National Forest GHG Inventories – A Stock Taking

23-25 February, 2010, Yokohama, Japan

Task Force on National Greenhouse Gas Inventories

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INTERGOVERNMENTAL PANEL ON climate change
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National Forest GHG Inventories

– A Stock Taking

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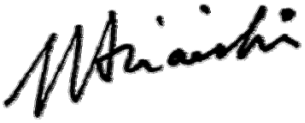
FOREWORD

The IPCC's Task Force on National Greenhouse Gas Inventories has, as part of its mandate, the objective of encouraging users to adopt the IPCC methodological guidelines for estimating national inventories of greenhouse gases. This report is one of a series, developed though expert meetings, which aims to assist users of the guidelines by addressing specific problem areas. Forest GHG inventories are one of the more difficult areas in GHG inventory compilation, in particular for developing countries that face difficulties with data collection, both current and time series, and with appropriate parameters for use in GHG estimation. Reliable monitoring and reporting of forests emissions and removals would be increasingly needed in light of the current negotiations on REDD+ and NAMAs. This Expert meeting sought to address some of the challenges to the application of IPCC Guidelines to forest GHG inventories. The Co-chairs of the Task Force Bureau would like to thank all those involved in this meeting, and we would like to express our sincere thanks and appreciation to IGES and the Government of the Japan for their support by hosting this meeting.

Thelma Krug
Co-Chair Task Force Bureau



Taka Hiraishi
Co-Chair Task Force Bureau

Executive Summary

The meetings reviewed the use of the current IPCC guidelines on forest GHG inventories particularly with regard to the use of remote sensing and ground-based methods of data acquisition on C stocks and area changes of forests[1].

The meeting identified a number of key areas where IPCC TFI could provide advice to the inventory compilers including those on the use of remote sensing and ground-based methods and their combination in forest inventories, on new emission factors and on areas needing fresh or revised guidance. The meeting recommended future actions from IPCC TFI such as addition of new FAQs on the IPCC TFI website, inclusion of new and revised emission factors in the IPCC Emission Factor Database (EFDB), guidance on the use of remote sensing and tools such as online discussion forum and technical bulletins to help inventory compilers.

In particular the meeting noted that there is a need to provide additional guidance on the design of forest monitoring systems including issues such as:

a. *Stratification particularly in dynamic landscapes subject to disturbances and management practices,*
b. *Approaches to sampling,*
c. *Treatment of pools,*
d. *Accuracy/uncertainty assessment,*
e. *Combination of ground based inventories with remote sensing and modelling approaches.*

The meeting noted that there was a need to provide additional guidance on transparently documenting model structure, assumptions and validation and application of QA/QC in LULUCF models and that this would be addressed in the upcoming Expert Meeting on Use of Models and Measurements in GHG Inventories to be held in Sydney, Australia, on 9-11 August 2010.

The participants also noted that now there is more and better information on some areas since the IPCC Guidelines were compiled, for example; Biomass Expansion (and Conversion) Factors (BEF/BCEF); biomass growth and loss in selectively logged forests; losses due to collateral damage and infrastructure damage from selective logging; and emission factors for peat lands.

[1] Presentations made at the meeting are available on the IPCC NGGIP website. < http://www.ipcc-nggip.iges.or.jp/>

1. Introduction

The IPCC held an Expert Meeting on the National Forest GHG Inventories - a Stock-taking on 23-25 February, 2010 in Yokohama, Japan. The meeting was financially supported by the Government of Japan and IPCC wishes to express its sincere gratitude to it.

The IPCC Guidelines on National Greenhouse Gas Inventories are used by Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to report their emissions and removals as required by the Convention. The Revised 1996 Guidelines and the subsequent Good Practice Guidance are currently adopted by the UNFCCC for reporting. The IPCC has recently updated this guidance in the 2006 Guidelines and its use is currently being considered by the UNFCCC Parties. Forest GHG inventories are one of the more difficult areas in GHG inventory compilation, in particular for developing countries that face difficulties with data collection, both current and time series, and with appropriate parameters for use in GHG estimation. More reliable GHG inventories for forests will be increasingly required if UNFCCC deliberations, and agreements, advance on both REDD+ and NAMAs. While there has not yet been a specific invitation to the IPCC for additional work, it is reasonable to expect that eventually there will be expectations on the IPCC work in this area. The meeting was meant to take stock of current knowledge in this area with a view towards contributing to the development of this area as well as towards preparing for the eventual future IPCC work, by

- Exchange of experiences and good practice in this area
- Identification of additional emission factors and other parameters
- Dissemination of this information

While there is no plan to change the 2006 IPCC Guidelines now, the meeting proceedings, FAQs, or new emission factors would better inform inventory practitioners and policy developments. This work could also feed into new guidelines at a future date.

A total of 52 participants including IPCC Task Force on National Greenhouse Gas Inventories (TFI) Co-chairs, Task Force Bureau (TFB) members, experts and members of Technical Support Unit (TSU) took part in the meeting. Presentations were made by 17 experts on topics relating to forest GHG inventories.

2. Summary of discussions

The Expert Meeting started with the opening session chaired by Mr. Takahiko Hiraishi, IPCC TFI Co-chair who welcomed the participants and discussed the background of the meeting.

Mr. Ono, Director, Research and Information Office, Global Environment Bureau of Ministry of the Environment, Japan welcomed the participants on behalf of the Government of Japan. He emphasized the importance of this meeting at the present juncture in climate negotiations. He also highlighted Japan's continued commitment to supporting inventory development and IPCC TFI.

Mr. Kuniaki Makiya, the Secretary General of Institute of Global Environmental Strategies (IGES) welcomed all participants on behalf of I.G.E.S. and noted the long-standing relationship between IGES and IPCC TFI Technical Support Unit (TSU) hosted by IGES. He also emphasized the importance of GHG inventories in climate negotiations and policy-making.

2.1 Presentations & discussions

Opening remarks were followed by the presentations from the TSU giving the general outline and background of the meeting. Simon Eggleston (Head, TSU) provided a brief outline of the meeting objectives in his opening presentation. Nalin Srivastava (TSU) presented a summary of the IPCC guidance on forest GHG inventories.

As the main objective of the meeting was to share experiences and the best practices in the area of forest GHG inventories, the presentations by the 15 invited speakers dealt with a wide variety of topics ranging from the forest GHG inventories under the UNFCCC and the use of the Good Practice Guidance by the countries for their forest GHG inventories for reporting under the Convention to topics related to the use of remote sensing and ground inventories for forest GHG inventories and treatment of issues such as disturbances. The list of presentations[2] is attached as Annex 4.

2.2 Break-out Groups

In the afternoon session on the second day it was decided to convene two break-out groups (BOGs) to continue further deliberations in a focused manner. Based on the outline suggested by Taka Hiraishi the two breakout groups were asked to focus on the following areas:

- *Group 1: Area data*
- *Group 2: Carbon stock change estimation*

[2] Presentations made at the meeting are available on the IPCC NGGIP website. < http://www.ipcc-nggip.iges.or.jp/>

These groups presented on the progress of their deliberations in the morning and later presented their final conclusions in the afternoon to the plenary on the final day.

3. Meeting Discussions

The main discussion points can be summarized as follows:

- The issue of identification of forest areas subject to degradation and distinguishing them from Sustainable Forest Management (SFM) areas. The importance of identifying the drivers of degradation was emphasized as sometimes lowering of carbon stocks alone may not be sufficient to characterize degradation which may be attributable to other factors like age-class structure or management operations. Irreversibility of the process can be another guiding criterion for identifying degradation. It was also mentioned that stratification could potentially resolve the problem of distinguishing the forest areas subject to degradation from SFM areas.
- Use of models in LULUCF inventories. The need for transparency and full documentation of model structure, assumptions, parameters, calibration and validation was strongly emphasized. Various ways to document the models more transparently were suggested such as:
    - Summarizing the outputs of the model and comparing them to Tier 1 and 2 methods as a way of model validation;
    - Making the model source code open to reveal the data;
    - Providing good practice guidance for the use of models in the LULUCF inventories.
- Use of remote sensing (RS) in forest GHG inventories. As in the case of models, transparency and validation of remote sensing was strongly recommended. Some experts noted the great potential of airborne systems like LIDAR for remotely sensing biomass especially considering the lack of ground data and the problems in ensuring coverage for large countries. However there also were some questions raised regarding the effectiveness of remote sensing methods like laser altimetry for selectively logged and multi-strata and multi-species forests. The need for the IPCC to collaborate with other international initiatives on setting of remote sensing standards for forest monitoring such as GEOSS and GOFC-GOLD[3] was also emphasized.
- Experts also highlighted several areas where the IPCC guidance has been difficult to implement or fresh guidance or improved emission factors/parameters were need. These included:
    - Carbon stock change estimations in selectively logged forests. The biomass loss is also due to collateral damage and infrastructure damage from selective logging (e.g. in roads, skid trails, logging damage in gaps etc.) while the appropriate use and magnitude of growth factors in selectively logged forests is unclear.

[3] See www.gofc-gold.uni-jena.de/redd/

- Periodic updating of the IPCC default values of the emission factors and other parameters e.g. Biomass Expansion Factors (BEF) to bring them in line with country-specific values from recent studies was also emphasized as a way to reduce uncertainties in emissions estimations.
- New emission factors for peatlands were also mentioned as a priority area for further work.

- TFI Bulletins, Some experts felt that in light of rapid advancements in measurements, methods and remote sensing, they would strongly recommend the IPCC to issue periodically updated technical bulletins to address important technical issues on a continuing basis.

3.1 Area data

A group with Co-Chairs Gary Richards (Australia) and Frederic Achard (EU) considered issues surrounding area data. The important issues to be addressed were identified as:

- Availability of remote sensing imagery:
  - The issue of suitability of the remote sensing imagery to the forest GHG inventories has to be considered taking into account the issue of multi-scaling and constraints of availability of historical time series remote sensing data and their changes over time. Multi-scaling (imagery) and changes of data availability over time have to be also considered.
  - There is a need for coordination among different agencies to address issues with regard to continuity of remote sensing imagery.
  - Interoperability and comparability between sensors (e.g. between optical and radar) is a major issue to be addressed for a consistent time series of data.
  - There is a need to compile an Inventory of available information on remote sensing from different sources such as UNFCCC, IPCC technical report, GOFC/GOLD, CEOS etc.
  - Periodic updates on the mission status of satellite and airborne remote sensing would be a useful.
  - There is a need to consider data issues such as data distribution policies and data ownership (taking into account international initiatives such as GMES & GEO); cost and access to data including ground infrastructure for reception; and data processing (methods, agencies, archiving and data transfer).
  - Processes for acquiring data should be transparent (e.g. through GEO initiative, FAO process).
- Interpretation of remote sensing data:

- The key issue for forest GHG inventories is change assessment.
- The use of interpretation methods should be transparent, flexible and 'objective-driven' (e.g. through the GEO initiative, FAO processes).
- The important issues to be addressed in interpretation of remote sensing data are:
  - definition of classes (vegetation types, land use categories, subcategories, stratification) and how to apply them consistently over the time series;
  - issue of land use vs. land cover[4];
  - relevance of country information and recognition of national circumstances that are important to interpret the satellite images;
  - biophysical parameters and data assimilation;
  - accuracy assessment, QA/QC and uncertainty assessment;
  - combining data from different sources (satellite, aerial and ground) and with models
  - time-series consistency;
  - objective analysis for consistency between operators should be rule-based.

The group came up with the following specific recommendations:

- Producing an "orientation/getting-started" document to support inventory developers for initiating or advancing inventories (with topics of data sources, stratification, accuracy/uncertainty, transparency) to complement the existing guidelines;
- Producing further guidance on the use of remote sensing and other data sources and techniques for the identification and stratification of areas associated with:
  - disturbances, e.g. fires, illegal logging;
  - management practices, e.g. harvesting (forest land), peat land drainage and rewetting (wetlands).
- Specific advice on technical and methodological practices in applying Approach 3 with regard to:
  - use of remote sensing and other data techniques;
  - assessment of accuracy /uncertainties.
- Specific advice on technical and methodological practices in applying Tier 3.

[4] The land use and land cover issue is addressed in the GPG-LULUCF and 2006GLs

3.2 Carbon stock change estimation

This group with Co-Chairs Zoltan Somogyi (Hungary) and Edwin Castellanos (Guatemala) considered the following issues:

3.2.1 Stratification of forest land:

Guidance on stratification in rapidly changing landscapes was identified as one area where there was a need to share experiences to assess whether more guidance was needed. This could be done by:

- Questionnaire/White Paper on stratification based on the experiences with the IPCC Guidelines; Workshop on experiences with stratification;
- Decision Trees to help stratification of forest lands could be useful to the inventory compliers.

3.2.2 Sampling and monitoring design:

It was agreed that a workshop on the improvement and design of monitoring systems for forest carbon stock change monitoring including a discussion on inventory design, stratification, sampling, pools, and use and integration of existing and evolving new remote sensing data and methods for biomass estimation (e.g. multi remote sensing data layers, very high resolution remote sensing data, LIDAR, etc.). The results should be posted on the TFI website together with a compilation of relevant publications addressing specific issues in sampling design.

3.2.3 Use of models (specific to LULUCF):

The validation and improving the transparency of models is key to their use. A compilation of feedback from reviewers on the disadvantages, shortcomings, and benefits of the use of LULUCF models in National Inventory Reports (NIR) and additional good practice guidance on the use of models in LULUCF will greatly assist improving model reporting especially with regard to:

- transparency in documenting model structure, assumptions, parameters and validation;
- application of QA/QC.

3.2.4 Forest-related uncertainties and QA/QC:

Additional information and advice on uncertainty analysis and the application of the guidelines will help address the problems faced by many inventory compilers, particularly regarding the combination of uncertainties using the error-propagation equation and Monte Carlo methods in LULUCF. This could be provided to users via Frequently-Asked-Questions (FAQ) on the IPCC TFI website, Technical Bulletins and/or a Discussion Forum. It could be supplemented by a compilation of the latest papers on uncertainty assessment in forest inventories on the TFI website.

3.2.5 *Emission factors (EF) and other additional guidance:*

Improved and more specific emission factors for peat lands (both forested and non-forested peat lands in boreal to tropical climate) are now available and should be collected together in, for example, the IPCC Emission Factor Database (EFDB). Participants noted that the EFDB is not easy to use for the land use categories and recommended that some thought is given to redesigning the interface. The TFI should consider holding a special Data Meeting on peat lands.

Specific problems were noted in assessing the damage from selective logging and re-growth afterwards. In particular, the gain-loss method needs to include collateral damage and infrastructure development (roads, skids, decks etc.). In addition, there is a lack of guidance as to what area the re-growth should occur over and there is limited data on the magnitude of the rate of growth and over what time period this should occur in selectively logged forests.

The TFI should consider producing specific guidance on (perhaps through technical workshops):

- estimation of the impact of selective logging on the change of carbon stocks (e.g. from collateral damage to stands, roads, skid trails, etc.);
- guidance on the appropriate use and magnitude of growth factors in selectively logged forests;
- interpretation of good practice guidance (e.g. by decision trees, charts etc.);
- revisiting some emission factors and parameters in the IPCC Guidelines like Biomass Expansion (Conversion) Factors (BEF/BCEF) etc.;
- use of other ways of biomass estimation (e.g. allometric equations).

3.2.6 *Technical Bulletin (TB) (possibly the result from the technical workshop)*

Technical Bulletins could be produced by the TFI to communicate new and updated information to inventory compilers. This could be supplemented by the TFI website providing an internet-based discussion forum on inventory issues and posting links to other tools and models for inventory estimations.

4. Conclusions

1. There is an urgent need to provide additional guidance on the design of forest monitoring systems including issues such as forest inventory design, stratification, sampling, pools, accuracy/uncertainty assessment and the combination of ground based inventories with remote sensing and modelling approaches. It was noted that stratification particularly in dynamic landscapes subject to disturbances and management practices posed a great challenge to inventory compilers. This guidance would assist with fulfilling existing GHG inventory requirements and will be especially important in emerging areas like REDD+ etc.
2. Models pose a unique challenge to the inventory compilers and the reviewers alike. While their use is generally supposed to improve the inventory accuracy, sometimes they are difficult to validate[5] as they often not transparently documented. The meeting noted that there was a need to provide additional guidance on the use of models in LULUCF especially with regard to transparently documenting model structure, assumptions and validation and application of QA/QC. These issues would be addressed in the upcoming IPCC Expert Meeting on Greater Detail in GHG Inventories.
3. The meeting noted that the existing IPCC methods may not provide sufficient detail to capture the biomass growth and loss in selectively logged forests due to collateral damage and infrastructure damage from selective logging (e.g. in roads, skid trails and other logging damage) and the incorrect magnitude of growth factors in selectively logged forests. It was felt that this was one the areas where guidance could be reviewed and revised if necessary.
4. The participants noted that now there is more and better information on emission factors and parameters in many areas since the IPCC Guidelines were compiled. Some of the important ones were Biomass Expansion (and Conversion) Factors (BEF/BCEF), and emission factors for peat lands.
5. Inventory compilers need to be provided with the latest available information and experience (including recently published material) through .updated guidance and sharing experiences with on a continuing basis.

[5] "validate" is used here in an emission inventory sense – to check that the model is consistent with lower tier inventory methods.

6. The meeting agreed the following specific steps to tackle these issues:

a. Expert Meeting on Technical Issues in Forest GHG Inventories to be organized by TFI focusing on the following issues in forest GHG inventories:

   i. design of forest monitoring systems including issues like inventory design, stratification, sampling, pools and accuracy/uncertainty assessment;

   ii. combination of ground based inventories with remote sensing and modeling approaches;

   iii. use of remote sensing data in forest GHG inventories including on stratification, change assessment and use of remote sensing methods for biomass estimation;

   iv. guidance on selectively logged forests.

b. Population of the EFDB with the latest country-specific data in areas where it is relatively poor or has outdated data was suggested as an important step. Participants were encouraged to contribute data to the EFDB. An EFDB Data Meeting on peat lands was proposed.

c. Technical Bulletins produced by expert meetings, and approved by the TFB, on important technical issues for inventory compilers as a way of reviewing the latest technical publications, and other relevant material providing advice and help to the inventory compilers.

d. Discussion Forum on TFI website that includes the latest updated information the latest publications, links to useful websites and other relevant material to help to the inventory compilers on a continuing basis.

e. Addition of important issues requiring clarification or additional advice to the inventory compilers to the FAQs was also suggested.

Table1. List of suggested actions and tools for forest GHG inventories

	TFI Expert Meeting	EFDB/Data Meeting	EFDB	FAQs	Technical Bulletin
Guidance on design of monitoring systems	✓			✓	✓
Guidance on the use of models	✓			✓	✓
Guidance on selectively logged forests	✓		✓	✓	✓
Updates on EFs and parameters		✓	✓		
Peat lands	✓		✓	✓	✓

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Annex 2. **Meeting Agenda**

Agenda

IPCC Expert Meeting on National Forest GHG Inventories - a Stock Taking

23-25 February 2010, Yokohama, Japan

Tuesday 23 Feb

09:30 – 10:00	Registration	
10:00 – 10:30	Welcome	Co-Chairs MoEJ IGES
10:30 – 13:00	Agenda Introduction (Simon Eggleston, TSU) IPCC methodologies for forests (Nalin Srivastava, TSU) Forest GHG inventories reporting under UNFCCC Maria Sanz-Sanchez (UNFCCC) Review of application of GPG - LULUCF Guidelines for GHG Inventory by Annex-1 Countries Nijavalli Hanumantha Rao Ravindranath (India)	
13:00 – 14:00	LUNCH	
14:00 – 17:00	Continuous forest inventory-CFI- system in use in the State of Amazonas, Amazon region, Brazil Niro Higuchi (Brazil) The Brazilian experience in the use of remotely sensed data to estimate CO2 emissions and removals from forestland Thelma Krug(Brazil) The use of remote sensing in forest carbon estimation: Approaches, technical and institutional issues Gary Phillip Richards (Australia) The use of remote sensing in national forest monitoring for forest GHG inventories Martin Herold (Germany) Forest carbon budgeting using airborne laser altimetry Tatsuo Sweda (Japan) Remote sensing of carbon stock and carbon sequestration potential in Southern African forests Amon Murwira (Zimbabwe) Design of forest MRV system in Tanzania Erkki Tomppo (Finland) (Remote presentation from Finland) DISCUSSION	
18:00	RECEPTION (transport will be provided from the venue to the reception, and back to the hotels afterwards)	

Wednesday 24 Feb

10:00 – 13:00	Canada's National Forest Carbon Monitoring, Accounting and Reporting System: combining inventories, remote sensing and models to estimate emissions and removals Werner Alexander Kurz (Canada) Japan's experience in forest carbon accounting Mitsuo Matsumoto (Japan) Recent progress on forest monitoring in UK and potential applications to carbon reporting Robert Matthews (UK) Forest disturbances in Mexico Bernardus H.J. de Jong (Mexico) Emission factors from selective logging and update on default C stocks for tropical forests Sandra Brown (USA) How well do we know carbon balance in China? Baozhang Chen (China) DISCUSSION – Decide BOGs
13:00 – 14:00	LUNCH
14:00 – 17:00	Breakout Groups 1: Use of remote sensing and ground based measurements for assessing deforestation 2: Techniques for assessing and measuring forest degradation

Thursday 25 Feb

10:00 – 13:00	Breakout Groups continue and agree text for meeting report.
13:00 – 14:00	LUNCH
14:00 – 17:00	Plenary: Agree Draft Meeting Report

Annex 3. **References**

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IPCC (2000). Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., and Tanabe K.(Eds.). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. IPCC/OECD/IEA/IGES, Hayama, Japan.

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IPCC (2006). Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme*, *Published*: IGES, Japan.

Annex 4. **Presentations**

- *"Introduction" Simon Eggleston (TSU)*
- *"IPCC methodologies for forests" Nalin Srivastava (TSU)*
- *"Forest GHG inventories reporting under UNFCCC" Maria Sanz-Sanchez (UNFCCC)*
- *"Review of application of GPG - LULUCF Guidelines for GHG Inventory by Annex-1 Countries" Nijavalli Hanumantha Rao Ravindranath (India)*
- *"Continuous forest inventory –CFI-system in use in the State of Amazonas, Amazon region, Brazil" Niro Higuchi (Brazil)*
- *"The Brazilian experience in the use of remotely sensed data to estimate CO_2 emissions and removals from forest land" Thelma Krug (Brazil)*
- *"The use of remote sensing in forest carbon estimation: Approaches, technical and institutional Issues" Gary Phillip Richards (Australia)*
- *"The use of remote sensing in national forest monitoring for forest GHG inventories" Martin Herold" (Germany)*
- *"Forest carbon budgeting using airborne laser altimetry" Tatsuo Sweda (Japan)*
- *"Remote sensing of carbon stock and carbon sequestration potential in Southern African forests" Amon Murwira (Zimbabwe)*
- *"Design of forest MRV system in Tanzania" Erkki Tomppo (Finland) (Remote presentation from Finland)*
- *"Canada's National Forest Carbon Monitoring, Accounting and Reporting System: combining inventories, remote sensing and models to estimate emissions and removals" Werner Alexander Kurz (Canada)*
- *"Japan's experience in forest carbon accounting" Mitsuo Matsumoto (Japan)*
- *"Recent progress on forest monitoring in UK and potential applications to carbon Reporting" Robert Matthews (UK)*
- *"Forest disturbances in Mexico" Bernardus H.J. de Jong (Mexico)*
- *"Emission factors for selective logging and update on default C stocks for tropical forests" Sandra Brown (USA)*
- *"How well do we know carbon balance in China?" Baozhang Chen (China)*