are to be excluded from a FRL/FREL. A reasonable justification is that the order of magnitude of emissions are not significant to justify investment in the measuring and reporting of those emission sources.

'First-order' estimates at country and provincial/state level are now available[15] and were discussed at the workshop (see Table 2). These estimates are based upon publicly available, global data sets and while these estimates were contested, for many of the country delegates, this was the first time an order of magnitude could be assigned to forest degradation activities. While there was debate and discussion about the validity of these numbers presented, these 'first-order' estimates do provide important data and information upon which countries can decide which activities to include in their REDD+ program and therefore, which activities require more accurate and precise emission estimates.

[13] Goslee, Katie. *Critical decisions and key components,* Presentation at Regional Workshop on Moving on From Experimental Approaches to Advancing National Systems for Measuring and Monitoring Forest Degradation Across Asia, June 16-18, 2015, Bangkok, Thailand. http://www.leafasia.org/library/critical-decisions-and-key-components

[14] Debate continues over how to categorize shifting cultivation. The change of primary forest to a 'cropping' system of shifting cultivation can be defined as deforestation. But once converted and a cultivation cycle begins of agricultural production, fallow land, regrowth, conversion of secondary forest to a new agricultural cycle, this could be defined as an agricultural system – with a possible zero change in long term carbon stocks.

[15] World Bank' Forest Carbon Partnership Facility REDD+ Decision Support Toolbox (access available at: http://www.forestcarbonpartnership.org/technical-decision-support-and-training-material)

Table 2: First-Order Estimates of Country Emissions from Three Degradation Activities

Country	Deforestation		Timber		Fuelwood		Fire		Total Degradation		Total Emissions (1000 tCO2)
	1000 tCO2/yr	%	1000 tCO2/yr	%	1000 tCO2/yr	%	1000 tCO2/yr	%	1000 tCO2/yr	%	
Bangladesh	2,831	13%	1,854	9%	16,070	74%	1,014	5%	18,938	87%	21,770
Bhutan	678	15%	912	20%	2,787	62%	115	3%	3,813	85%	4,492
Myanmar	92,094	41%	24,238	11%	293	0%	107,016	48%	131,546	59%	223,641
Cambodia	53,611	67%	823	1%	1,277	2%	23,969	30%	26,069	33%	79,680
India	48,291	29%	9,447	6%	84,281	50%	25,790	15%	119,517	71%	167,808
Indonesia	1,479,862	83%	73,405	4%	57,179	3%	170,079	10%	300,663	17%	1,780,525
Laos	66,978	64%	2,974	3%	895	1%	33,682	32%	37,551	36%	104,528
Malaysia	427,012	80%	100,077	19%	0	0%	4,303	1%	104,381	20%	531,393
Nepal	1,918	9%	349	2%	17,919	84%	1,229	6%	19,498	91%	21,416
PNG	43,620	64%	11,454	17%	1,320	2%	11,772	17%	24,546	36%	68,165
Philippines	37,272	80%	2,410	5%	5,144	11%	1,965	4%	9,519	20%	46,791
Sri Lanka	3,550	33%	3,939	37%	3,116	29%	29	0%	7,085	67%	10,635
Thailand	60,854	66%	192	0%	346	0%	30,914	33%	31,452	34%	92,307
Vietnam	64,762	65%	21,955	22%	2,867	3%	9,945	10%	34,767	35%	99,529

So while definitions and defining significance is important, other critical decisions still must be made: What Tier or level of accuracy is required? Does reliable and verifiable data exist? What additional data is needed? Is there capacity to collect the data at the required level of accuracy? Can capacity be increased? At what frequency will degradation be monitored? To support this decision-making process, a framework was presented (see Table 3) that details critical decisions that must be agreed upon from which a forest degradation measuring and monitoring plan could emerge. During the workshop, country delegates were asked to use this framework to reflect upon their own current and emerging forest degradation monitoring systems. A summary of these responses is outlined in Tables Table **1**,Table **5** andTable **6**.

A review of USAID sustainable landscapes projects across Asia illustrated that most projects had rudimentary definitions of degradation abd the significance of degradation emissions had not been quantified, either as a proportion of total forest emissions or by activity. Challenges included: 1) lack of a precise, measurable definition, 2) uncertainty regarding accounting approach, 3) insufficient ground and satellite data to accurately calculate activity data and emission factors, 3) tenure uncertainty, 4) insufficient capacity, 6) lack of political will (often due to significance of deforestation)[16].

[16] Turner, Rick. *Measuring and monitoring forest degradation, regional assessment,* 2015 workshop presentation: http://www.leafasia.org/library/measuring-and-monitoring-forest-degradation

During the mixed-country group sessions, the following topics were discussed:

- All delegates at the workshop agreed that forest degradation was important, but quantifying significance was difficult. Data and information are lacking to accurately quantify and therefore justify resources being directed toward measuring forest degradation across a country, landscape or by activity.
- The motivation or rationale for measuring forest degradation included: policy imperative (i.e. action required under national policies and regulations); better management of forest resources and ecosystems; validation and verification of sustainable forest management systems; increased transparency in forest management; advantages of participating in international schemes (ie REDD+); and to regulate shifting cultivation.
- Investment and decisions on measuring degradation were spread across a spectrum. At one end of the spectrum, considerable investment has been made in the NFIs of India and Vietnam where changes in forest 'quality' are periodically measured. Both countries do however recognize the limitations in accurately reporting emissions from forest degradation (measurements based on changes in canopy cover in India and timber volumes in Vietnam). Countries such as PNG, Philippines, Bhutan, Bangladesh, Laos and Cambodia are now investing in systems and trials – but significance is yet to be determined. Thailand, even though degradation is recognized as a problem has not yet decided on required investment necessary for inclusion in the country's emerging FRL/FREL. At the other end of the spectrum are countries such as Malaysia and Bhutan where drivers (ie legal logging in Malaysia and legal community harvesting in Bhutan) are not considered to reduce long term forest carbon stocks (ie Malaysia) or where policies and measures are unlikely to change due to negative impacts of mitigation actions on local livelihoods (ie Bhutan). 'Degradation' in this context is seen as significant, but through a positive economic lens (i.e. access to timber for rural house construction in Bhutan or planned logging for economic development in Peninsula Malaysia).

Table 3: Forest Degradation Framework to Aid Development of a Measuring Plan

Forest Degradation Framework
1. Definition of Degradation
2. Assessment of current conditions
• Location of degradation
• Types of degradation/degrading activities
• First order emissions assessment
Monitoring design
• Land- vs. Activity-based
• Monitoring objectives
4. Monitoring design
• Land- vs. Activity-based
• Monitoring objectives
• Available data
• Gap assessment
• Institutional capacity for additional data collection
• Monitoring systems/data sources
5. Data analysis
• Emission factors
• Activity data
• Total emissions
• Uncertainty
• Predictive modeling
6. Implementation plan
• Responsible parties
• Schedule and cost estimates
• Integration within REDD+ system

Recent research advances and development of cost-effective approaches to measuring degradation were noted. The Global Forest Observations Initiative (GOFI) Second Research and Development Expert Workshop held in November 2014 (http://www.gfoi.org/rd/second-rd-workshop/) examined approaches to assess degradation for REDD+ using earth observations, ground-based surveys and proxies. An excellent summary of forest degradation data sources and operational readiness of sensors was presented at the GOFI

workshop and summarized. Yet further research is needed[17], particularly on measurement periods for the development of a 'true' emission factor.

The discussion on emission factors quickly turned to which 'approach' a country should select. Two accounting methods are described by the IPCC and summarized in Table 4.

Table 4: A Summary of Land-Based and Activity-Based Accounting

Aggregate or Land-Based Accounting • Land-based estimates the change in carbon stocks in a specified area of land, regardless of activities occurring.	**Activity-Based Accounting** • Activity-based considers specific human activities leading to forest degradation, and estimates emissions separately for each activity.
Full accounting of all land-based emissions.	Emissions combined across activities.
Can capture net effect of emissions and sinks across large areas.	Where multiple activities occur, it may be difficult to verify emissions.
Difficulty in distinguishing between effects of multiple activities.	Inherently distinguishes between activities.
Requires large amounts of data that are expensive to collect.	Cost effective approach; complexity of methods based on each activity
Measurement resolution will likely miss many localized small-scale impacts.	Small scale impacts can be included by activity if deemed significant.
May simplify tracking net emissions and removals from place to place or year to year.	Requires development of emission or removal factors for each activity in each region.
Example: Vietnam NFI • NFI with extensive biomass data and 20 years data on forest cover change - including degradation of timber stocks • Not clear which activities result in emissions from degradation • High uncertainty in areas/forest types with few plots	**Example: Guyana** • Limited existing biomass data • No reliable data on land use change • Most degradation from logging and small scale mining • Field work focused on areas most impacted by degradation

The presentations of Dr Lawrence[17] and Ms Goslee[18] outlined the advantages and disadvantages for both approaches. Both presenters provided interpretations of applicability. As most country delegates are involved in the development of their NFIs (many with FAO/UN-REDD support), many delegates gravitated toward an aggregated or land-based approach. Considerable discussion continued, particularly on issues of cost-effectiveness and accuracy. Many country delegates considered a hybrid approach where an NFI was established to measure fluxes in forest carbon stocks regardless of driver or activity. A second, more detailed assessment would take an activity-based approach were highly accurate data was collected on one or more significant drivers, upon which policy and mitigation actions can be targeted. General agreement was that further information on resourcing and guidance on the advantages and disadvantages of each approach was required for countries to make a definitive decision.

[17] Lawrence, Deborah, *Approaches to monitoring forest degradation for REDD+, GOFI/GOFC-GOLD Guidance for Asia.* 2015 workshop presentation: http://www.leafasia.org/library/approaches-monitoring-forest-degradation
[18] Goslee, Katie. *Degradation accounting methods.* 2015 workshop presentation: http://www.leafasia.org/library/degradation-accounting-methods

Session Discussion Points and Section Summary

Estimating the significance of emissions from degradation is important for cost-effective and targeted resource mobilization. Global data has been compiled that provides a 'first order' estimate. But determining significance is only one critical decision in the development of a national degradation measuring system. Delegates worked through a framework that provides guidance on further critical decisions that need to be considered.

The discussion on accounting approaches (land-based versus activity based) was lively. Most delegates are now developing their NFI and felt more comfortable and aligned with a land-based system. But both have merits that were actively debated. Regardless of approach, national degradation monitoring systems should be: simple; based on existing systems if possible; affordable; replicable and scalable; assessed for uncertainty and error; verifiable; and if activity-based, focused on areas likely subject to disturbance and those activities driving disturbance.

Key summary points included:

- Degradation significance (as a total or per activity) is important and countries can use this as a justification for degradation or degradation activities to be excluded from a FRL/FREL. Good 'first order' data is required.
- If degradation is included in a FRL/FREL, or other national forest monitoring systems, decisions on data accuracy, resources, capacity, approaches and responsibilities must be determined and articulated through a forest measuring and monitoring plan.
- The approach to measuring degradation emissions is a critical decision. Land-based and activity-based approaches to measure forest degradation each have advantages and disadvantages. As outlined, delegates lack knowledge and remain confused over the relative merits of each approach. Further guidance is required on the advantages and disadvantages, required resourcing and certainty levels expected by each approach.

Table 5: Degradation Definition, Accounting and Accuracy - Country Responses

Country	Definition	Accounting Approach	Level of Accuracy (Ambition of countries)
Bangladesh	Loss of forest cover; converting high forest into shrub forest [Proposed: NFI every 5 years; Land cover monitoring every 2 years]	Land-based in part. Activity-based in part – measurements of stumps from illegal logging. Have change in forest cover over 10 years. Have measured stumps in forest.	Tier 3 for deforestation & carbon stock, Likely Tier 1 (or first order) for degradation
Bhutan	Need to be developed by Technical Working Group and approved by policy makers	Activity based (subject to discussion)	Tier 2
Cambodia	Forest degradation – Change in forest stocks over time	Activity-based initially. Possibly moving to land-based approach with NFI implementation	Tier 2 – country specific data and Tier 1 – IPCC global default values
Indonesia	There are 2 definitions of degradation: 1) Formal definition decrees quality of forest cover. 2) Working definition defined as a change of primary forest to secondary forest classes based on satellite image classification.	Not stated	Depends on availability of data
Laos	None	Not stated	Tier 3
Malaysia	Draft definition: A direct long term (10 years), human-induced decline in forest canopy cover up to 30%, and/or at least 50% of existing forest carbon stocks and not qualifying as deforestation (Definition currently being field tested)	Not stated, but use of National Forest Inventory implies a land-based approach. But UNFCCC FRL submission implies an activity-based approach	Tier 3
Myanmar	No agreed definition available yet; though elements exist (definition of closed forest more than 40% canopy cover and open forests between 10 – 40%); no thresholds or no time frames defined not for the definition of degradation nor the measurements cycles. (Some political debate on forest degradation/shifting cultivation).	Probably a combination of both since purely activity based monitoring somehow difficult (sequential overlaying of different activities over the same land areas)	Tier 2 & hopefully Tier 3
Philippines	Use FAO degradation definition as official definition but it is not the common working definition	Land based to start then activity based	Tier 1
PNG	No agree definition	Phased approach: Phase 1- Land-based. Phase 2 – Activity-based	Tier 1
Sri Lanka	Reduction of canopy cover, bio diversity and biomass of forests over years. (Sri Lanka has not defined threshold levels)	Land based approach	Tier 2 and Tier 3
Thailand	R-PP: "Land remains as forest but the density and quality of the forest is decreased."	Mixed accounting approaches (but R-PP suggests an activity-based approach to monitoring drivers)	Tier 3
Vietnam	Decrease in stock volume from forest types that have high stock volumes to the forest types that have low stock volumes.	Land based	Tier 2

Data and Approaches

This section of the workshop allowed delegates to review recent technological advances and closely consider issues of utility, cost-effectiveness, resources and capacity to scale-up and operationalize at a national level.

Remote sensing and Geographic Information Systems (GIS) approaches are critical in mapping forest canopy change over time. The ability to track both spatial and temporal changes is essential, but also limited by the ability to validate this work through the collection of sufficient field data. Decisions on the remote sensing approach are therefore determined by: 1) National circumstances; 2) Integration into other forest monitoring aspects, ie satellite data already in use, NFI systems already established and availability of data (ground and satellite data); and 3) Available resources, ie data, budgets, capacity, time[19].

Difficulties are well documented. In continental Southeast Asia, the variety of natural forest types (e.g. canopy openness) and the seasonal variation of reflectance in the satellite image present challenges. In Insular Southeast Asia, limited availability and poor quality images are the main difficulties. In both regions, remote and rugged topography and complexity in the socio-economic landscapes further complicates the task of using remote sensing to measure degradation.

Is a system therefore possible that would consistently and uniformly measure forest disturbance? Is such a system required across Asia? In response to the first question, the methodology is known and common indices are available. New Landsat 8 and Sentinel-2 satellite imagery, availability of cheap, high resolution imagery (ie SPOT 6 and 7) and improved processing capabilities (ie Google Earth Engine, IMPACT tool, CLASLite, etc) will dramatically improve data availability and rapid processing. So it is possible. In response to the second question, the advantages in tracking cross-country drivers of forest disturbance (fire, logging and possibly shifting cultivation) are appealing, particularly under emerging REDD+ schemes. But REDD+ is a voluntary system with each country defining the parameters and mechanisms for their own national systems. Theoretically, a robust, comparable and consistent approach for measuring forest disturbance across Asia is possible with many advantages, but possibly not necessary and would require considerable good will between countries to share data and methodological approaches.

Data and Approaches – Activity Data

The activity data session was divided into two streams. The first considered the application and advances in medium resolution imagery, namely Landsat imagery to help define activity data for degradation. The second stream looked at high resolution data imagery, focusing on the cost-effectiveness of scaling up from single study sites to national approaches.

Medium Resolution Approaches

Landsat imagery is, and will remain for the coming 5 or so years, the 'work-horse' of forest and land use change analysis. Three presentations highlighted the ability of Landsat to monitor forest disturbance to provide quick, relatively accurate and national level estimates of historical forest disturbance. Those presentations examined: i) The manipulation and analysis of Google Earth Engine to estimate forest

[19] Meittien, J. et al. *Remote Sensing of Forest Degradation in Southeast Asia – Regional Review.* 2015 workshop presentation: http://www.leafasia.org/library/remote-sensing-forest-degradation

disturbance in Laos, PNG, Thailand and Vietnam[20] using the CLASLite software program; ii) Time series analysis using Landsat imagery in Vietnam[21]; and iii) the Collect Earth analysis software in PNG[22].

All three processes illustrated that medium resolution imagery can relatively accurately detect major forest disturbance (ie logging), and highlight subtle forest disturbance (crop encroachment). But that medium resolution, on its own, was unlikely to produce data of sufficient certainty for national level reporting. Good field data is also essential in defining and validating spectral signatures indicating forest disturbance. The advantages in the use of free and historically complete data sets through Landsat is the ability to provide rapid and relatively robust 'first-order estimates' of forest disturbance upon which countries could define the significance of forest degradation, determine major historical trends and patterns and start defining appropriate mitigation responses.

High Resolutions Approaches

High resolution data (less than 5 meters) can effectively detect forest disturbance, but can be costly and resource intensive. So can approaches and outcomes from single study sites be scaled up and incorporated into national programs? Three presentations considered the use of: Mixed imagery (ie Rapid Eye, SPOT MS and ALOS/PALSAR) to detect forest disturbance in Laos[23]; LIDAR to detect disturbance in the USA and Nepal[24]; and LIDAR and SAR to detect disturbance in Kalimantan, Indonesia[25].

Detecting forest disturbance using high resolution imagery is accepted. All three presentations showed impressive results, but as discussed, capacity limitations, financial considerations, necessity for good field data and basic issues such as definitions are preventing the scaling-up of study site methodologies to national approaches. Interestingly, in Laos the complexity of forest degradation drivers, and in Indonesia scale of deforestation, has meant little attention has been paid to developing national systems to measure and monitor forest degradation.

High resolution approaches are being used to validate other data sources or explore in finer detail areas of high disturbance (in Nepal, 1-2% LIDAR coverage has been sufficient to 'test' and validate wall-to-wall Landsat satellite imagery[24]). It is expected that high resolution approaches will continue, in the foreseeable future, to be used to validate national medium resolution (5-30 meter) due to cost and processing limitations.

[20] Houseman, P and Maus, I. *Mapping Forest Degradation and Deforestation: Google Earth Engine and CLASLite for Rapid Detection in Four Countries.* 2015 workshop presentation: http://www.leafasia.org/library/mapping-forest-degradation-and-deforestation

[21] Vogelmann, J. *et al*, *Landsat and time series analysis in Vietnam*. 2015 workshop presentation: http://www.leafasia.org/library/landsat-analysis-vietnam

[22] Gamoga, G., *Using Collect Earth to Measure and Monitor Forest Degradation in PNG.* 2015 workshop presentation: http://www.leafasia.org/library/using-collect-earth-png

[23] Yoshiyuki, K., *Status for development of activity data and detecting degradation in Laos.* 2015 workshop presentation: http://www.leafasia.org/library/degradation-laos

[24] Whitehurst, Amanda. *Using LIDAR remote sensing to detect forest change.* 2015 workshop presentation: http://www.leafasia.org/library/using-lidar-remote-sensing

[25] Englhart, Sandra. *Monitoring forest degradation using LIDAR and SAR.* 2015 workshop presentation: http://www.leafasia.org/library/monitoring-forest-degradation

Session Discussion Points and Section Summary

- Advances in the manipulation and analysis of medium resolution Landsat imagery are now providing rapid 'first-order' estimates of the significance, patterns/trends and location of forest disturbance at a national scale.
- High resolution imagery (less than 5 meters) is required to validate these assessments, quantify more subtle disturbances, and define activity data with low uncertainty levels.
- Significant challenges still exist in calculating forest degradation activity data. Methodology, imagery and processing advances are overcoming these challenges, but basic issues of inadequate field data, imprecise/no operational definitions and limited capacity continue to prevent reliable reporting at a national level.
- A combination of approaches will likely be necessary if a country is to establish a robust monitoring plan for forest degradation. The combination will be dependent on:
    - Objectives for measuring and monitoring degradation;
    - National circumstances, particularly geography, forest types, drivers of degradation, significance, and definitions;
    - The presence (or absence) of a National Forest Inventory and data already being collected;
    - Approach to accounting (ie land-based or activity based);
    - Available resources, including access to new imagery and resources to procure and analyze; and
    - Resource and capacity gaps.
- Calculating forest degradation activity data must be linked to calculating activity data for deforestation.
- The Joint GFOI/GOFC-GOLD R&D Expert Workshop on approaches to monitoring forest degradation for REDD+ held at the University of Wageningen in October 2014 provides an excellent summary of remote sensing approaches used to measuring and monitoring forest disturbances (presentations and workshop paper is available at: http://www.gfoi.org/rd/second-rd-workshop/).

Data and Approaches – Emission Factors

Ground inventory is an essential task in validating remote sensing imagery and in measuring forest biomass upon which to calculate emission factors. Like remote sensing, technological and methodological advances are being made in the collection of field data for the estimation of emission factors. Examples presented illustrated advances in methodology (sampling of tree stumps to estimate emission factors in Bangladesh[26]) and technology (combination of CLASLite and e-Cognition to identify areas distributed or areas under threat and then the use of hand held devices to improve QA/QC mechanisms during field data collection in Laos[27]). The main issue for discussion was in quality control of field inventory data being taken and methods to ensure accurate entry of data. Boundaries can be set through hand held devices, but ultimately a thorough QA/QC system is required across the total forest measuring and monitoring system.

[26] Uddin, Shams. *Measuring degraded forests and developing emissions factors in Bangladesh*. 2015 workshop presentation: http://www.leafasia.org/library/measuring-degraded-forests-bangladesh

[27] Eickhoff, Gabriel. *Measuring degraded forests developing emissions factors in Laos.* 2015 workshop presentation: http://www.leafasia.org/library/measuring-degraded-forests

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Table 6 summarizes available data, gaps and data sources to calculate activity data and emission factors. (There is some missing information, as not all country delegates reached this stage while completing the framework during the workshop).

- Field data is an essential part of any system to measure forest degradation. Like remote sensing, the scale and scope of field inventory work will be dependent on national circumstances, particularly geography, forest types, drivers of degradation, significance, and definitions. Plus other forest monitoring systems already established.
- Defining the significance of degradation is important for designing field inventory work. As stated by Gabriel Eickhoff, the objective is to capture 'the big stuff' and not to worry about the 'small stuff'. This becomes difficult in highly disturbed, mosaic forests but knowledge of drivers, forest history and first-order estimates of forest disturbance will lead to better field designs to measure carbon stocks and develop emission factors for disturbed forest strata.

Table 6: Degradation Data, Gaps and Data Sources - Country Responses

Country	Available Data	Gap Assessment	Field Data	Remote Sensing Data
Bangladesh	(1) Biomass data from PAs and Sunderbans; (2) National Forest Assessment, 2005-2007; (3) 2010 Sunderban carbon inventory, 120 PSPs since 1981; (4) Land cover classification (national level)	Limited data on forest cover change, esp. for degradation	(1) Pilot efforts to establish plots measuring stumps – trees removed from illegal logging; (2) GHG inventory (FAO, June 2015)	(1) Hansen data (only forest loss, not degradation) (2) Access to RapidEye (5m) for PAs; Access only to Landsat (30m) for rest of forest land
Bhutan	1) Statistical and some spatial data; (2) livestock figures	1) Inconsistency in data collection & lack of conversion factors; (2) Technical and financial; (3) Lack of quantified data on grazing	Not available	Partially available for fire detection, otherwise unavailable
Cambodia	(1) For illegal logging, Law enforcement data, annual timber flow assessments, and third-party verification data.	(1) Insufficient law enforcement in border areas – timber smuggling. Need agreements for data sharing with neighbor countries; (2) Lack of data medium-scale use (commercial, industrial); (3) Need more comprehensive household timber data use; (4) Insufficient fire data. Can track location and area but not impacts.	N/A	N/A for all
Indonesia	(1) Legal permit of concession area, mining area, etc; (2) Over cutting tree (3) volume of tree for each type of forest	N/A	(1) National standard of ground based forest carbon accounting; (2) volume of tree for each type of forest and each forest management (NFI report); (3)forest carbon accounting for each type of forest and each forest management	Planned degradation (a) RS Imagery data set for each period of data (medium – high resolution) (b) National forest monitoring system (update and time series data) (c) Web service (update and time series data) (d) Ina-geoportal (update and time series data) Unplanned degradation - Imagery data set for each period of data (medium – high resolution)
Laos	Production logging, there is no data for non-production logging	(1) Non-production logging data; (2) land allocation and spatial planning	Planned NFI	Landsat and some Quick Brid imagery

Malaysia	N/A	N/A	N/A	
Myanmar	(1) Long term negative economic and silvicultural impact; (2) Dimensions of impact especially in dry forest areas; (3) Impact on ecosystem services and costs of restoration; (4) Some data definitions still to be decided (e.g. is shifting cultivation deforestation or agriculture); (5) In cases where shifting cultivation encroaches PFE economic impact and costs for reforestation/ restoration.	1 Legal & illegal logging - National level comprehensive inventory data (2) Change detection methodologies based on RS (3) Firewood cutting – lack of a reliable ground based inventory (4) Fire associated with shifting cultivation - Technology and methodologies for detecting and monitoring forest fire in real terms (5) Shifting cultivation - Still large amount of land unclassified.	(1) logging - Be included in the new NFMS (2) firewood cutting - Be included in new NFM system, perhaps in SE (3) forest fire - Develop a sample approach for that (GEF project?) (4) shifting cultivation - If implemented also a sample approach for field	N/A
Philippines	(1) Land cover change data & (2) some logging data	(1) better maps (2) NFI data- NFI is now being expanded/re-measured	N/A	
PNG	(1) Logging - Collect Earth, Log export/Harvest data (2) Other - Need further investigation by CE (mining, mobile sawmilling activities) (3) gardening - Census 2000/2011 (4) fire - PNG Watch	Gaps not assessed	Use IPCC default factors, then use country specific factors after the NFI	(1) Collect Earth, (Landsat time series and RapidEye (2) Hansen data set –Google Earth Engine
Sri Lanka	Dry Zone : Forest Fires-partially; Illegal felling-Available; Cattle grazing –partially; Mining/gravel extraction; Fuelwood collection- No; Invasive species- Partially; Elephant damages- Partially Low wet zone: Forest Fires –Partially; Illegal felling-Available; Spreading of invasive species- Partially Up Country: Forest Fires-Partially; Fuel wood collection-Partially; Spreading of invasive species-Partially; Cardamom cultivation-Available Arid Zone: Forest Fires –Partially; Cattle grazing-No; Mining/gravel extraction-Partially; Fuel wood collection-No; Spreading of invasive species-Partially		(1) Not available(2) There are Allometric Equations for selected species	There are forest cover maps for different time periods
Thailand	N/A	Thai Policy	N/A	Yes
Vietnam	(1) Illegal logging – data not available (2) natural forest converted to planted forest – not sufficient (3) shifting cultivation – not available (4) road construction and mining – available but difficult to collect	(1) Illegal logging – need to collect data; (2) natural forest converted to planted forest – need to update data; (3) shifting cultivation – need to collect data; (4) road construction and mining – multi sector cooperation	NFI	Landsat and SPOT 6 and SPOT 7

Methods and Utility

The final, formal presentations for the workshop focused on the technical details and specific actions to measure and monitor emissions from shifting cultivation[28], planned and unplanned logging[29] and fire[30] and actions to increase data certainty[31]. The focus on specific activities again raised the debate on the pros and cons of land-based or activity-based accounting. As discussed, most country delegates are working toward the establishment, or upgrading, of NFIs and therefore tended to consider a land-based approach a more obvious approach. But understanding the development of emission factors and activity data for specific forest degradation activities contributes to the overall knowledge base of measuring emissions from forest disturbance.

Shifting cultivation presents unique challenges, but good field data and annual analysis of high resolution imagery can contribute to accurate emissions estimates. Discussions however focused on whether shifting cultivation should be classified as degradation, deforestation or an agricultural system. These were expert views that shifting cultivation was not a degradation activity; rather, it is either a cropping system (cropping remaining cropping) or the conversion from forest to a cropping system (deforestation). If considered a cropping system, the full spectrum of vegetation states (ie cropping, fallow and secondary, re-growth forest) need to be spatially defined and a time bound average of carbon stocks estimated and then tracked to see if carbon stocks within a defined area decline over time constituting degradation (and ultimately reported as a cropping emission).

Estimating emissions from logging is now well defined with recent work outlining a robust methodology[32]. The approach uses a combination of field data to estimate carbon losses and emission factors and extracted timber volumes and high resolution imagery to estimate the area of logging infrastructure in order to determine activity data.

Methodologies to estimate emissions from fire are possibly the least developed. But Thailand data suggests anthropogenic sources of fire are significant. Between 1985 and 2013, only 4 fires from 174,482 fires were attributed to natural causes, ie lightning. Challenges in estimating fire emissions included: no agreed standard operating procedures to detect burn areas through remote sensing; lack of field data; lack of knowledge on fuel consumption and fire behaviour. Larkin et al (2014) stated "every component used to calculate wildland fire emissions is uncertain[33]".

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[28] Kiyono Yoshiyuki, *Shifting Cultivation: Activity Data & Emission Factors for an integrated, scalable system.* 2015 workshop presentation: http://www.leafasia.org/library/shifting-cultivation

[29] Brown, Sandra. *Logging (Planned and Unplanned: Activity Data & Emission Factors for an integrated, scalable system.* 2015 workshop presentation: http://www.leafasia.org/library/logging-planned-and-unplanned

[30] Anuchit Ratanasuwan and Veerachai Tanpipat, *Fire emissions (planned and unplanned): Activity Data & Emission Factors for an integrated, scalable system.* 2015 workshop presentation: http://www.leafasia.org/library/fire-emissions-planned-and-unplanned

[31] Sandra Brown, *Increasing data certainty.* 2015 workshop presentation: http://www.leafasia.org/library/increasing-data-certainty

[32] Pearson, T. Brown, S. and Casarim, F. 2014, Carbon emissions from tropical forest degradation caused by logging. Environmental Research Letters, Volume 9, Number 3. Available at: http://iopscience.iop.org/1748-9326/9/3/034017/article

[33] Larkin, N. K., RaffuseS. M., Strand, T. M., 2014. Wildland fire emissions, carbon, and climate: U.S. emissions inventories. Available at: http://www.fs.fed.us/rm/pubs_other/rmrs_2014_larkin_n001.pdf

If resources are to be invested in measuring and monitoring emissions from forest degradation, increased data certainty is essential, and fundamental in the IPCC and UNFCCC context. Most commonly accepted guidance is that certainty levels should be between ±10% and ±20% at a 95% confidence interval. Country determination of certainty levels ranged from Vietnam's aim to achieve less than 5% error in carbon stocks at a 95% confidence level at the national level, to Cambodia that had not yet started the discussion on required certainty levels.

Session Discussion Points and Section Summary

- Methodologies are now well defined for measuring and monitoring emissions from most degradation activities, fire being the outstanding challenge in which a reliable methodology has not yet been defined.
- There is ongoing debate on the classification of shifting cultivation, with some expert now believing it is not a degrading activity (ie a reduction in carbon stocks within a 'forest remaining forest', see Annex B of the 'Forest Degradation Guidance and Decision Support Tool'[34]), but rather a deforestation process (forest land to cropping land) or part of a cropping system (cropland remaining cropland). But as there is tremendous temporal and spatial variability in shifting cultivation patterns across Asia, there is also great difficulty in defining the boundary between the forest and cropping strata, as well as defining tenure rights and the political implications for 'transferring' land subject to shifting cultivation into an agricultural strata. Therefore further national level consideration is required to classify shifting cultivation practices according to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Chapter 4).
- Definitions of certainty levels are relatively imprecise and inconsistent across the region, but common and relatively simple QA/QC steps can be put in place to define and if necessary increase certainty in establishing activity data and emission factors.
- Defining certainty levels has only occurred in a couple of countries that have long standing NFIs, namely Vietnam and India. But all countries will need to report accuracy levels for degradation activity data and emission factors, if reported.

Conclusion

The motivation for investing resources in the measuring and monitoring of forest degradation is strong across the region. But reasons vary: international reporting and the inclusion in national REDD+ programs; improving policies and laws, particularly around illegal logging; biodiversity conservation; and improving forest management and livelihood outcomes for forest dependent communities.

The drivers of forest degradation are generally well understood: logging (planned and unplanned); grazing, fuelwood collection; fire; and forest incursions from infrastructure development. But impacts tend to be localized, subtle and spatially and temporally erratic over time – making detection and measuring difficult. For many countries, how to categorize shifting cultivation is difficult. It was suggested at this workshop that shifting cultivation was either a deforestation process or part of a cropping system and should be accounted for as such. While this does not diminish the difficultly in tracking declining carbon stocks in such systems, countries must confirm how shifting cultivation is to be described and accounted for.

Consideration of drivers allowed countries to relatively quickly agree that forest degradation is a nationally significant issue. Perceptions of the relative impact did however differ; both Bhutan and Malaysia considered

the positive impacts of forest disturbance due to important economic and rural benefits suggesting that elucidation of trade-offs should accompany measuring and monitoring systems. All delegates indicated that further investment was needed to improve the measuring and monitoring of emissions from forest disturbance.

Until recently, quantifying the significance of emissions from forest degradation has been difficult. First order estimates are now available[34] (see Table 2) and while there is not wide acceptance of these figures, they do provide a starting point for discussion and consideration for the allocation of resources. However further capacity building is required to accelerate the use of free and historically complete Landsat data sets for countries to rapidly produce their own, relatively robust 'first-order estimates' of forest disturbance. Based on this, countries can then elect to include degradation activities in their FRL/FREL and allocate further resources to develop more accurate estimates of associated emissions and defining appropriate mitigation responses.

The approach for accounting for degradation emissions is still debated, with the mechanisms and pros and cons between a land-based approach and an activity-based approach still somewhat ambiguous. Given historical attachment to NFIs, most countries align closer to a land-based approach, but upon consideration of both approaches, see the value in moving towards an activity-based approach. Further information and consideration is needed to understand if a phased approach or even a hybrid approach can be implemented without double accounting, unacceptably low accuracy levels or unsustainable investments.

Dependent on how a country elects to account for forest based emissions, defining threshold criteria that can be measured against to determine significance of emissions is another critical issue many countries in the region are still yet to complete. During the workshop, the following thresholds were recommended:

> *Degradation emissions are significant and must be accounted when they are more than 10% of total emissions from the forest sector. In addition, it is recommended that emissions from any individual activity that accounts for at least 3% of total annual emissions should be included.*

But no country has agreed to an explicit definition of forest degradation (Malaysia's draft definition being a possible exception), with many deferring to simply a change in forest 'quality' as measured by changes in canopy cover or standing wood volume.

As many Asian countries are now developing National Forest Monitoring Systems and FRLs/FRELs, these issues are important. Virtually all countries are now considering the inclusion of degradation within their FRL/FREL; however without serious consideration to the above issues, it will be unlikely that degradation can be included in the first iteration of a UNFCCC 'approved' FRL/FREL.

A further consideration is data. Outcomes from this workshop, and many previous workshops, indicate that data is 'patchy'. Consistency, accuracy and availability all tend to be low. The structure and objective of the workshop however placed an emphasis on understanding what is significant, what is critical to measure and what can be ignored. Data scope and integrity and the capacity to measure, monitor and analyze can only really be defined once a clear decision has been made on how degradation is defined, accounted for and

[34] Goslee, K. *et al* 2015. Technical Guidance Series for the Development of a National or Subnational Forest Monitoring System for REDD+: Forest Degradation Guidance and Decision Support Tool. Developed by Winrock International and the United States Forest Service for the USAID LEAF program. Available at: http://www.leafasia.org/library/forest-degradation-guidance-and-decision-support-tool

which activities (if any) will be included in a FRL/FREL. The completion of the measuring and monitoring framework tried to support this approach by allowing delegates to consider the critical issues in developing a forest degradation measuring and monitoring plan and how this could be incorporated into a national measuring and monitoring system.

But measuring forest degradation and the associated emissions is challenging. Advances are being made in radar imagery, cost-effective high resolution imagery, processing and frequency of imagery interpretation and the spectral range and resolution of optical data from Landsat 8 and Sentinel 2. Research also continues to build our knowledge base. But this workshop focused on the need for cost-effective forest monitoring and measuring systems that can be nationally implemented. An on-going discussion will be required as technological advances are matched against a country's desire to measure persistent forest change and disturbance and the resources they have to achieve this. On-going support from the workshop partners, the SERVIR Mekong Program, the SilvaCarbon Program, UN-REDD and the European Union Joint Research Centre's ReCaREDD Project[35], will continue to be a valuable source of knowledge. But ultimately it will be up to national governments and forest agencies to build a common understanding of the value and importance in measuring and monitoring forest degradation in the context of climate change mitigation and establish complementary platforms for national decision makers, technicians and international researchers to share information on methodologies and approaches. It is hoped the discussion and debate during the workshop and the release of the USAID LEAF Forest Degradation Guidance and Decision Support Tool will go some way towards advancing this goal.

[35] Stibig, H. *Strengthening national and regional capacities for reporting on the mitigation actions of the forest sector.* 2015 workshop presentation: http://www.leafasia.org/library/strengthening-national-and-regional-capacities

Annex 1: Summary of Participant Feedback and Suggested Next Steps

Results from the workshop evaluation revealed that participants generally enjoyed the workshop and gained new knowledge. When participants were asked if the workshop met their expectations, 73% of respondents said 'Yes' (see Figure 1) and when asked if the workshop content was applicable to the participants job, 58% responded 'significantly' (see Figure 2).

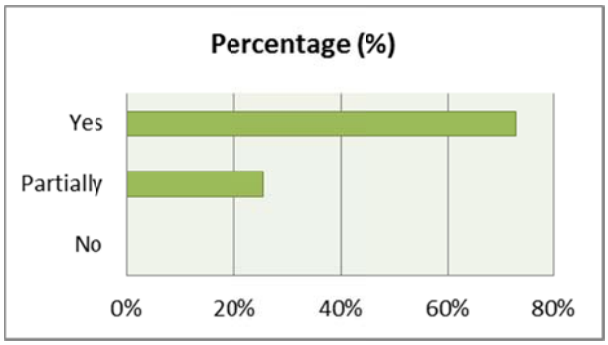

Figure 1: Participants responses to the question, 'Did the workshop meet your expectations?'

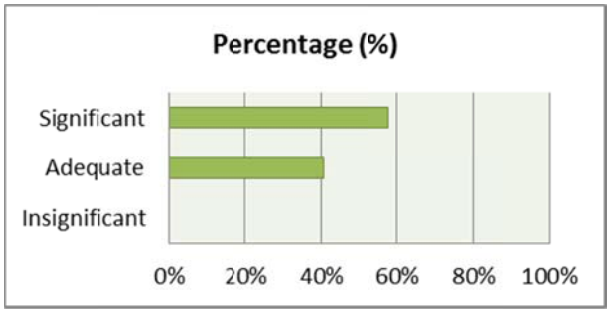

Figure 2: Participants response to the question, 'How applicable was the workshop content to your job?'

The strongest points of the workshop are outlined in Table 7. The list of issues is in an approximate order of importance.

Table 7: Participants consideration of the 'stronger' points of the workshop

Issues	Indicative Responses from participants
Opportunity to learn from other delegates	• "Country groups - active learning, discussion, participation" • "Interaction with the non-Annex I countries- contacts", "Country engagement and information sharing" • "I found the space for dialogue the most productive, as well as case studies on countries in the region".
Organization and interaction with topic specialists	• "Group work and strong facilitation. High technical experts and open discussions" • "Technical contents presentation. Presence of experts/resource persons are very knowledgeable. Participation of different countries - exchange of information and experience" • "Diverse participants and diverse resource persons" • "Gathering people from all over the region that gave interesting inputs. Good balance of international expert/local representative" • "Overall organization: I liked the way the presentations and interactive sessions followed the logic and step wise organization of the guidance document" • "The strongest points are: Sufficient resource persons - presentation on each topic and country group works because those points helped me to understand the workshop topics"
Definitions and	• "Discussions on Degradation definitions and its assessment parameters"

implications of how degradation is defined.	• "Definition of degradation, vital to define for policy and decision making" • "Definition of degradation, every country has their own definitions/ interpretations. Even though its varies between countries, at least now participants have better information/knowledge on the matter" • "The presentation on defining degradation and how to set up monitoring. They helped the country discussions which brought up questions that may not have been considered in previous NFMS discussions"
Discussion on activity- based and land-based accounting approaches	• "Opportunity to consider degradation from the beginning. Land based and activity based are very critical to contribute to considering degradation" • "Accounting methods for measuring and monitoring degradation. Remote sensing guidance" • "Activity data/landscape data to assess emissions" • "Help me understand more about Activity based. Was very helpful for us to see divers of forest degradation"
Methods for monitoring forest degradation	• "The strongest point was measuring and monitoring degradation because for me this was new knowledge" • "New technology to use in detecting change in forest areas (ie LIDAR and SAR)" • "The guidelines for monitoring forest degradation (eg IPCC, Winrock)" •
The framework presented to assist countries develop a degradation measuring and monitoring plan	• "Framework for making decisions about monitoring degradation" • "Forest degradation technical guidance document"

When participants were asked what may have been improved, the issues outlined in Table 8 were identified

Table 8: Participants views on what could have been improved

Issues	Indicative Responses from participants
Increased emphasis on methodologies for measuring and monitoring	• "Should spend more time on LIDAR, RADAR techniques" • "Technical capacity building on data gathering. Processing high resolution imagery. Satellite monitoring" • "We could be improve the methodology about how to monitor degradation in regional Asia" • "Capacity building for technical software and RS image processing" • "The RS component was a little bit short, especially the splinters. I would have liked to visit both groups" • "Explore more quantifiable ways of measurement" • "More technical discussions, go deeper next time" • "For the points we could be improve more methodology for measuring and monitoring in Asia" • "Degradation assessment methods and monitoring methods" • "Methodology for measuring of degradation" • "Technique on measuring and monitoring using remote sensing technology"
More group discussion and better guidance	• "Time for group discussion should be longer. It possible follow up w/s should be set after discussion in own countries" • "Clearer objectives and more prep work to determine country level of activity and knowledge before the workshop" • "Need more guidance on group work as participant some time worked on the right track and out of topic" • "More interaction and discussion with the w/s on DeG issues on country experiences"
Better examples/ understanding on	• "Examples of land based and activity based approaches" • "More elaboration on land based approach"

activity and land based accounting	• "More certainty about accounting approaches"
Better exploration of definitions	• "Starting on definitions - share local specific definitions on what is degradation is • "Definition of degradation should be harmonized for all countries"

When asked about additional topics, participants list issues around the use of remote sensing technology to detect, measure and monitoring degradation. After this, the topics listed below are in no particular order:

- Hand-on training on remote sensing/GIS software to estimate degradation and capacity building in remote sensing technologies and methodologies to detect degradation.
- The use of LIDAR, SAR and other high resolution imagery.
- Methodologies to remove cloud and haze factors to detect forest disturbance.
- The use of medium resolution satellite imagery as an element in monitoring degradation.
- More information on QA/QC approaches.
- How to combine or phase activity and land based accounting approaches.
- How to account for shifting cultivation.
- How to detect degradation for logging and fuel wood collection.
- Impact of degradation on ecosystem services and methods to estimate this.
- How to calculate and produce a matrix of change for forest degradation over time.
- "Grand overview of all datasets and tools available and knowledge on where to find these (and which are free)".

Annex 2: Workshop Agenda

Day 1, Tuesday June 16, 2015: Why Measure Degradation –Reasons and Rates?

Time	Session Theme	Title	Presenter
9:00am	***Start***		
20 mins	Open & Welcome	Opening and Welcome • Vili Fuavao, Deputy Regional Representative, FAO Regional Office for Asia and the Pacific • Mrs. J. Lundmark, EU Delegation • Dr Geoff Blate, US Forest Service	
10 mins		Workshop aims and structure	Peter Stephen USAID LEAF
20 mins	Why Measure?	Why worry about forest degradation? Multiple perspectives and multiple dimensions	Dr Deborah Lawrence University of Virginia
20 mins		UNFCCC and IPCC guidance on measuring and monitoring forest degradation	Dr. Sapit Diloksumpun Kasetsart University
20 mins		The policy imperative for acting on degradation – investments and management.	Ben Vickers FAO/UN-REDD
10:30-11:00	***Break***		
20 mins	Why Measure?	Measuring degradation for REDD+ forest reference emission levels / forest reference levels	Dr Julian Fox FAO/UN-REDD
20 mins	Why Measure? Country Case Study	Case Study 1: Vietnam (Reasons, rates and definition)	Mr. Vu Quang Hien Forest Inventory and Planning, MARD
20 mins		Case Study 2: Sri Lanka (Reasons, rates and definition)	Raushan Kumar FAO/UN-REDD Sri Lanka
12:00-1:00	***Lunch***		
15 mins	Why Measure? Guidance	Overview of critical decisions and key components in planning to measure and monitor degradation	Katie Goslee Winrock International/ USAID LEAF
15 mins		USAID LEAF/USFS Regional Review- Guidance and 'Best Practice'	Rick Turner USFS
60 mins		**MIXED Country group work #1:** Why measure? What is the motivation?	**Break-Out Groups**
2:30-3:00		***Afternoon Break***	
20 mins	Guidance	Estimating national and sub-national levels of forest degradation: Identifying the significance of degradation activities.	Katie Goslee Winrock International/ USAID LEAF
20 mins		Approaches to Monitoring Forest Degradation for REDD+, GFOI GOFC-GOLD Guidance for Asia	Dr Deborah Lawrence University of Virginia
60 mins		**Country group work #2:** Assessing and defining degradation?	**Break-Out Groups**
20 mins		Feedback and Review	
5:00pm		***Close***	

Day 2, Wednesday June 17, 2015: Process and Practice

Time	Session Theme	Title	Presenter
9:00am		***Start***	
30 mins	Data and Approach	Accounting methods for Measuring and Monitoring Degradation.	Katie Goslee Winrock International/ USAID LEAF
30 mins		Remote Sensing Regional Review- Guidance and 'Best Practice'	Jukka Miettien JRC and CRISP/National University of Singapore
10-10:30		***Morning Break***	
	Data and Approaches (***Activity Data)***	**Medium Resolution Imagery**. Is it good enough?	**High Resolution Imagery**: Is it needed?
20 mins		Google Earth Engine and CLASLite for rapid detection in 4 countries — Ian Housman, Paul Maus, Veerachai Tanpipat USFS/USAID LEAF	Detecting degradation in Laos — Dr. Kajiwara Kokusai Kogyo Co., Ltd.
20 mins		LandSat and time series analysis in Vietnam — Jim Vogelmann USGS EROS Center/ Silvacarbon	Lidar to detect degradation, USA & Nepal — Dr Amanda Whitehurst, USFS
20 mins		CollectEarth in PNG — Gewa Gamoga, PNGFA	Monitoring forest degradation using LiDAR & SAR data — Dr. Sandra Englhart RSS - Remote Sensing Solutions GmbH
45 mins		**Country Group Work #3: Activity Data** *What is needed and what is good enough? Are the right data being collected to answer the right questions?*	**Break-Out Groups**
12:15:-1:15		***Lunch***	
20 mins	Data and Approach ***(Emission Factors)***	Measuring degraded forests and developing emissions factors in Bangladesh	Mr. Md. Shams Uddin USAID CREL
20 mins		Measuring degraded forests developing emissions factors in Laos	Gabriel Eickhoff Forest Carbon
20 mins		TBA	TBA
45 mins		**Country Group Work #4: Emission Factors** *What is needed and what is good enough? Are the right data being collected to answer the right questions?*	**Break-Out Groups**
3:00-3:30		***Afternoon Break***	
20 mins	Methods and Utility	Shifting Cultivation: Activity Data & Emission Factors for an integrated, scalable system	Kiyono Yoshiyuki (FFPRI)
20 mins		Logging (Planned and Unplanned: Activity Data & Emission Factors for an integrated, scalable system	Sandra Brown (Winrock/USAID LEAF)
20 mins		Fire emissions (planned and unplanned): Activity Data & Emission Factors for an integrated, scalable system	Anuchit Ratanasuwan Director Geoinfomatics & Veerachai Tanpipat (USAID LEAF)
60 mins		**Panel Discussion:** *Are the right data being collected to answer the right questions?*	Panel made up of above presenters
5:30		***Close***	

Day 3, Thursday June 18, 2015: Plans and Operations

Time	Session Theme	Title	Presenter
8:30am		***Start and Introduction the morning session***	
30 mins	Methods and Utility	Increasing data certainty	Dr Sandra Brown Winrock International
60 mins		**Country Group Work #5 :** Country delegates to share knowledge on national approaches, utility and cost-effectiveness. - What is being monitored? - How often? What method? - Is it effective? (Does it match the Why?)	**Break Out Groups**
10:00-10:30		***Morning Break***	
60 mins	Planning and Operations	**Country Group Work #6:** Completing the degradation measuring and monitoring decision framework	**Break-Out Groups**
45 mins		**Country reporting#7** **- South Asia** **- Lower Mekong** **- Insular Asia + PNG**	
15 mins	Planning and next steps	Introducing the European Union Joint Research Centre's project on 'Capacity Building for Improving the Assessment of Forest Degradation' (ReCaREDD)	Hans-Jürgen Stibig EC JRC/ReCaREDD,
15 mins		Concluding comments and next steps	
12:45		***Lunch and Close***	

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