Report of "Training on GHG inventory and emission factors estimation for AFOLU/ LULUCF sector in Pakistan" 10-12th March 2015

at

Islamabad

Reducing Emissions from Deforestation and Forest Degradation (REDD+): "Preparation of Action Plan and Capacity Building for a National Forest Monitoring System (NFMS)"

Table of Contents

Background and Objectives

A complete and transparent GHG inventory is essential for understanding emission trends and assessing the international community's collective and individual efforts to address climate change and meet the ultimate objective of the Framework Convention on Climate Change (UNFCCC). GHG inventories can be used to evaluate mitigation options, assess the effectiveness of policies and measures, make long term emissions projections, provide the foundation of emission trading schemes and identify sectors for cost-effective emission reduction opportunities.

When reporting to international conventions and participating to voluntary performance-based mechanisms like REDD+, the consistency of the provided information is a key principle.

In the frame of the UN-REDD programme in Pakistan, which aims at reducing emissions from deforestation and forest degradation, targeted support on the following actions were required: 1. Development of an action plan for the National Forest Monitoring System (NFMS), 2. Capacity development for NFMS Action Plan. This activity is part of the Output 1.2 of the Support to National Actions of the UN-REDD programme and aims at supporting capacity building of national staff on GHG inventory and on estimation of national Emission Factors for the AFOLU/LULUCF sector. The training was focused on the issues related to GHG Inventory methodologies, and to the estimation of emission factors for Forestry, Agriculture and Land Use Changes, following the diverse suite of capacities in Pakistan.

The objectives of the workshop were, as follows:

- Build capacity of national staff on GHG inventory for the LULUCF/AFOLU sector and on estimation of national Emission Factors for the AFOLU/LULUCF sector;
- Participants will be familiar with IPCC Guidelines and greenhouse gas inventory procedures;
- Participants will be able to produce and analyze country emission factors for the LULUCF/AFOLU sector.

The implementation of the training followed some general principles that proved to be successful in previous capacity development programs and was consistent with the guiding Principles of the UN-REDD NFMS Strategy, such as:

- Step-wise approach;
- Build upon existing capacities;
- Make use of available tools that are freely available and preferably open source;
- Alignment with the UNFCCC COP decisions and IPCC guidance and guidelines;

- Build on lessons learned from former capacity building projects.

Training Participants and Agenda

The training was targeted to the technical staff working on Green House Gas inventory for the LULUCF/AFOLU sector in Pakistan, Officers representing an administrative body with the capacity to present the different initiatives and the institutional arrangements in the country and experts belonging to the Unit responsible for GHG inventory (with the necessary technical skills). 25 participants from various national and subnational entities in Pakistan (Annex-II) participated to the training on GHG inventory for LULUCF in Islamabad. The training focused on supporting capacity building of national staff on GHG inventory for the LULUCF sector and on the use of the IPCC software, (2) develop understanding of IPCC methods for GHG inventory, (3) familiarization with IPCC Guidelines and Good Practice Guidance, and (4) enable participants to use data to undertake exercise for carbon and carbon stock changes in aboveground biomass, soil and other pools. The detailed training program is available in annex I.

Organizers and Facilitators

The training was co-organized by WWF-Pakistan and the Ministry of Climate Change with financial support from the Targeted Support (TS) fund of UN-REDD and took place at Hotel Hillview, Islamabad.

The overall training was facilitated by the International Expert Mr. Mathieu Henry. WWF-Pakistan team included Mr. Muhammad Ibrahim Khan and Mr. Muhammad Afrasiyab provided the overall support.

Proceedings of the training

Inaugural Session

Training started with the recitation of Holy Quran by Mr. Muhammad Ibrahim Khan. He welcomed honorable chief guest Mr. Mushahidullah Khan (Minister of climate change), Mr. Patrick Evan (country representative of FAO Pakistan), Mr. Syed Mahmood Nasir (IG forests, MoCC) and all participants of training.

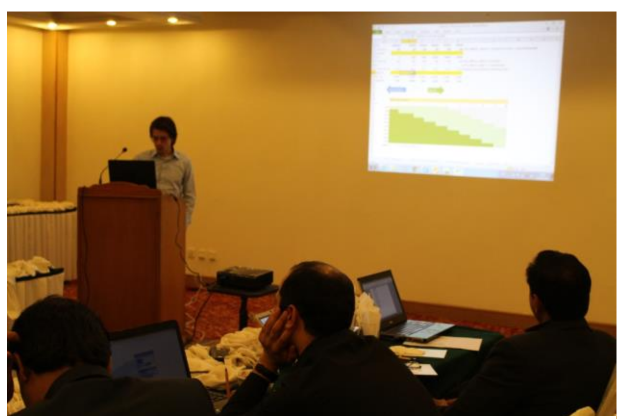

Figure 1 Mr. Matieu Henry briefing about the objectives of the training

Mr. Matieu Henry also welcomed guests and participants. He briefed the participants about the objectives and content of the training. Referring to the importance of the subject he updated audience on climate change factors contributing to emission of GHGs especially contribution of anthropogenic activities in GHG emissions and the adverse impacts faced by the countries. He directed the attention of the audience on recent climate change indicators including temperature rise, glacial retreat, sea level rise and increase in GHG concentration. The importance of GHG-Inventories was emphasized upon in order to identify mitigation measures, effective policies, food security and agriculture resilience.

He discussed four key elements of REDD+ related to UNFCCC decisions i.e. National action plan, NFMS, Safeguards information system and FRL's/FREL's. He gave an overview of recommended (FOSS) advanced tools of GHG monitoring dealing with data collection, data analysis and generation of output maps. At the end he pointed out issues and constraints related to forest monitoring and GHG inventory.

Figure 2 Mr. Patrick Evan, FAO during his speech

Mr. Patrick Evan, country representative of FAO Pakistan, delivered his speech. He shared his past experiences about forest management and its importance in climate change mitigation. Furthermore he discussed impact of climate change in Pakistan like floods, droughts in south east Sindh and advised that forestry can play an important role in climate change mitigation.

Figure 3 Syed Mahmood Nasir during his speech

A short documentary on the basics of REDD+ prepared by office of IGF was shown to the audience. The documentary focused on activities of REDD+, impacts of climate change, role of deforestation in GHG emissions. Furthermore, impact and causes of deforestation in some areas of Pakistan were highlighted including landslides, air pollution, forest fire and desertification.

After the documentary on REDD+, Syed Mahmood Nasir delivered his speech. He greeted honorable chief guest Mr. Mushaidullah Khan, Mr. Patrick Evan and all the other participants of the training. He gave a brief overview of pervious national and international trainings programs in Pakistan during REDD+ readiness phase and praised the role of students in taking interests on the subject.

Mr. Mushahidulah Khan, Minister of climate change as the chief guest delivered his opening speech. In his speech he conveyed the message of Mr. Nawaz Sharif, Prime Minister of Pakistan to leave no stone unturned for the conservation of forest cover in Pakistan. He also revealed his great interest in REDD+ program in Pakistan. He requested media to promote REDD+ as a new method of protecting forests and emphasized on the participation of the local communities and forest dependents. He highlighted some social problems related to environmental pollution and hoped for the solution of these issues on account of new technologies introduced by REDD+ programme. In the end he appreciated the efforts of office of IGF and showed satisfaction over the training contents.

Figure 4 Mr. Mushahidullah Khan during his opening speech

Training Sessions

Presentations by National Experts

GHG Emissions from Agro-Ecosystems in Pakistan: Past Actions at National and Project Level

The first presentation was delivered by Dr. Muhammad Mohsin Iqbal, Head Coordination and agriculture, Global Change Impact Studies Centre. The presentation covered the past actions taken at the national/sub-national level in estimating the greenhouse gas emissions from different sectors including the agriculture and forestry. He described the statistics of direct and indirect emissions and sector wise share of global GHG emissions. Actions taken at national level includes ALGAS (Asian least cost gas abatement strategy) prepared in 1995-98, initial national communication in 1999-2003 and the second national communication prepared by ASAD (Applied system Analysis division of Pakistan atomic energy commission). He also shared experiences of calculating province wise contribution of methane (CH_4) emissions and from burning of crop residue at project level during 2005-

06 in Pakistan. He also mentioned the research/data gaps involved. The detailed presentation is available in Annex III-A.

Pakistan's Current Capacity on National GHG Inventory and Requirements under International Climate Policy Agreements and IPCC Guidelines

The second presentation was conveyed by Mr. Kamran hussain, National Consultant REDD+ Pakistan. The presentation mainly covered the existing capacity and identified gaps in implementing a GHG Inventory following the IPCC guidelines and international climate policy agreements. The detailed presentation is available in Annex III-B.

Figure 5 Presentation by Mr. Kamran Hussain

Important decisions of the COP on MRV, FREL/FRL and NFMS in the context of implementing REDD+ activities

Dr. Shahzad jehangir, Deputy Inspector General Forests, Ministry of Climate Change presented important decisions of the conference of parties (COP) relevant to the development of a National Forest Monitoring System of Pakistan.

Training on GHG preparation of LULUCF in Pakistan

Introduction

Non-Annex I countries parties are requested to use the Revised 1996 IPCC Guidelines and are recommended to use the IPCC GPG-LULUCF 2003 for the preparation of their Greenhouse Gas Inventory. The IPCC provides worksheets for the preparation of the GHG inventory, in which activity data and emission factors are being compiled to make the calculations.


Figure 6 Mr. Matieu Henry, FAO

Basically two methods are proposed to assess carbon stock and stock changes for the LULUCF sector: the stock difference and the gain loss methods. Different approaches are proposed to represent land categories. Countries can use whether tier 1, 2 or 3 values and methods to prepare their GHG inventory. A combination of methods, approaches and tiers can be used depending on resources and data available. Tools such as quality control and key category analysis allows to improving the preparation of the inventory in term of quality and priority. According to the Cancun agreements, countries are requested to prepare Biennial Update Report by December 2014 which includes a national inventory report, and national communications every four years. The training course focused on assessing carbon in different pools, in different land category and particularly on forest, and on calculation methods according to the IPCC Guidelines and Good Practices Guidance.

Presentation of the content and objectives of the training

A complete and transparent GHG inventory is essential for understanding emission trends and assessing the international community's collective and individual efforts to address climate change and meet the ultimate objective of the Framework Convention on Climate Change (UNFCCC). GHG inventories can be used to evaluate mitigation options, assess the effectiveness of policies and measures, make long term emissions projections, provide the foundation of emission trading schemes and identify sectors for cost-effective emission reduction opportunities. When reporting to international conventions and participating to voluntary performance-based mechanisms like REDD+, the consistency of the provided information is a key principle.

In the frame of the UN-REDD programme in Pakistan, which aims at reducing emissions from deforestation and forest degradation, the government has requested targeted support on the following actions: 1. National REDD+ Readiness Roadmap, 2. Capacity development for MRV Action Plan. This activity is part of the Output 1.2. of the Support to National Actions of the UN-REDD programme and aims at supporting capacity building of national staff on GHG inventory and on estimation of national Emission Factors for the AFOLU/LULUCF sector. The training workshop will focus on the issues related to GHG Inventory methodologies, and to the estimation of emission factors for Forestry, Agriculture and Land Use Changes, following the diverse suite of capacities in Pakistan.

The objectives of the training were as follows (1) support building capacity of national staff on GHG inventory for the LULUCF/AFOLU sector and on estimation of national Emission Factors for the AFOLU/LULUCF sector, (2) to familiarize with IPCC Guidelines and greenhouse gas inventory procedures; and (3) to support producing and analyze country emission factors for the LULUCF/AFOLU sector.

Importance of a GHG inventory and IPCC principles

Greenhouse gas inventories are a type of emission inventory that are developed for a variety of reasons. Scientists use inventories of natural and anthropogenic (human-caused) emissions as tools when developing atmospheric models. Policy makers use inventories to develop strategies and policies for emissions reductions and to track the progress of those policies. And, regulatory agencies and corporations rely on inventories to establish compliance records with allowable emission rates. Businesses, the public, and other interest groups use inventories to better understand the sources and trends in emissions.

Unlike some other air emission inventories, greenhouse gas inventories include not only emissions from source categories, but also removals by carbon sinks. These removals are typically referred to as carbon sequestration. Greenhouse gas inventories typically use Global warming potential (GWP) values to combine emissions of various greenhouse gases into a single weighted value of emissions.

The IPCC principles are crucial for the preparation of GHG inventory for LULUCF. Through the national GHG inventory, Parties will quantitatively demonstrate the extent to which LULUCF activities affect their emission reduction commitments. Building on the principles established in the UNFCCC reporting guidelines for biennial GHG inventories, an ideal GHG inventory possesses the following core principles: transparency, consistency, comparability, completeness, and accuracy.

Transparency

Transparency means that the data sources, assumptions and methodologies used for an inventory should be clearly explained, in order to facilitate the replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of the information.

Consistency

Consistency means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. Under certain circumstances, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Comparability

Comparability means that estimates of emissions and removals reported by Annex I Parties in inventories should be comparable among Annex I Parties. For this purpose, Annex I Parties should use the methodologies and formats agreed by the COP for estimating and reporting inventories.

Completeness

Completeness means that an inventory covers all sources and sinks, as well as all gases, included in the IPCC Guidelines as well as other existing relevant source/sink categories which are specific to individual Annex I Parties and, therefore, may not be included in the IPCC Guidelines. Completeness also means full geographic coverage of sources and sinks of an Annex I Party.

Accuracy

Accuracy is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the IPCC Good Practice Guidance, to promote accuracy in inventories.

Institutional arrangements for GHG inventory

Institutional arrangements are crucial for (1) helping each Party meet reporting requirements by ensuring that the GHG inventory is prepared in accordance with the relevant COP decisions (e.g., 17/CP.8), (2) to ensure continuity through the development of national capacities and capabilities, (3) to ensure the sustainability of the GHG preparation process, (4) to inform international, national and local policy making, (5) to foster consistent estimation approaches across government agencies and offices, (6) to coordinate responses to requests for information, and (7) to ensure high quality and objective inventory information.

Figure 7 Participants of the training during training session

Figure 8 Group Work

Elements of a GHG Inventory: (activity data, emissions and carbon-stock-change factors, uncertainty analysis, key categories analysis, CRF tables, NIR)

Inventory agencies, when preparing the national greenhouse gas inventory for the LULUCF Sector for annual reporting under the UNFCCC, should follow steps 1 to 6:

(1) Use the approaches in Chapter 2 (Basis for Consistent Representation of Land Areas), singly or in combination, to estimate land areas for each land-use category relevant to the country. For each land-use category, inventory agencies should complement the advice in Chapter 2 with the more detailed guidance in Chapters 3 and 4 on the preparation of specific emission and removal estimates and, if relevant, the reporting on the activities under the Kyoto Protocol.

Figure 9 Group Work

(2) Follow the good practice guidance in Chapter 3 (LUCF Sector Good Practice Guidance) to estimate the emissions and removals of greenhouse gases for each land use, land-use change and pool relevant to the country. The decision trees in this chapter guide choices of method in terms of tiers. The tier structure used in the IPCC Guidelines (Tier 1, Tier 2 and Tier 3) is hierarchical, with higher tiers implying increased accuracy of the method and/or emissions factor and other parameters used in the estimation of the emissions and removals. Key categories should be identified following the guidance in Chapter 5 and the results taken into account in the application of the decision trees.

Figure 10 Group Work

(3) If necessary, in some cases, collect additional data (if required to implement a particular tier) to improve emission factors, other parameters and activity data.

Figure 11 Group presentation

(4) Estimate uncertainties at the 95% confidence level, using sectoral advice and

the detailed guidance in Chapter 5.

(5) Report the emissions and removals in the reporting tables provided in Chapter 3 Annex 3A.2 taking into account any modifications by SBSTA15 and any additional information as specified under each category.

(6) Implement QA/QC procedures as described in the generic guidance in Chapter 5 and specific advice under each category, including documentation and archiving of the information used to produce the national emission and removal estimates.

Land representation and stratification

Chapter 2 of the GPG 2003 provides indication for the representation of land areas. Information about land area is needed to estimate carbon stocks and emissions and removals of greenhouse gases associated with Land Use, Land-Use Change and Forestry (LULUCF) activities. This chapter seeks to provide guidance on the selection of suitable methods for identifying and representing land areas as consistently as possible in inventory calculations. In practice, countries use methods including annual census, periodic surveys and remote sensing to obtain area data. Starting from this position, Chapter 2 provides good practice guidance on three approaches for representing land area. The approaches are intended to provide the area data specified in Chapters 3 and 4 for estimating and reporting greenhouse gas inventories for different categories of land. The approaches are also intended to make the best use of available data and models, and to reduce, as far as practicable, possible overlaps and omissions in reporting land areas. The approaches described here should minimize the chance that some areas of land appear under more than one activity whilst others are overlooked. The approaches and guidance presented here allow informed decisions on these matters to be made by those preparing greenhouse gas inventories but are not intended to be definitive or exhaustive. Good practice approaches for representing areas should have the following general characteristics: (1) adequate, (2) consistent, (3) complete and (4) transparent.

Figure 12 Mr. Matieu henry during training

The proposed following six broad categories of land are: Forest Land, Cropland, Wetlands, Settlements, Grassland and Other Lands. The categories are broad enough to classify all land areas in most countries and to accommodate differences in national classification systems. These national classification systems should be used consistently over time. The categories are intended for use in conjunction with the approaches described in subsequent sections of this chapter to facilitate consistent estimation of land use over time.

Soil Organic Carbon

Soil organic carbon represents 2/3 of the terrestrial carbon. Although both organic and inorganic forms of C are found in soils, land use and management typically has a larger impact on organic C stocks. Consequently, the methods provided in these guidelines focus mostly on soil organic C. Overall, the influence of land use and management on soil organic C is dramatically different in a mineral versus an organic soil type. Organic (e.g., peat and muck) soils have a minimum of 12 to 20 percent organic matter by mass, and develop under poorly drained conditions of wetlands. All other soils are classified as mineral soil types, and typically have relatively low amounts of organic matter, occurring under moderate to well drained conditions, and predominate in most ecosystems except wetlands. Discussion about land-use and management influences on these contrasting soil types is provided in the next two sections.

Mineral soils are a carbon pool that is influenced by land-use and management activities. Land use can have a large effect on the size of this pool through activities such as conversion of native Grassland and Forest Land to Cropland. Within a land-use type, a variety of management practices can also have a significant impact on soil organic C storage, particularly in Cropland and Grassland.

For organic soils, inputs of organic matter can exceed decomposition losses under anaerobic conditions, which are common in undrained organic soils, and considerable amounts of organic matter can accumulate over time. The carbon dynamics of these soils are closely linked to the hydrological conditions, including available moisture, depth of the water table, and reduction-oxidation conditions. Drainage is a practice used in agriculture and forestry to improve site conditions for plant growth. Loss rates vary by climate, with drainage under warmer conditions leading to faster decomposition rates. Losses of CO_2 are also influenced by drainage depth; liming; the fertility and consistency of the organic substrate; and temperature. Soil C inventories include estimates of soil organic C stock changes for mineral soils and CO_2 emissions from organic soils due to enhanced microbial decomposition caused by drainage and associated management activity. In addition, inventories can address C stock changes for soil inorganic C pools (e.g., calcareous grasslands that become acidified over time) if sufficient information is available to use a Tier 3 approach.

Emission Factors in Forestry

The chapter 3 of the GPG 2003 provides indications methods for estimating carbon stock changes and greenhouse gas emissions and removals associated with changes in biomass and soil organic carbon on forest lands and lands converted to forest land. It is consistent with the approach in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) whereby the annual change in biomass is calculated from the difference between biomass growth and loss terms. The Guidance: (1) Addresses the five carbon pools; (2) Links biomass and soil carbon pools for the same land areas at the higher tiers; (3) Includes emissions of carbon on managed lands due to natural losses caused by fire, windstorms, pest and disease outbreaks; (4) Provides methods to estimate non-CO_2 greenhouse gas emissions; and (5) Should be used together with the approaches for obtaining consistent area data.

The section 3.2.1.concerns forest land remaining forest land and provides guidance for estimation of changes in carbon stock from five carbon pools (i.e. aboveground biomass, belowground biomass, dead wood, litter, and soil organic matter), as well as emissions of non-CO_2 gases from such pools. The section 3.2.2. concerns land converted to forest land. Managed land is converted to forest land by afforestation and reforestation, either by natural or artificial regeneration (including plantations). These activities are covered under categories 5A, 5C, and 5D of IPCC Guidelines. The conversion involves a change in land use.

Data compilation and estimates preparation (data quality, data gaps, data consistency, data sources, quality control and assurance)

Collection activities should be established, adapted to countries' national circumstances, and reviewed periodically as a part of implementing good practice. In most cases generating new source data will be limited by the resources available and prioritization will be needed, taking account the results of key category analysis. Data collection procedures are necessary for finding and processing existing data, (i.e., data that are compiled and stored for other statistical uses than the inventory), as well as for generating new data by surveys or measurement campaigns. Other activities include maintaining data flows, improving estimates, generating estimates for new categories and/or replacing existing data sources when those currently used are no longer available. The methodological principles of data collection that underpin good practice are the following: (1) Focus on the collection of data needed to improve estimates of key categories which are the largest, have the greatest potential to change, or have the greatest uncertainty. (2) Choose data collection procedures that iteratively improve the quality of the inventory in line with the data quality objectives. (3) Put in place data collection activities (resource prioritization, planning, implementation, documentation etc.) that lead to continuous improvement of the data sets used in the inventory. (4) Collect data/information at a level of detail appropriate to the method used. (5) Review data collection activities and methodological needs on a regular basis, to guide progressive, and efficient, inventory improvement. And (6) Introduce agreements with data suppliers to support consistent and continuing information flows.

More information is available at:

http://unfccc.int/national_reports/non-annex_i_natcom/cge/items/2608.php

http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

http://www.ipcc-nggip.iges.or.jp/public/gp/english/

http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm

http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm

Closing Session

After the recitation of Holy Quran, Mr. Ibrahim Khan gave a brief over view of the training session conducted.

Remarks by the Participants

Different representatives from nominated forest department shared their remarks on the training program.

- Mr. Anwar Ali from Pakistan Forest Institute (PFI) appreciated the overall training and advised the organizations to sustain the participation of those officers in training programs/ workshops that have remained a part of pervious trainings and have the basic knowledge about REDD+.
- Mr. Abdur Rauf Qureshi, Conservator Forests, Azad Jammu and Kashmir, advised the formation of a group of foresters from provincial forest departments who should attend the training programs on permanent basis to lead REDD+ in their respective provinces.
- Mr. Kamran Hussian, SDFO GB, also appreciated the role of office of IGF, WWF-Pakistan and UNREDD in conducting the training. He proposed that provincial REDD+ cells should be created and activated in each Province of Pakistan in order to effectively implement REDD+ mechanism.

Figure 13 Mr. Anwar Ali, PFI during his remarks

- Mr. Iftikharul Hassan Farooqi, DFO Punjab raised a few concerns on the repeating of basic training content during past workshops and trainings and suggested that the training should only cover advanced modules. Dr. Ghulam Akbar, Senior Director Programmes, WWF Pakistan acknowledged the concerns however emphasized on the importance of Basics of REDD+ for recalling the previous knowledge of all the participants being on the same page during the main training sessions.
- Mr. SamiUllah, conservator forests, Baluchistan showed satisfaction over the training however suggested leadership roles at federal and provincial level to improve the coordination between organizations and provinces.
- Mr. Inamullah Khan, IUCN, expressed his concern over the shortage of time for the training and suggested that PFI should also arrange similar refresher courses for participants.
- Mr. Atif Shahzad, Assistant Manager SUPARCO expressed his satisfaction over the content of the training and told that the training was very useful and easy to understand.

Figure 14 Mr. Atif shahzad, SUPARCO sharing his remarks

Distribution of Certificates

The certificates of the training were awarded to the participants of the training by the chief guest.

Closing Speech and Vote of thanks

Dr. Ghulam Akbar, Sr. Director Programmes, WWF Pakistan talked about suggestions/ remarks of different representatives of provinces. He concurred with the idea of the participation of same officers to attend the trainings and workshops of REDD+ in order to fully understand training material even in short available time in an effective way. He was grateful to Mr. Matieu Henry for leading the training on GHG-I. He thanked honorable chief guest Syed Mahmood Nasir, IGF for leading the REDD+ process in Pakistan as National Focal Point. He thanked all the training participants and appreciated the hard work of WWF- Pakistan REDD+ team for successfully conducting a fruitful training program.

Figure 15 Dr. Ghulam Akbar, WWF Pakistan during his closing speech

Syed Mahmood Nasir, IGF, in his closing speech thanked the participants and the international trainer for making the training useful. He welcomed the role of young professional in promoting REDD+ in Pakistan. He showed full confidence over the acceptability of REDD+ project in Pakistan and insisted the participants to get fully prepared during the REDD+ Preparedness phase to implement the programme in near future.

Figure 16 Syed Mahmood Nasir, IGF, during his closing speech

Recommendations

100% of the participants in Pakistan evaluated the training as good. Lack of data accessibility has been identified as one of the main issue to support the preparation of the next national communication to the UNFCCC. In addition, further support for building capacity on monitoring natural resources and particularly forest monitoring is essential for Pakistan to operationalize a transparent national forest monitoring system that could support national efforts towards mitigating climate change.

Annex I: Training Program/ Agenda

Date	Programme	Resource person
Day 1		
Session 1: Opening Session		
08:30	Registration of the participant	
09:00	Opening of the workshop	Syed Mahmood Nasir, IGF, MoCC/ Muhammad Ibrahim Khan
09:30	Introduction of participants	
09:45	Presentation of the content and objectives of the training	Matieu Henry
11:00	Arrival of Mushahidullah khan, Minister Climate change	
11:05	Tilawat	
11:05	Importance of a GHG inventory and IPCC principles	Matieu Henry
11:30	Short Documentary on REDD+	MoCC
11:40	Statement by Country Representative FAO	Mr. Patrick Evan
12:00	Statement by Inspector General Forests	Syed Mahmood Nasir
12:15	Opening Speech	Mr. Mushahidullah Khan
13:00	Vote of Thanks	WWF-Pak
12:35	Coffee Break	
12:40	Questions and Answers	
13:00	Lunch Break	
Session 2 : Introduction to the GHG Inventory		
14:15	National GHG inventory requirements for the LULUCF/AFOLU.	Dr. Shahzad Jehangir, (MoCC)
15:00	GHG Emissions from Agro Ecosystems in Pakistan: Past actions at National and Project Level	Dr. Mohsin Iqbal (GCISC)
15:30	Practical session on the importance of a GHG inventory	By groups of 3-4
16:00	Coffee Break	
16:15	National Systems for GHG inventory	Matieu Henry
16:45	Practical session on national systems for GHG inventory	By groups of 3-4
17 :30	End of the day	
Day 2		
Session 2 : GHG Inventory methodologies		
09:00	Recap of previous day	Facilitator
09:10	Elements of a GHG Inventory: (activity data, emissions and carbon-stock-change factors, uncertainty analysis, key categories analysis, CRF tables, NIR)	Matieu Henry
10:00	Coffee break	

10:15	Practical session	By groups of 4
12:30	Presentations by each group	
13:00	lunch Break	
Session 3 : Emission factors		
14:15	UNFCCC guidance and Pakistan's existing capacity for GHG Inventories	Kamran Hussain (National Consultant REDD+)
15:00	Coffee break	
16:15	Emission Factors in Forestry	Matieu Henry
16:30	Practical session on emission factors in Forestry	By groups of 3-4
17 :00	End of the day	
Day 3		
Session 4 : Activity data and land representation		
09:30	Recap of previous day	Facilitator
09:45	Land representation and stratification	Matieu Henry
10:00	Practical sessions on land representation	
10:30	Coffee break	
10:45	Practical sessions on land representation	
13:00	lunch Break	
Session 5 : Uncertainty estimation		
14:00	Data compilation and estimates preparation (data quality, data gaps, data consistency, data sources, quality control and assurance)	Matieu Henry
14:45	Emission Factors in Agriculture	Matieu Henry
15:15	Soil Organic Carbon	Matieu Henry
Session 6 : Concluding		
16:00	Tilawat	
16:05	A brief overview of the day	Mr. Ibrahim Khan
16:15	Remarks by the representatives of each Province and Organization	Mr. Anwar Ali Mr. Abdul Rauf Qureshi, Mr. Kamran Hussian, Mr. Iftikharul Hassan Mr. Kaleem Mr. Inamullah Khan
	A Plenary Discussion with representatives of IESE, NUST	Dr. FAheem Khokhar, OIGF, Trainees, WWF-Pak
16:45	Summary of Recommendations	Mathieu Henry
16:50	Vote of Thanks	Dr. Ghulam Akbar
16:55	Certificate Distribution	
17:00	Closing Remarks	Syed Mahmood Nasir
	Group Photo	
17:10	Refreshments/ End of Day	

Annex II: Attendance Sheets 10-12 March 2015

Day 1

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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16	Mushahidullah Khan	Minister for CC	GOP		-	-
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Day 1

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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Day-2

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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Day - 2

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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Day-3

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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15	Muhammad Afrasiyab	Sr. Proj officer Redd+	WWF-P	03245029077	mafrasiyab@gmail.c	[signature]
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Day - 3

Training on Greenhouse gases Inventory and emission factors estimation for the AFOLU/LULUCF Sector in Pakistan"

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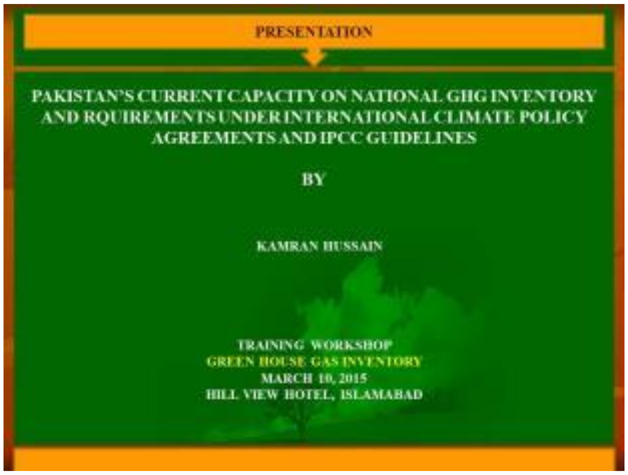
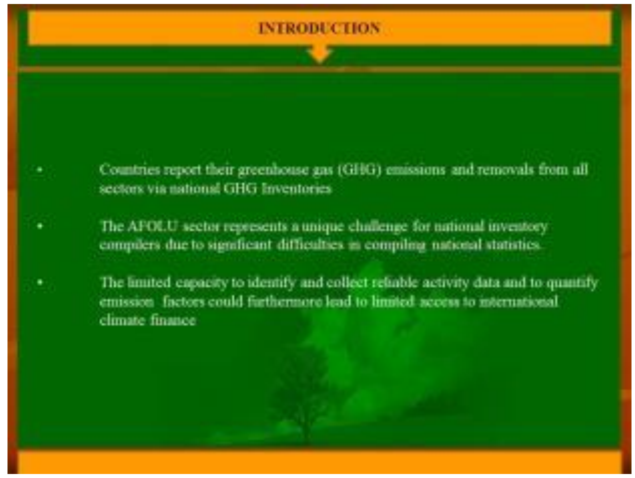
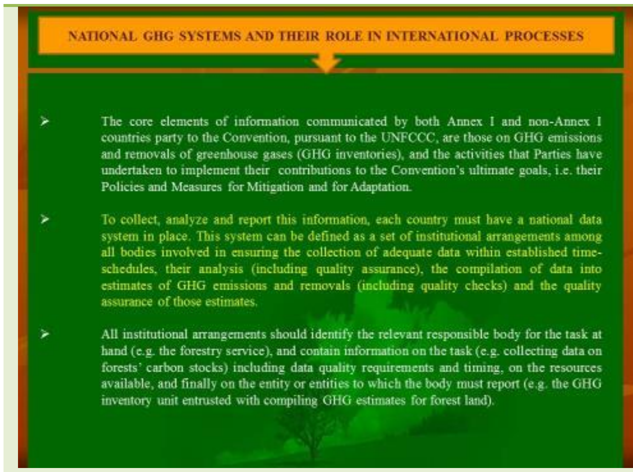
26	NUSRAT SHAHEEN					

Annex III (a) Presentation by Mr. Kamran Hussain







NATIONAL CAPACITY ASSESSMENT ON NFMS

PAKISTAN'S CAPCITY ON GHG – INVENTORY

Pakistan's First National Communication

Pakistan's First National Communication	2003
Pakistan's First Green House Gas Inventory (submitted along with first NC)	▪ Carried out in 1993 – 1994 ▪ Prepared in 1999 – 2003
Methodology for GHGI	▪ Guidelines: IPCC 1996 ▪ GHG source categories: Energy, industrial processes, livestock and agriculture, forestry and land use change, waste sector ▪ Practices: Changes in forest and other woody biomass stock, forest and other grassland conversion, abandonment of managed lands ▪ Emissions estimates: Forest and other biomass stocks
Total estimates reported	223.50 million tons
Total carbon stocks	111.75 million tons (using carbon fraction conversion factor of 0.5)

PAKISTAN'S CAPCITY ON GHG – INVENTORY

Pakistan's First National Communication and GHG Inventory

Average Net Primary Productivity increase of different biomes (base year 1990)	12 %(125.16 million tons) in 2020 19% (132.98 million tons) in 2040-2050

Summary report of National Green House Gas Inventories from Agriculture and Forestry Sectors

Green House Gas Source and Sink Categories	CO2 Emissions	CO2 Removals	CH4	N2O	NOx	CO	NMVOC	SO2	Halocarbons	
									P	A
Agriculture	-	-	**2509.9**	**29.916**	**0.349**	**10.254**	-	-	-	-
A. Enteric Fermentation	-	-	2093.0	-	-	-	-	-	-	-
B. Manure Management	-	-	191.8	-	-	-	-	-	-	-
C. Rice Cultivation	-	-	222.6	-	-	-	-	-	-	-
D. Agriculture Soils	-	-	-	-	-	-	-	-	-	-
E. Prescribed Burning of Savannas	-	-	-	-	-	-	-	-	-	-
F. Field Burning of Agriculture Residues	-	-	0.5	-	-	-	-	-	-	-

PAKISTAN'S CAPCITY ON GHG – INVENTORY

Pakistan's First National Communication and GHG Inventory

Average Net Primary Productivity increase of different biomes (base year 1990)	12 %(125.16 million tons) in 2020 19% (132.98 million tons) in 2040-2050

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Green House Gas Source and Sink Categories	CO2 Emissions	CO2 Removals	CH4	N2O	NOx	CO	NMVOC	SO2	Halocarbons	
									P	A
Forestry and Land Use Change	**6527.1**	-	-	-	-		-	-	-	-
A. Changes in Forest and Other Woody Biomass Stocks	6527.1	-	-	-	-	-	-	-	-	-
B. Forest and Grassland Conversion	-	-	-	-	-	-	-	-	-	-
C. Abandonment of Managed lands	-	-	-	-	-	-	-	-	-	-
D. Emissions from Soils	-	-	-	-	-	-	-	-	-	-

Source: Pakistan's Initial National Communication to UNFCCC, 2003, Exhibit 3.6, Pp 39.

PAKISTAN'S CAPCITY ON GHG – INVENTORY

Pakistan's 2nd National Communication and GHG Inventory

Pakistan's 2nd National Communication	Still due
Pakistan's 2nd Green House Gas Inventory (to be submitted along with 2nd NC)	▪ Carried out in 2007 – 2008 ▪ Prepared in 2009 by ASAD & PAEC
Methodology for GHGI	▪ Guidelines: IPCC 2006 (Tier 1)
Total CO2 emissions reported	166.6 million tons
Forest contribution	5 % of total CO2 emissions
Difference of Emissions from LULUCF sector	1993-1994: 3.6% 2007-2008: 2.9%

PAKISTAN'S CAPCITY ON GHG – INVENTORY

GHG Inventory Results for the Year 2008

Sector	CO_2	CH_4	N_2O	CO	NMVOC
Energy Related	140,160	11,838	2,440	1,706	675
Fuel Combustion	140,160	7,128	2,440	1,704	623
Power sector	44,310	30	63	21	16
Manufacturing	42,408	69	120	93	46
Transport	30,693	243	496	1,533	508
Other sectors	22,750	6,786	1,761	57	53
Fugitive emissions	-	4,710	-	2	52
Non – Energy Related	26,471	99,369	26,098	322	315
Industrial processes	17,551	-	-	-	315
Agriculture	-	94,636	25,326	322	-
Forestry	8,920	-	-	-	-
Waste	-	4,733	772	-	-
Total	**166,631**	**111,208**	**28,538**	**2,028**	**990**

Source: http://www.cdredd.org/sites/default/files/users/common/2011_workshop_durban/presentations/11_Pakistan.pdf

PAKISTAN'S CAPCITY ON GHG – INVENTORY

- It was reported that the country's forests contain 213 million metric tons of carbon in their living biomass (GFRA, 2005).
- Nevertheless, no scientific study was executed on actual measurements regarding biomass and carbon stocks estimation in any forest type of Pakistan and the GFRA (2005)

PAKISTAN'S CAPCITY ON GHG – INVENTORY BASED ON CBNA REPORT

Components	Capacity Assessment
Data Availability and Accessibility	▪ Data available in National Communication 2003 ▪ Data in recent GHG Inventory to be submitted ▪ Data represents Tier – I default values
Technical Capabilities	▪ An Archive system has not yet been developed ▪ The storage capacity of the computers need to be enhanced ▪ Licensed software not available ▪ Web hosting service is not developed
Human Capacity (Processing and Analysis of Information)	▪ All the professional forestry staff of recently created working plan circle is being trained in conventional forest inventories and adequate in numbers ▪ Knowledge about carbon pools and understanding of processes influencing terrestrial carbon stocks is very limited. ▪ Expertise on forest carbon stock assessment is very limited i.e. 1-2 in numbers ▪ Expertise on dealing with technical challenges of image interpretation (cloud cover, geo referencing, missing data, topographic and elevation factors etc) is limited ▪ Expertise dealing with technical challenges of sample design and plot configuration is limited ▪ The knowledge and understanding of IPCC guidance and REDD+ relevant national and international negotiations and UNFCCC decisions is very limited.

PAKISTAN'S CAPCITY ON GHG – INVENTORY BASED ON CBNA REPORT

Human Capacity (Reporting)	▪ Human resource with professional report writing skills ▪ Capacity to review consolidate and integrate the field inventory data and information into forest inventory reports ▪ Understanding of UNFCCC and IPCC reporting requirements
Quality Control and Quality Assurance	▪ Internal verification within the department s is done by the high ranked officials in an hierarchical order but not available for public review ▪ Expertise on the application of statistical methods and understanding of error sources and uncertainties in assessment process are limited ▪ External Review System has not yet established
Training Facilities	▪ Local trainers/ experts on forest carbon accounting are very limited i.e. 1-3 in numbers ▪ Training to the right person and retention of trained person due to transfer and postings is a big issue ▪ REDD+ relevant trainings are being delivered but future availability and sustainability of the relevant experts and trainers could be an issue.

PAKISTAN'S CAPCITY ON GHG – INVENTORY BASED ON CBNA REPORT

Pakistan's NFI Status with respect to REDD+ MMRV and IPCC Indicators

IPCC Indicators	Pakistan's NFI Status
Consistency	There is lack of regular forest monitoring in Pakistan, hence the data is not consistent. To keep the data and methodologies consistent, there is the forest manual of Pakistan, which provides guidance to all the FDs of provinces.
Comparability	Though the existing forest inventory data is comparable among the provinces due to use of same approaches and methods for the development of traditional working plans, however it cannot be compared with respect to the UNFCCC/ IPCC guidelines for carbon based forest inventories.
Completeness	The data is not complete as it did not meet the IPCC and UNFCCC guidelines and lacks: • Carbon based biomass inventory i.e. data on emission factors • Statistical procedures to identify sources of errors and uncertainties
Transparency	The transparency is not ensured in the past forest inventories as these inventories are not available for public review and lacks clarity of data verification (quality control).
Accuracy	Sources of errors and uncertainty issues are not properly addressed.

PAKISTAN'S CAPCITY ON GHG – INVENTORY BASED ON CBNA REPORT

Pakistan's SLMS Status with respect to REDD+ MMRV and IPCC Indicators

IPCC Indicators	Pakistan's SLMS Status
Consistency	The available satellite based studies show that the systematic approaches and methods used for the spatial analysis of forest cover and forest cover change assessments are inconsistent. There is lack of regular forest monitoring in Pakistan.
Comparability	Since methods and approaches used for past satellite based forest inventories are inconsistent, the data is not comparable
Completeness	The data is not complete as it did not meet the following IPCC and UNFCCC guidelines: • Consistent land representation • Data uncertainty management • Clarity of definitions, methods and procedures
Transparency	The transparency is partially ensured in the past satellite based inventories as some of the studies are available for public review and lacks clarity of data verification (quality control).
Accuracy	Sources of errors and uncertainty issues are not properly addressed.

THANK YOU

Annex III (b) Presentation by Dr. Muhammad Mohsin Iqbal

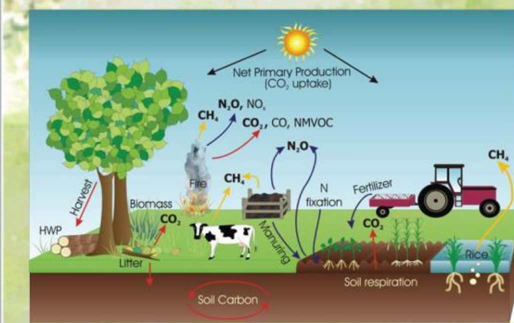
GHG Emissions from Agro-Ecosystems in Pakistan: Past Actions at National and Project Level

GCISC

Muhammad Mohsin Iqbal
Global Change Impact Studies Centre GCISC

Training Workshop
on GHG Inventory for REDD+ in Pakistan
March 10-12, 2015

Greenhouse gas emissions from agro-ecosystems



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AFOLU Sector

➢Agriculture and Livestock sector is the mainstay of the national economy in Pakistan. It contributes 21% to Gross Domestic Product (GDP), accounts for 60% of country's exports, provides livelihood to about 68% of the country's population living in rural areas and employs 45% of the national labor force.

➢Existing forest cover in Pakistan is miserably low: Only about 4.2 million hectares or 4.8% of Pakistan's total land area is under forests, whereas the recommended level for forests is 20-25 percent of land area (GoP-PC 2005).

➢The forests in the mountainous areas of Pakistan are degrading fast with a high rate of deforestation of 0.2 - 0.4% per annum (ADB/GEF/UNDP 1998), believed to be mainly due to illegal cutting of trees for fuel wood and timber.

➢Pakistan is ranked at 135th place on the basis of its per capita GHG emissions without land use change and at 149th place when land use change was also taken into consideration (US-DOE 2009).

3

Sector-wise Share of Global GHG Emissions

[49 Gt CO_2 eq (2010)]

Direct Emissions

	2014 (IPCC AR5)	2007 (IPCC AR4)
• Buildings:	6.4%	7.9%
• Transport:	14%	13.1%
• Industry:	21%	19.4%
• Other Energy:	9.6%	2.8%
• Electricity and Heat Production:	25%	25.9%
• AFOLU:	24%	30.9%

(Contd.)

Sector-wise Share of Global GHG Emissions

Indirect Emissions

- Buildings: 12%
- Transport: 0.3%
- Industry : 11%
- Energy : 1.4%
- AFOLU: 0.87%

Source: IPCC AR5 (2014)

Greenhouse Gases

- Carbon dioxide CO2
- Methane CH4
- Nitrous oxide N2O
- Tetraflouromethane CF4
- Hexaflouroethane C2F6
- Sulfur hexaflouride SF6

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MAIN GREENHOUSE GASES

Greenhouse Gas	Chemical Formula	Pre-Industrial Concentration	Concentration in 2005	Atmospheric Life (years)	Anthropogenic Sources	Global Warming Potential (GWP)
Carbon-dioxide	CO_2	280 ppm	379 ppm	Variable	Fossil Fuel Combustion Land Use Conversion Cement Production	1
Methane	CH_4	700 ppb	1774 ppb	12	Fossil Fuel Rice Paddies Landfill Waste Livestock	21
Nitrous oxide	N_2O	275 ppb	319 ppb	114	Fertilisers Combustion Industrial Processes	310

Ewings, 2007

Past Actions at National Level

1. ALGAS (Asia Least Cost Abatement Strategy):

- Prepared during 1995-98 for the period 1989-90;
- Was based on IPCC Guidelines 1996;
- Funded by ADB (Asian Development Bank);
- Developed by a Consultant.

Past Actions (contd.)

2. INC (Initial National Communication):

- Prepared during 1999-2003 for the period 1993-94;
- Was based on IPCC Guidelines 1996;
- Funded by GEF (Global Environmental Facility) through UNEP (United Nation Environmental Programme);
- Developed by a Consultant (Hagler & Bailly) for Ministry of Environment.

Past Actions (contd.)

3. ASAD (Applied System Analysis Division of Pakistan Atomic Energy Commission):

- Prepared in 2009 for the period 2007-08;
- Was based on IPCC Guidelines 2006;
- No funding, was prepared at the instance of Dr. Ishfaq Ahmad, Special Advisor S&T, Planning Commission of Pakistan);
- The Inventory has been reported in the government documents like Pakistan Economic Survey 2009-10 and Final Report of the Task Force on Climate Change, 2010.

Past Actions at Project Level

- A research paper was written on 'Greenhouse gas emissions from the agro-ecosystems and their contribution to environmental change in Indus Basin of Pakistan', by Dr. Muhammad Mohsin Iqbal, Head, and Mr. M Arif Goheer, Senior Scientific Officer, Agriculture Section of Global Change Impact Studies Centre, which was published in 2008.
- This presentation is based on the data reported in this paper.

Methodology for Emissions Reported in this Presentation

- The data reported in this presentation was taken from the GCISC Paper :
  "Iqbal, M.M. and M.A. Goheer (2008). Greenhouse Gas Emissions from Agro-Ecosystems and Their Contribution to Environmental Change in the Indus Basin of Pakistan. Advances in Atmospheric Sciences, 25 (No.6):1043-1052".
- The estimation of Greenhouse Gas emissions was based on the methodology provided by IPCC 'Guidelines for National Greenhouse Gas Inventories (2006), and
- The national data of different activities leading to greenhouse gas (GHG) emissions.
- IPCC National GHG Inventory software was not used.

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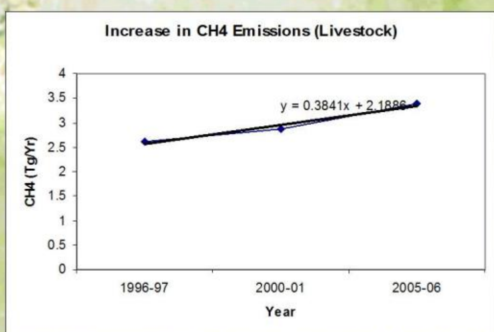
Methane Emissions

- From Livestock
- From Manure Management
- From Paddy Fields

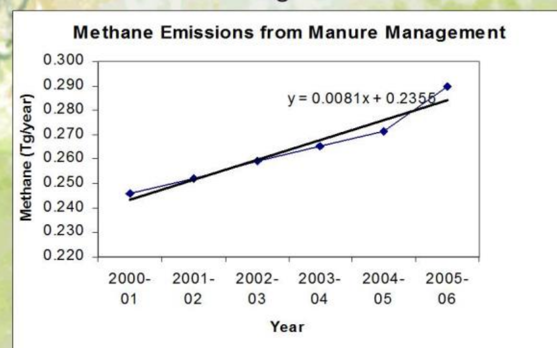
CH4 emissions from different livestock species during 2005-06 in Pakistan

Species	Emission Factor (Kg CH4/head/Year)	Population (Million)	Emissions (Tg/year)	Percent of Total
Cattle	51	25.5	1.301	38.5
Buffalo	55	28.4	1.562	46.2
Sheep	5	25.5	0.128	3.8
Goat	5	61.9	0.310	9.2
Camel	46	0.7	0.032	0.9
Horses	18	0.3	0.005	0.1
Assess	10	4.3	0.043	1.3
Mules	10	0.3	0.003	0.1
Total			**3.383**	

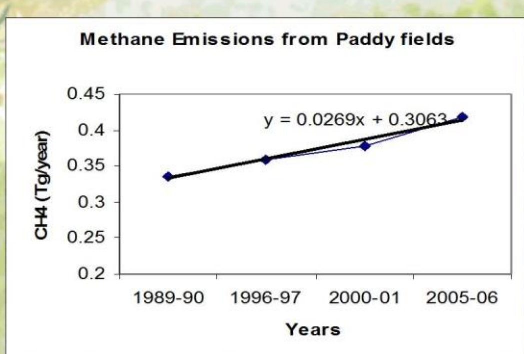
Trend of Methane (CH_4) Emissions from Livestock



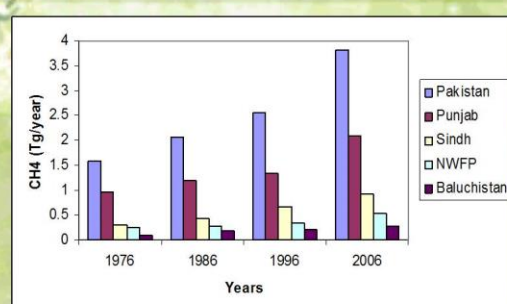
Trend of Methane Emission from Manure Management



Trend of Methane Emission from Paddy Fields



Province-wise contribution to methane emissions from livestock (1976-2006)



Provincial contribution of CH4 from enteric fermentation during the year 2006

Province	CH_4 Emissions (Tg/year)	% Share
Punjab	2.100	55
Sindh	0.910	24
N.W.F.P	0.524	14
Baluchistan	0.273	7
Pakistan	**3.807**	**100**

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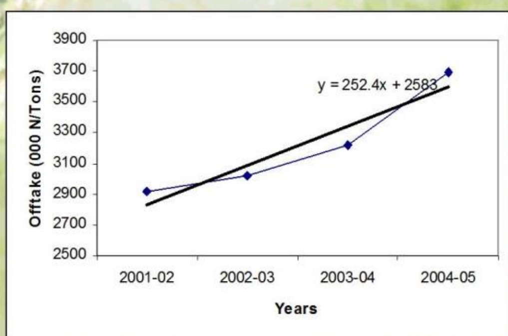
Nitrous oxide Emissions

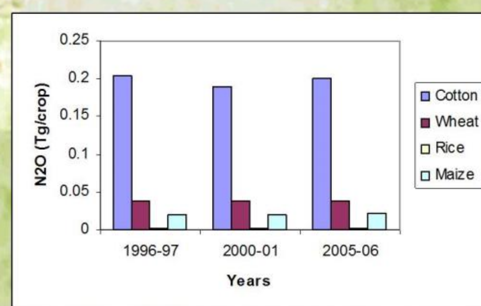
- From Nitrogenous Fertilizer Usage
- From Soils under Major Crops
- From Manure Management

Fertilizer Offtake trend in Pakistan during the period 2001-2004



GCISC

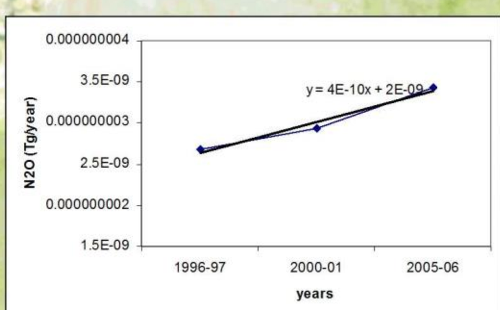
N_2O emissions from soils under major crops through the process of denitirification



Source: Mahmood *et. al.* (2000)
Mahmood *et al.* (1999)

GCISC

N_2O emissions from manure management during 1996-97 to 2005-2006



GCISC

GHG Emissions from Burning of Crop Residue

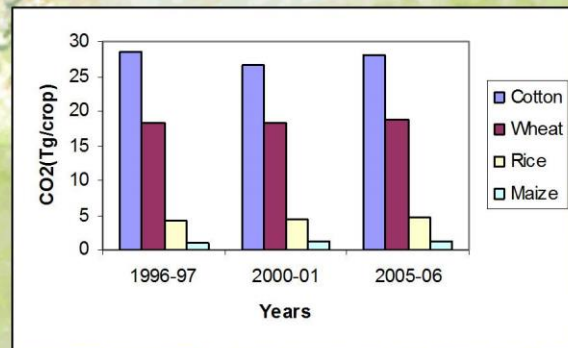
- CO_2 emissions
- CH_4 emissions
- Nox emissions
- Sox emissions

Parameters used in calculation of GHG emissions from burning of crop residues

Crop	Production to residue ratio	Dry matter Fraction	Dry matter* Burnt (%)
Wheat	1.75	0.83	25
Rice	1.76	0.85	25
Sugarcane	0.30	0.71	25
Maize	2.00	0.40	25

* 1 kg of biomass burnt releases 1515 g of CO_2, 207 g of CH_4, 3.83 g of NO_x and 0.4 g of SO_2 (Source: Andreae and Merlet, 2001)

CO_2 emissions from major crops



GHG emissions (Tg/year) from burning of crop residues in Pakistan

Year	Crop	CO_2	CH_4	NOx	SO_2
1996-97	Wheat	9.160	0.0163	0.0232	0.0024
	Rice	2.439	0.0043	0.0062	0.00064
	Sugarcane	3.381	0.0060	0.0085	0.00089
	Maize	0.452	0.0008	0.0011	0.00012
	Total	**15.432**	**0.0275**	**0.0390**	**0.00407**
2000-01	Wheat	10.197	0.0179	0.1031	0.0107
	Rice	2.721	0.0049	0.0069	0.0007
	Sugarcane	3.518	0.0063	0.0089	0.0009
	Maize	0.524	0.0009	0.0013	0.0001
	Total	**16.961**	**0.0299**	**0.1202**	**0.01255**
2005-06	Wheat	11.938	0.0215	0.1207	0.0126
	Rice	3.143	0.0056	0.0079	0.0008
	Sugarcane	3.575	0.0064	0.0090	0.0009
	Maize	1.079	0.0019	0.0027	0.00028
	Total	**19.734**	**0.0354**	**0.1404**	**0.01467**

Source-wise Total Emissions of GHGs in Pakistan during 2006

Source	CH_4	N_2O	CO_2	NOx	SO_2
Enteric Fermentation	3.383				
Manure Management	0.29	3.43×10^{-9}			
Rice Cultivation	0.419	0.0023			
Agricultural Soils		0.2627	52.67		
Burning of Crop Residues	0.0354		19.734	0.1404	0.0146
Total	4.1273	0.265	72.40	0.1404	0.0146

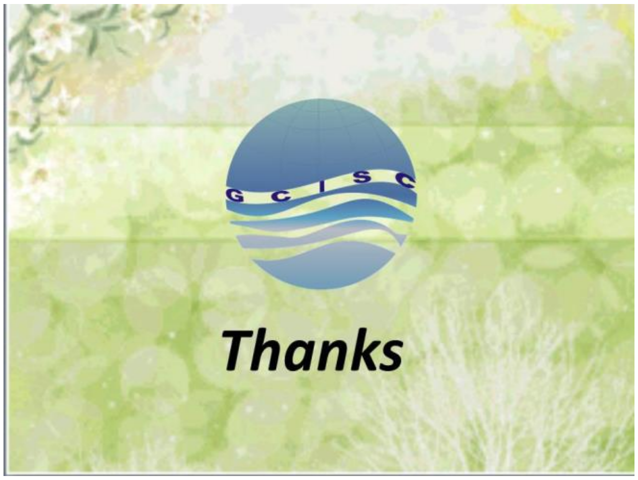
Research/Data Gaps

- Unavailability of data – data may not be there;
- Accessibility of data – data may be there but not accessible because it is considered proprietary, or one may not know whom to approach;
- Reliability of data – may be questionable due to a number of reasons;
- Authenticity of data – should be cross verified.

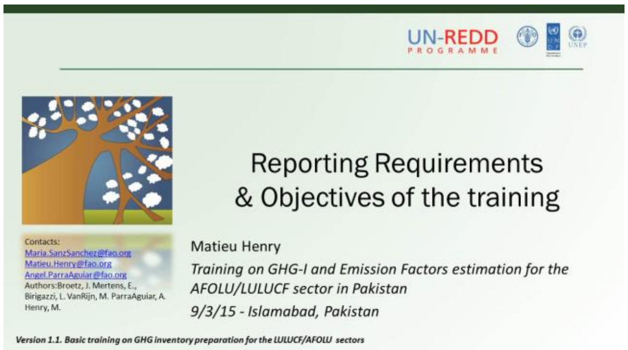
Way Forward for AFOLU Sector

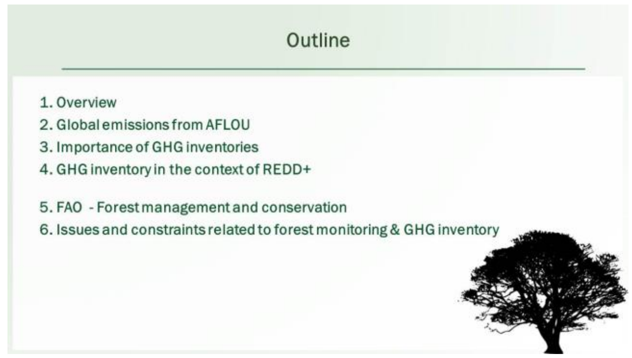
Country specific emission factors for non-CO_2 GHGs are needed for :

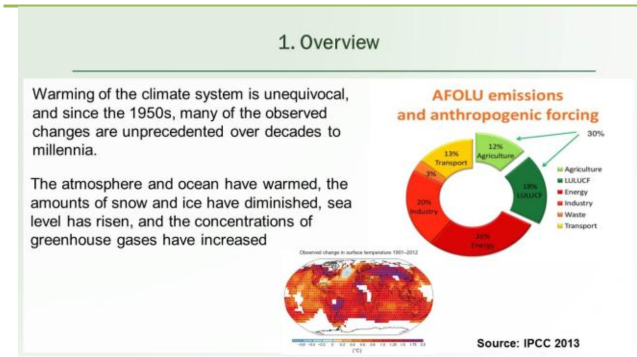
- **Livestock Enteric CH_4 Emission Factor**: these are maximum of agricultural emissions in Pakistan, hence highly important.
- **Rice Methane Emission Factor**: depends on local climatic conditions, cultivar, irrigation method and application of organic material, etc.
- **Emission factor of N_2O**: from application of synthetic fertilizer in agricultural fields.

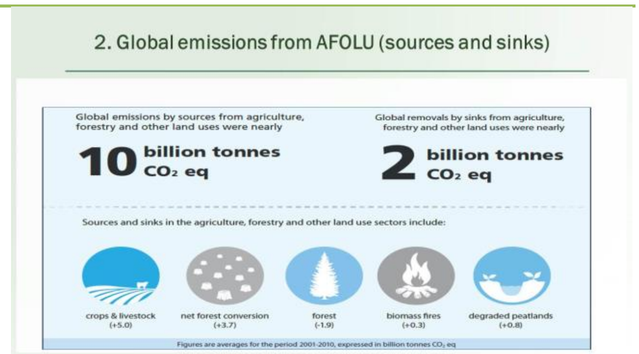

GCISC
Thanks

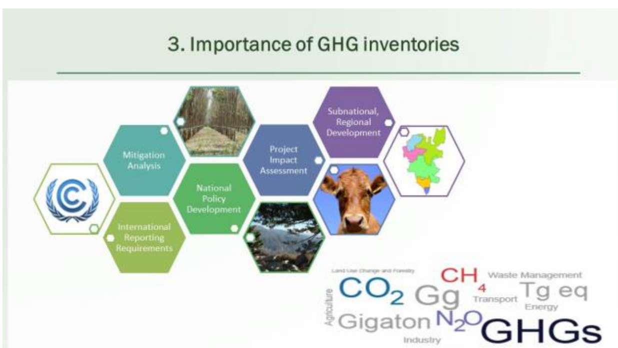
Annex III (c) Presentations by Mr. Matieu Henry

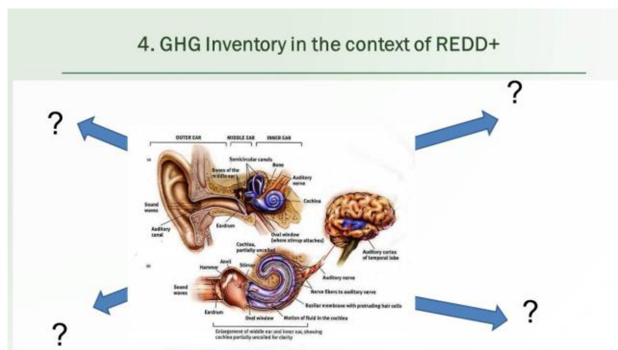


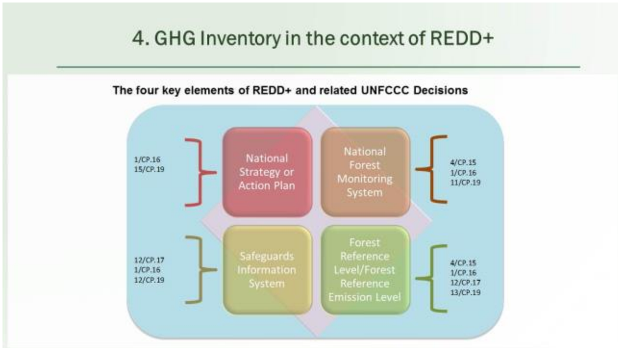











4. GHG Inventory in the context of REDD+
The four key elements of REDD+ and related UNFCCC Decisions
1/CP.16
15/CP.19
National Strategy or Action Plan
National Forest Monitoring System
4/CP.15
1/CP.16
11/CP.19
12/CP.17
1/CP.16
12/CP.19
Safeguards Information System
Forest Reference Level/Forest Reference Emission Level
4/CP.15
1/CP.16
12/CP.17
13/CP.19


A standard
sure we can

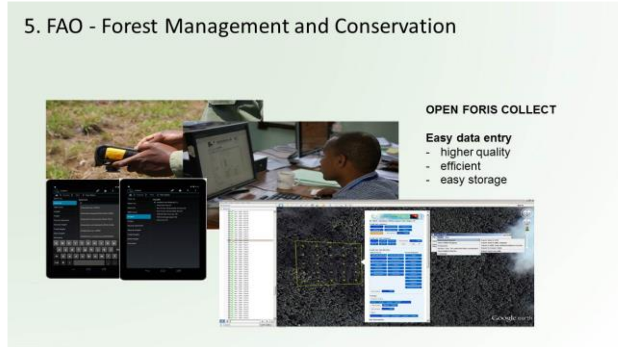

Good practices
ospedale
autostrada
A 3
ospedale
A 3
autostrada

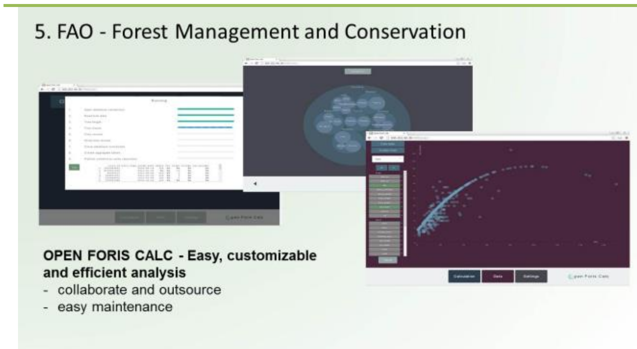

5. FAO - Forest Management and Conservation
FAO supports countries in the development of National Forest Monitoring System
• Building on decades of experience (e.g. NFMA programme).
• Advocating for multi-purpose NFMS→ meeting national and international needs
• Respecting national decisions, and building on existing systems and data.
• Combining multiple expertise (field inventory, remote sensing, information systems, socio-economic assessments, forest governance and policy....)
• Working with a multitude of partners (e.g. UN agencies, Universities, Research centers etc.)
Forestry


5. FAO - Forest Management and Conservation
Two examples of M&A tools developed by the forestry department
OPENFORIS Initiative
Set of open source tools to collect, analyze and disseminate forest resource information.
•Collect - for field data collection and visual interpretation of satellite imagery
•Calc – for easy analysis of the results
•Geospatial Toolkit – for analysis of Remote Sensing data
•Arena – for dissemination of the results
GlobAllomeTree
International web platform for tree allometric equations to support volume, biomass and carbon stock assessment
•Allometric equation database – access to tree allometric equations from all over the world
•Manuals and tutorials, and scientific literature.
•Fantallometrik Software – to compare tree allometric equations
Policies and measures
Forest resources assessment
Analysis
Tree functions
Field inventories


Visits:
• 50,805 visitors
• 00:06:33 average duration of visits
• 55.4 % are new visits
GlobAllomeTree
www.globallometree.org
Launched in July 2013
Field inventory
Capacity building
Registration:
• >1500 registered users
• 125 countries
• 30 countries have > 10 registered users
• 80 institutions have more than 2 registered users


OPENFORIS
Design & Planning
Sampling & protocol design
Field computer setup
Field map production
Data Collection
PC-based data entry
Mobile data collection
Data Processing
Data validation & QA
Result calculation & analysis
GIS/RS analysis
Dissemination & Reporting
1. International Reporting: UNFCCC, GHG, REDD+, FRA
2. National policies
3. Local level planning

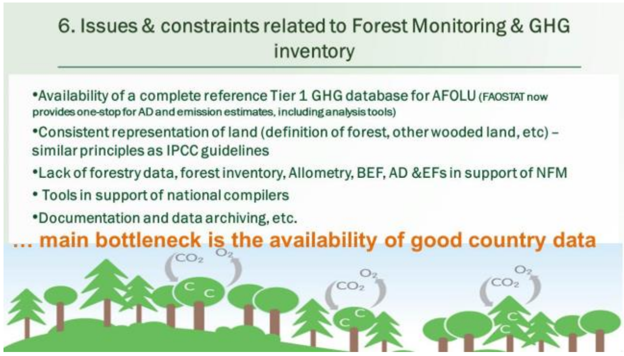

5. FAO - Forest Management and Conservation
OPEN FORIS COLLECT
Easy data entry
- higher quality
- efficient
- easy storage

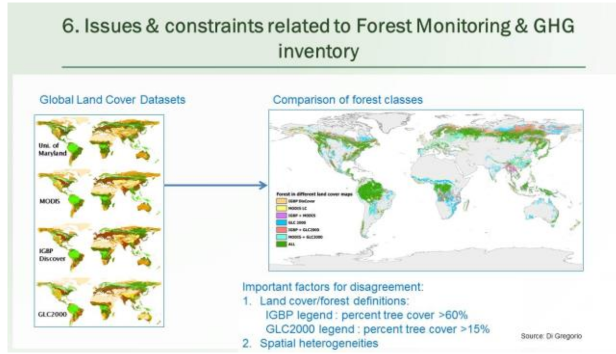

5. FAO - Forest Management and Conservation
OPEN FORIS CALC - Easy, customizable and efficient analysis
- collaborate and outsource
- easy maintenance


5. FAO - Forest Management and Conservation
NAFORMA
MULTI-SOURCE PILOT - Volume
GEOSPATIAL TOOLKIT
Professional image processing
- flexible and efficient
- for experts
- SDMS
FAO Forestry


5. FAO - Forest Management and Conservation
OPEN FORIS ARENA
Share your data and results
- Easy to use
- Dynamic browsing
FAO Forestry

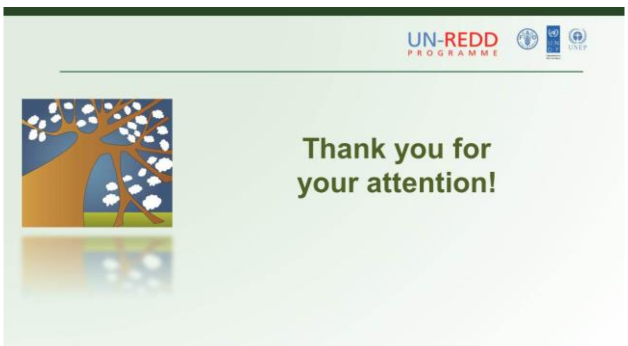

5. FAO - Forest Management and Conservation
COMBINED PROJECTS AND EFFORTS
UNREDD (Norway, CE, Denmark, Spain, Japan, Luxemburg) — 50 countries
FAO-Finland (Finland) — 5 countries
NFMA (Sweden, Finland, USA, Check republic, Brazil, Angola, FAO TCP) — 19 countries
58 countries


6. Issues & constraints related to Forest Monitoring & GHG inventory
•Availability of a complete reference Tier 1 GHG database for AFOLU (FAOSTAT now provides one-stop for AD and emission estimates, including analysis tools)
•Consistent representation of land (definition of forest, other wooded land, etc) – similar principles as IPCC guidelines
•Lack of forestry data, forest inventory, Allometry, BEF, AD &EFs in support of NFM
• Tools in support of national compilers
•Documentation and data archiving, etc.
… main bottleneck is the availability of good country data


6. Issues & constraints related to Forest Monitoring & GHG inventory
Global Land Cover Datasets
Comparison of forest classes
Important factors for disagreement:
1. Land cover/forest definitions:
IGBP legend : percent tree cover >60%
GLC2000 legend : percent tree cover >15%
2. Spatial heterogeneities
Source: Di Gregorio


7. Options for improvement
▪ Create dialogue
▪ Understand each point of view/objectives/priorities
▪ Document , store and archive
▪ Build semantic interoperability
▪ Integrate within one system
▪ Facilitate access and accessibility
▪ Complete & strengthen when possible


7. Options for improvement
A national system to allow a GHG inventory: an example
Geospatial information
Estimating
Livestock
Archiving
National system for GHG inventory
Forest inventory
QA/QC and verification
Soil properties
Planning Managing


UN-REDD PROGRAMME
Thank you for your attention!

Reporting Requirements & Objectives of the training

UN-REDD PROGRAMME

Matieu Henry

Training on GHG-I and Emission Factors estimation for the AFOLU/LULUCF sector in Pakistan

9/3/15 - Islamabad, Pakistan

Theoretical course

Contacts:

Authors: Broetz, J. Mertens, E., Birigazzi, L. VanRijn, M. ParraAguiar, A. Henry, M.

Version 1.1. Basic training on GHG inventory preparation for the LULUCF/AFOLU sectors

Outline

1.1. UNFCCC Background – the Convention

The **UNFCCC**
- Is an **international environmental treaty** negotiated at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, in 1992;
- Has the ultimate goal to "**stabilize GHG concentrations** in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system";
- Consists of **26 articles**.

United Nations Framework Convention on Climate Change

1.2. Articles 4 of the UNFCCC

Article 4: 1) **All Country Parties**

United Nations Framework Convention on Climate Change

a) Develop a **GHG Inventory**;
b) Report national **mitigation activities**;
c) Cooperate in development of **technologies for low emission growth**;
d) Promote **sustainable management** of carbon sinks;
e) Cooperate in **preparation for adaptation**;
f) Incorporate CC considerations in **national policy** development;
g) Cooperate on CC research and h) + i) **dissemination** of information;
h) Communicate **relevant information** to the COP

3) - 5) Annex I + II country Parties shall provide **financial and technical resources and assistance** to NAI country Parties.

2), 6) - 10) [...]

Link Full Article 4

1.3. Articles 12 of the UNFCCC

Article 12: 1) All country Parties shall communicate:
a) "A national inventory of **anthropogenic emissions** by sources and removals by sinks";
b) Steps to be taken to **implement the convention**;
c) Any other **relevant information**.

4) Non-Annex I (NAI) country Parties may **propose projects** to reduce or increment removals of GHG emissions

5) Each NAI country Party should submit the initial communication **three years** after the ratification of the convention or when resources are available*.

9) + 10) Information will be **published** but the information marked as confidential.

2), 3), 6) - 8) [...]

Link Full Article 12

* Least developed countries submit at their own disposal

2. Country Party Reporting Annex I vs Non-Annex I

	Annex I	Non-Annex I
National Inventory Report	x	(x)[1]
Biennial Report	x	
Biennial Update Report		x[2]
National Communication	x	x
Kyoto Protocol	x[3]	
Guidelines to be used	2006 IPCC GL	Rev. 1996, 2000 & 2003 GPG
Funding & Technical supp.	self funded	GEF, GCF, UNEP/UNDP, CGE & Annex I
Timing	with BR requirement to report only biennial together with NC or stand-alone	BUR to be submitted by end 2014[2], every 2 years from then as part of NC or stand-alone
Time series	Every year since 1990 should be included	At least 4 years before submission should be reported on

1 NAI country Parties are encouraged to include a NIR in the BUR but it is not mandatory, 2 LDCs and SIDS are free to report at own convenience, 3 Only countries who ratified Kyoto Protocol

2.2. Transparency and accountability for NAI

At COP 13, through the BAP, Parties agreed on the principle of applying measurement, reporting and verification (MRV) for developing country Parties.

Measurement (M) for NAI Parties applies both to efforts to address climate change and to the impacts of these efforts. It occurs at the national level and refers to GHG emissions, mitigation actions and their effects, and the support needed and received;

Reporting (R) Parties is implemented through the national communications and BURs, where Parties report on their actions to address climate change in their national communications;

Verification (V) is addressed at the international level, through the ICA of BURs; It can also occur at the national level, but is voluntary.

2.2. Transparency and accountability for NAI

National Reports from non-Annex Parties

Submitted NCs	Submitted BURs

Reporting is implemented through NC & BUR. The first NC is expected within 3 yrs of entering the Convention, and every 4 yrs thereafter.
The first BUR should be, consistent with the Party's capabilities or level of support provided, submitted by December 2014, and every two years thereafter. Least developed country Parties and small island developing States may submit BURs at their own discretion.

Consideration of Reports

Compilation and Synthesis Reports	International Consultation and Analysis

Verification of reports is addressed at the international level through the process of ICA of BURs.
Information contained in initial NCs submitted by non-Annex I Parties up to April 1, 2005 is compiled and synthesized into one comprehensive document.

Financial and Technical Support

Financial and technical assistance are essential to helping developing countries prepare their NCs and BURS. Some of the key actors: Global Environment Fund (GEF), Global Climate Fund (GCF), Global Support Programme (UNEP/UNDP), the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention (CGE), and Annex I Parties.

2.3. BUR vs National Communication

BUR

- **National circumstances** and **institutional arrangements** relevant to the preparation of the national communications;
- **National Greenhouse Gas inventory**, including a national inventory report
- **Mitigation actions** and their effects including methodologies and assumptions
- **Constraints and gaps**, and related financial, technical and capacity needs
- Description of the **support needed** and received
- Information on the **level of support received** for the preparation of the BUR
- Information on **domestic MRV**
- Any other relevant information

National Communication

- **National circumstances**
- **National Greenhouse Gas Inventory**
- **General description** of steps taken or envisaged to implement the Convention:
  - Programmes containing measures to facilitate adequate **adaptation** to climate change
  - Programmes containing measures to **mitigate** climate change
- Other information considered relevant to the achievement of the objective of the convention:
  - **Transfer of technologies**
  - **Research** and systematic observation
  - **Education**, **training** and **public awareness**
  - Information and networking
- **Constraints and gaps**, and related financial, technical and capacity needs.

Much more information about BUR reporting for Non-Annex I Country Parties can be found here:
http://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf

2.4. National Communication

Non-Annex I country Parties **should submit** national communications (NCs) (decision1/CP.16): read the requirements in decision 10/CP.2.

NCs shall be communicated to the Conference of Parties (COP) in a **single document** and shall include an **executive summary in hard copy and electronic format**.

The executive summary cannot have more than 10 pages and shall be translated into **English** and made **publicity available**. NC shall be written in one of the official languages of the UN. Additional or supporting information may be supplied through other documents such as a technical annex (Annex to decision 17/CP.8).

2.4. National Communication

Methodology

- According to the decision 17/CP.8, para 11, NAI Parties should use *Revised 1996 IPCC* & are encouraged to apply the *IPCC GPG 2000*, taking into account the need to improve transparency, consistency, comparability, completeness and accuracy in inventories.

Key Category Analysis

- This same decision states that NAI Parties are also encouraged, to the extent possible, to undertake any key source analysis as indicated in the IPCC GPG 2000 to assist in developing inventories that better reflect their national circumstances (17/CP.8,Para 12).

2.4. National Communication

OUTILNE

1. National Circumstances
2. National Greenhouse Gas Inventory
3. General description of the step taken or envisaged to implement the Convention
4. Other information considered relevant to the achievement of the objective of the Convention, in which they are encouraged to provide following information related to:
   - Transfer of technologies
   - Research and systematic observation
   - Education, training and public awareness
   - Capacity-building
   - Information and networking
5. Constraints and gaps, and related financial, technical and capacity needs

According to Annex to decision 17/CP.8

2.5. Biennial Update Report

Since COP 16 held in Cancún, México in 2010, the Non-Annex I country Parties **are obliged** to prepare and report Biennial Update Reports (BURs).

The objective of the BURs is to "**provide an update to the most recently submitted national communication**" (Annex III to decision 2/CP.17).

In accordance with UNFCCC Biennial Update Reporting guidelines, Non-Annex I country Parties should **use the methodologies established by the latest UNFCCC guidelines** for the preparation of national communications from Non-Annex I country Parties.

2.5. Biennial Update Report

The updated national GHG inventory should be based on the methodologies :

- *Revised 1996 IPCC*
- IPCC GPG 2000
- IPCC GPG LULUCF 2003

NAI countries are encouraged to provide a consistent time series back to the years reported in the previous national communications, and if a country reported previously on their GHG inventories is encouraged to submit the summary information tables for previous years (Annex III to decision 2/CP.17, para III.8.)

2.5. Biennial Update Report

OUTLINE

1. National circumstances and institutional arrangements relevant to the preparation of the national communications on a continuous basis;
2. National inventory of anthropogenic emissions by sources and removal by sinks of all GHGs not controlled by the Montreal Protocol, including a national inventory report;
3. Information on mitigation actions and their effects; including associated methodologies and assumptions; i.e. NAMAs,
4. REDD+ activities constraints and gaps, and related financial, technical and capacity needs, including a description of support needed and received;
5. Information on the level of support received to enable the preparation and submission of biennial update reports;
6. Information on domestic measurement reporting and verification;
7. Any other relevant information.

The inventory section of the BURs should consist of a National Inventory Report (NIR) (consistent with capabilities) as a summary or as an update of the information contained in chapter 3 of the outline (National GHGI), (Annex III to decision 2/CP.17, para III. 6.)

2.5. NIR Reporting Requirements for Annex I country Parties

Under the UNFCCC reporting guidelines for Annex I country Parties, inventory submissions are in two parts:

- **Common reporting format (CRF)** – a series of standardized data tables containing mainly numerical information and submitted electronically
- **National Inventory Report (NIR)** – a comprehensive description of the methodologies used in compiling the inventory, the data sources, the institutional structures and quality assurance and control procedures

The secretariat of the convention has prepared an "annotated outline" for Annex I Country Parties to use for the NIR.

2.5. Annotated Outline LULUCF for Annex I country Parties

7.1. Overview of LULUCF (e.g., quantitative overview and description)
7.2. Category (LULUCF) (CRF category number)
7.2.1 Description (e.g., characteristics of category)
7.2.2 Information on **approaches used for representing land areas** and on land-use databases used for the inventory preparation
7.2.3 **Land-use definitions and the classification systems** used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix)
7.2.4 **Methodological issues** (e.g., choice of methods/activity data/emission factors, assumptions, parameters and conventions underlying the emission and removal estimates ñ the rationale for their selection, any specific methodological issues (e.g. description of national methods))
7.2.5 **Uncertainties and time-series consistency**
7.2.6 **Category-specific QA/QC and verification**, if applicable
7.2.7 **Category-specific recalculations**, if applicable, including changes made in response to the review process
7.2.8 **Category-specific planned improvements**, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Guidelines & Manuals for the Preparation of non-Annex I National Reports and International Consultation and Analysis

National Communications (NCs)	Biennial Update Reports (BURs)
Guidelines for the preparation of initial NCs from non-Annex I Parties were adopted at COP 2 in 1996. COP 5 in 1999 initiated a review of the guidelines, and with major contributions by the CGE COP 8 in 2002 adopted the following revised guidelines: Revised guidelines for the preparation of NCs	COP 17 adopted the following guidelines for the preparation of BURs from non-Annex I Parties contained in annex III of decision 2/CP.17: Guidelines for the preparation of BURs
The GEF prepared the following operational procedures for the Expedited Financing of NCs from non-Annex I Parties: GEF operational procedures for financing of NCs	The GEF prepared the following policy guidelines for the financing of BURs for non-Annex I Parties. GEF guidelines for the financing of BURs

Institutional arrangements for NCs and BURs

Toolkit on Establishing Institutional Arrangements for NCs & BURs
The toolkit aims to assist non-Annex I Parties in establishing and maintaining the most suitable

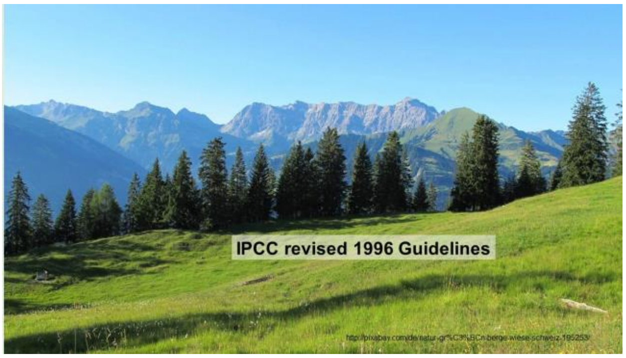
Handbook on MRV for developing countries, User Manual and Resource guide for NCs

The handbook on MRV for developing countries, developed by the secretariat, aims to provide
Handbook on MRV for developing countries:
English (3359 kB)
In response to a request by SBI 18, the secretariat prepared a user manual to facilitate the use of 17/CP.8, and also a Resource Guide for preparing the NCs of non-Annex I Parties.
User Manual:
English

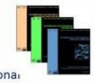
International Consultation and Analysis (ICA)

COP17 adopted the following modalities and guidelines for ICA contained in annex IV of decision
Modalities and guidelines for international consultation and analysis (ICA)
COP 19 adopted the composition, modalities and procedures of the team of technical experts
Composition, modalities and procedures of the team of technical experts (TTE)

http://unfccc.int/national_reports/non-annex_i_natcom/guidelines_and_user_manual/items/2607.php

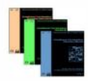


3.1. IPCC GL&GPG - IPCC Revised 1996 GL



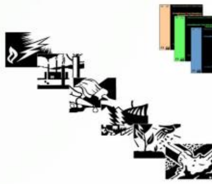
- First accepted 1994, published in 1995 by OECD & IEA
- Revised and approved in 1996
- COP3 (1997) reaffirmed Rev 1996 GL should be used
- Contains 3 volumes:
  I. HOW TO assemble, document and transmit completed national inventory data
  II. STEP-BY-STEP instructions for calculating emissions (CO2, CH4, other trace gases), from 6 emission source categories (Available in several languages)
  III. ADDITIONAL compendium of information on methods, summaries of scientific basis

3.1. IPCC GL&GPG - IPCC Revised 1996 GL



Volume 2 contains chapters on 6 major sectors:

- Energy
- Industrial Processes
- Solvents
- Agriculture
- Land-use Change and Forestry
- Waste



3.1. IPCC GL&GPG - IPCC Revised 1996 GL

Reporting categories – Agriculture & LUCF

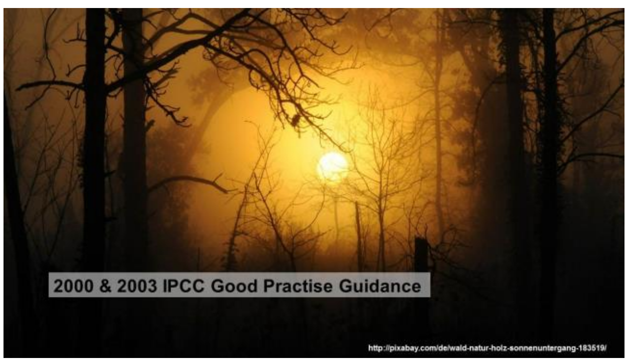
4 Agriculture		
A	Enteric Fermentation	Three-year average
B	Animal Wastes	Three-year average
C	Rice Cultivation	Three-year average
D	Agricultural Soils	Three-year average
E	Prescribed Burning of Savannas	Three-year average
F	Field Burning of Agricultural Residues	Three-year average
5 Land-Use Change/Forestry		
A	Changes in Forest and Other Woody Biomass Stocks	Three-year average
B	Forest and Grassland Conversion	
	- Immediate release from on-site burning	Three-year average
	- Delayed release from decay	Previous 10 years average
C	Abandonment of Managed Lands	Cumulative figures over previous 20 years Total figures more than 20 years ago
D	CO_2 Emissions and Removals from soil	Yearly figures Previous 20 year figures

The most important effects of human interactions with existing forests includes commercial management, harvest of industrial roundwood (logs) and fuelwood, production and use of wood commodities & establishment and operation of forest plantations as well as planting of trees in urban, village and other non-forest locations

The conversion of forests and grasslands to pasture, cropland or other managed uses can substantially change carbon stores in vegetation and soil

Which regrow into their prior natural grassland or forest condition

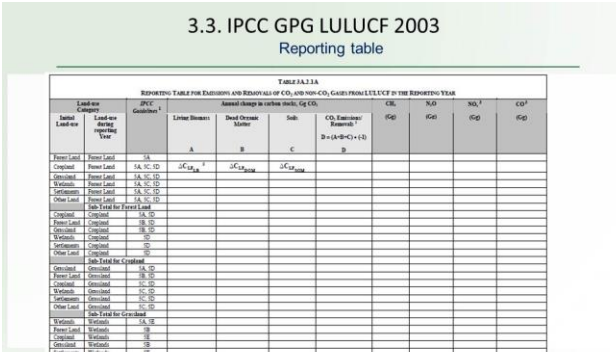
This category covers CO2 emissions or removals from: i) cultivation of mineral soils, ii) cultivation of organic soils, and iii) liming of agricultural soils.

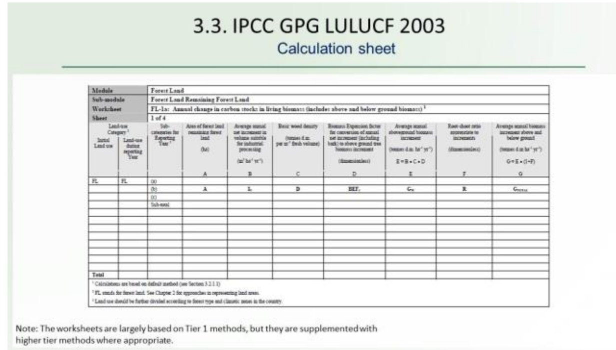


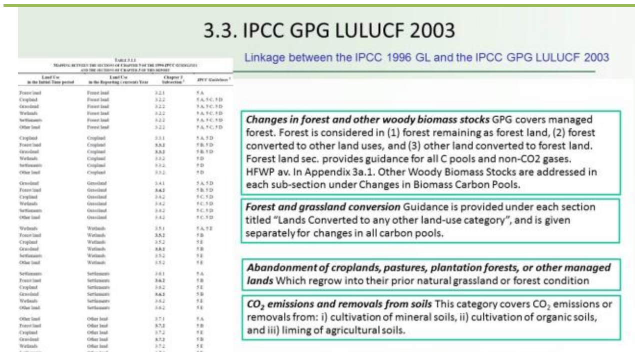
3.2. IPCC GPG & Uncertainty Management 2000

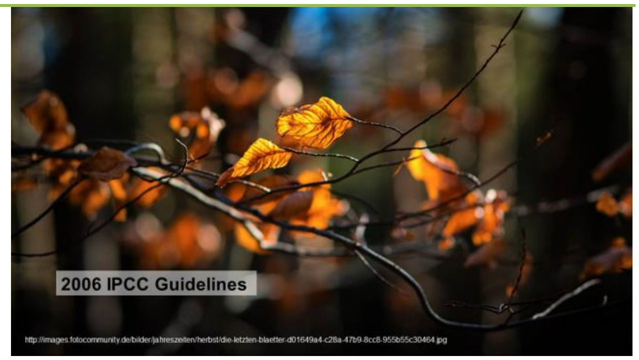
- Short: IPCC GPG2000
  – inventories are ... Consistent, Comparable (TACCC)
- Do NOT revise or replace the Rev 1996 GL
- Accepted in 2000

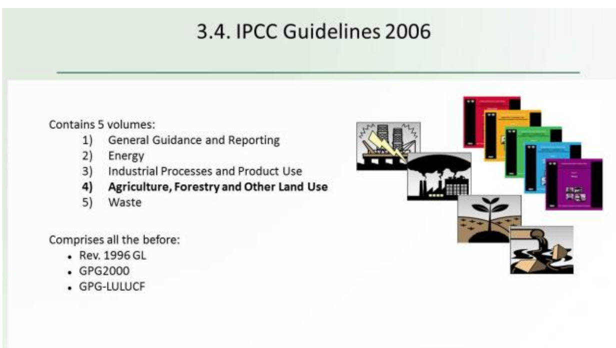
Non-Annex I Countries are required to use this set of GL in combination with Rev. 1996 but are encouraged to use...

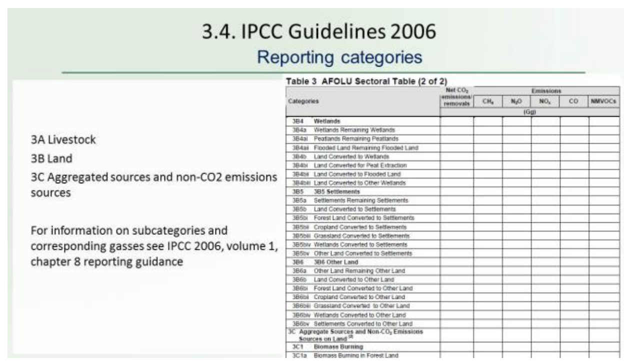

3.3. IPCC GPG LULUCF 2003
Reporting table


3.3. IPCC GPG LULUCF 2003
Calculation sheet
Note: The worksheets are largely based on Tier 1 methods, but they are supplemented with higher tier methods where appropriate.


3.3. IPCC GPG LULUCF 2003
Linkage between the IPCC 1996 GL and the IPCC GPG LULUCF 2003
Changes in forest and other woody biomass stocks GPG covers managed forest. Forest is considered in (1) forest remaining as forest land, (2) forest converted to other land uses, and (3) other land converted to forest land. Forest land sec. provides guidance for all C pools and non-CO2 gases. HFWP av. In Appendix 3a.1. Other Woody Biomass Stocks are addressed in each sub-section under Changes in Biomass Carbon Pools.
Forest and grassland conversion Guidance is provided under each section titled "Lands Converted to any other land-use category", and is given separately for changes in all carbon pools.
Abandonment of croplands, pastures, plantation forests, or other managed lands Which regrow into their prior natural grassland or forest condition
CO2 emissions and removals from soils This category covers CO2 emissions or removals from: i) cultivation of mineral soils, ii) cultivation of organic soils, and iii) liming of agricultural soils.


2006 IPCC Guidelines
http://images.fotocommunity.de/bilder/jahreszeiten/herbst/die-letzten-blaetter-d01649a4-c28a-47b9-8cc8-955b55c30464.jpg


3.4. IPCC Guidelines 2006
Contains 5 volumes:
1) General Guidance and Reporting
2) Energy
3) Industrial Processes and Product Use
4) Agriculture, Forestry and Other Land Use
5) Waste
Comprises all the before:
• Rev. 1996 GL
• GPG2000
• GPG-LULUCF


3.4. IPCC Guidelines 2006
Reporting categories
3A Livestock
3B Land
3C Aggregated sources and non-CO2 emissions sources
For information on subcategories and corresponding gasses see IPCC 2006, volume 1, chapter 8 reporting guidance
Table 3 AFOLU Sectoral Table (2 of 2)

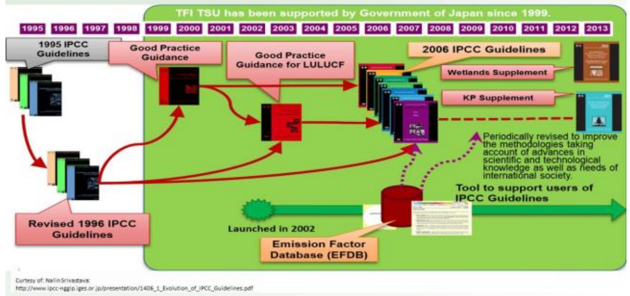
3.4. IPCC Guidelines 2006

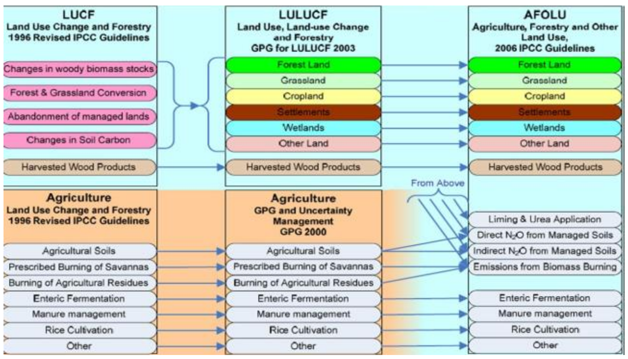
Sector			Agriculture, Forestry and Other Land Use					
Category			Forest Land Remaining Forest Land: Annual increase in carbon stocks in biomass (includes above-ground and below-ground biomass)					
Category code			3B1a					
Sheet			1 of 4					
Equation		Equation 2.2	Equation 2.9	Equation 2.10			Equation 2.9	
Land-use category		Subcategories for reporting year	Area of Forest Land Remaining Forest Land	Average annual above-ground biomass growth	Ratio of below-ground biomass to above-ground biomass	Average annual biomass growth above- and below-ground	Carbon fraction of dry matter	Annual increase in biomass carbon stocks due to biomass growth
Initial land use	Land use during reporting year		(ha)	(tonnes dm ha^{-1} yr^{-1})	[tonnes bg dm (tonne ag dm)$^{-1}$]	(tonnes dm ha^{-1} yr^{-1})	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			National statistics or international data sources	Tables 4.9, 4.10 and 4.12	zero (0) or Table 4.4	$G_{TOTAL} = GW * (1+R)$	0.5 or Table 4.3	$\Delta C_G = A * G_{TOTAL} * CF$
			A	G_W	R	G_{TOTAL}	CF	ΔC_G
FL	FL	(a)						
		(b)						
		(c)						
Total								

Note: only Tier 1 default methods

Volume 4, chapter 13, annex 1 worksheets

3.5. Evolution of the Guidelines





3.5. Evolution of the Guidelines

Inventory estimates obtained using the IPCC 1996 GL and the IPCC GPG 2003 and IPCC GL2006 can be different due to e.g. the following reasons:

- Inclusion of additional land categories: e.g. agroforestry, coconut, coffee, tea;
- Inclusion of additional C pools: BGB, DOM, HWFP, etc.
- Estimation of biomass increment and losses in each land category, subcategory
- Linking of biomass and soil carbon for each land category
- Use of improved default values
- Etc.

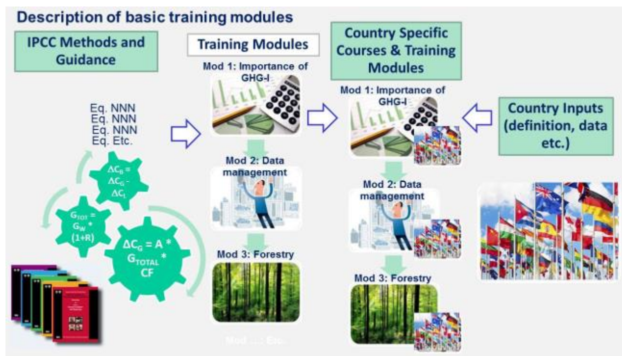
3/6/15

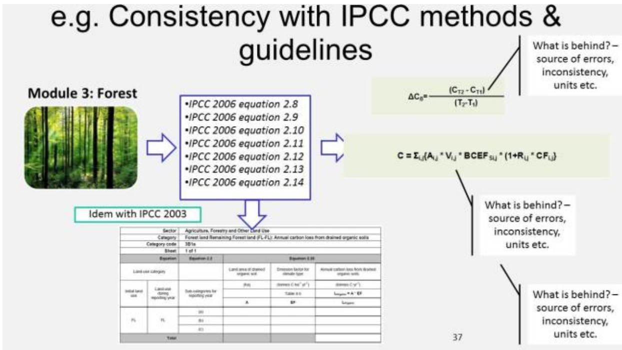
4. Objectives the training

Build capacity of national staff on GHG inventory for the LULUCF/AFOLU sector and on estimation of national Emission Factors for the AFOLU/LULUCF sector.

Transfer knowledge on:
-IPCC Guidelines and GHG inventory procedures;
- Producing and analyzing country emission factors for the LULUCF/AFOLU sector;

This training is part of a
- Step-wise approach;
- and aims to support existing capacities




e.g. Consistency with IPCC methods & guidelines
Module 3: Forest
•IPCC 2006 equation 2.8
•IPCC 2006 equation 2.9
•IPCC 2006 equation 2.10
•IPCC 2006 equation 2.11
•IPCC 2006 equation 2.12
•IPCC 2006 equation 2.13
•IPCC 2006 equation 2.14
Idem with IPCC 2003
What is behind? – source of errors, inconsistency, units etc.
What is behind? – source of errors, inconsistency, units etc.
What is behind? – source of errors, inconsistency, units etc.
37


Overview of the basic GHG Inventory Modules
Version 1.1.
Module 1: Importance
Module 2: Data management
Module 3: Forest
Module 4: Agriculture
Module 5: Land use
Module 6: Statistics
Module 7: Other pools
Others… under progress


…Advanced training modules
Module 1: Data compilation and EF preparation
Module 2: Data management and archiving system
Module 3: Harvested wood products, Permanent sample plot
Module 4: Recalculation, QC analysis,
Module 5: Data compilation and AD preparation
Module 6: Advanced statistics
Module 7: Organic soils, biomass burning, DOM and litter
Others… under progress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Thank you for your attention!
Theoretical course

Reporting principles

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[GHG TA member – Presenter]
[Training Activity Name]
Friday, June 12, 2015
[Country – Location – Venue]

Theoretical course

Version 1.1. Basic training on GHG inventory preparation for the LULUCF/AFOLU sectors

Outline

- Reporting principles
- Transparency
- Consistency
- Comparability
- Completeness
- Accuracy

Reporting Principles

The UNFCCC reporting framework has been designed to allow **any Party** under **any national circumstances** to provide an **assessment of its levels and trends** of anthropogenic GHG emissions and removals.

Assessments should be comparable to allow:
- Produce global estimates,
- Evaluate contribution of each Party to the final goal of the Convention

UNFCCC Article 2: The ultimate objective […] is to achieve […]
the stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Reporting Principles

To ensure such a comparability **five principles** have been set on which reporting requirements have been designed:

Transparency
Comparability
Completeness
Consistency
Accuracy

Each estimate, should be comparable with other estimates of other sectors and/or other countries.

Transparency

… means that the data sources, assumptions and methodologies used for an inventory should be **clearly explained**, in order to facilitate the replication and assessment of the inventory by users of the reported information.
The transparency of inventories is fundamental to the success of the process for the communication and consideration of the information.

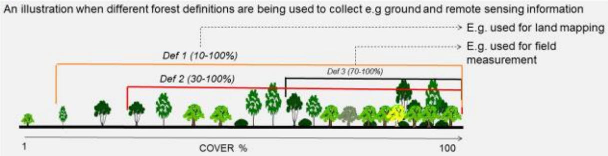
ALL needed information should be provided and structured in a clear way
- For Annex I Parties
  - **NIR** national inventory report with information on estimates
  - **CRF** common reporting format tables with estimated values
  - **BR** biennial reports
- For non-Annex I Parties
  - **NatCom:** in a chapter information and values are reported
  - **BUR** Biennial update reports

Transparency

Does the GHG-estimate actually estimate the category as the category has been defined?

E.g. a forest definition is applied, however data are collected according to another forest definition, no corrections are applied.
E.g.2. A portion of forest territory subject to human activities is left out.

An illustration when different forest definitions are being used to collect e.g ground and remote sensing information



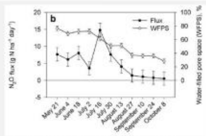
Transparency

Does the GHG-estimate represents the correct time period?

E.g. the data cover a portion of the year only
E.g.2. the data collected in a portion of the year are extrapolated to the whole year without considering seasonality

An illustration when data cover only a portion of the year

Figure. Mean (SE) nitrous oxide (N2O) flux in relation to soil water-filled pore space during 2003.



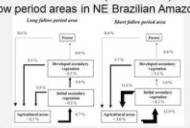
Gleason RA, BA Tangen, BA Browne, NH Euliss Jr (2009) Greenhouse gas flux from cropland and restored wetlands in the Prairie Pothole Region. Soil Biology and Biochemistry 41:2501-2507. doi: http://dx.doi.org/10.1016/j.soilbio.2009.09.008

Transparency

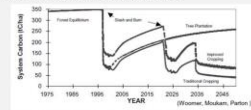
Are the assumptions reliable?

E.g. GHG emissions from biomass burning are not estimated since fire is not an ecological element of rainforest; however, slash and burning is applied by local populations.
E.g.2. A C pool is assumed in equilibrium across time; however, management practices are changing.

Mean overall transition rates (1985–1996) for short and long fallow period areas in NE Brazilian Amazon



Model simulations of changes in carbon stocks with slash and burn and alternative land uses



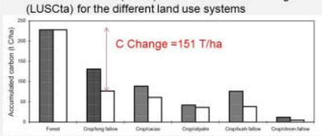
Metzger J (2002) Landscape dynamics and equilibrium in areas of slash-and-burn agriculture with short and long fallow period (Bragantina region, NE Brazilian Amazon). Landscape Ecol 17:419-431. Palm Caet al. (1999) Carbon sequestration and trace gaz emissions in slash-and-burn and alternative land uses in the humid tropics. ASB

Transparency

Does the inference correctly derives the estimate?

E.g. C stock belonging to 2 different locations at 2 different time points have been compared for estimating changes in C stock
E.g.2. the biomass expansion and conversion factor of conifers is applied to broadleaves.

Maximum C stock (Cmax) and land use time-averaged C (LUSCta) for the different land use systems



Dataset

ASB Site#	Carbon case#	Country	Benchmark	long	lat	Land-use System	Specific use	Age since burn	abvgrndC	soil C (0-20)*
CAMASB08	37	cam	ebol	11.03	2.59	ffor	logged forest	NA	205.38	45.01
	34	cam	ebol	11.25	2.42	oldaf	Joacao	25	131.64	49.60
CAMASB10	39	cam	ebol	11.03	2.59	oldaf	Joacao	25	100.14	41.80
	36	cam	ebol	11.25	2.42	newfal	natural fallow	4	7.19	51.70
CAMASB09	41	cam	ebol	11.03	2.59	newfal	natural fallow	4	6.10	29.95
	35	cam	ebol	11.25	2.42	midfal	natural fallow	10	36.35	54.60
	40	cam	ebol	11.03	2.59	midfal	natural fallow	11	69.23	39.61
	42	cam	ebol	11.03	2.59	crop		1	0.00	55.66
	46	cam	mbal	11.61	3.61	oldfal	natural fallow	10	161.12	60.80
	52	cam	mbal	11.79	3.30	oldfal	natural fallow	15	98.70	36.40
CAMASB01	45	cam	mbal	11.61	3.61	ffor	logged forest	NA	252.02	49.40
	51	cam	mbal	11.79	3.30	ffor	logged forest	NA	192.60	31.40
	48	cam	mbal	11.61	3.61	oldaf	Joacao	25	84.23	52.80
	54	cam	mbal	11.79	3.30	oldaf	Joacao	25	61.00	32.60
CAMASB02	49	cam	mbal	11.61	3.61	newfal	natural fallow	4	13.40	86.20
	55	cam	mbal	11.79	3.30	newfal	natural fallow	4	4.30	31.20
CAMASB04	47	cam	mbal	11.61	3.61	midfal	natural fallow	9	67.15	40.30

Palm Caet al. (1999) Carbon sequestration and trace gaz emissions in slash-and-burn and alternative land uses in the humid tropics. ASB

Transparency

Input data are consistent with technical requirements of the model applied?

E.g. net increment is applied while the gross increment is the input data requested by the model.

It is fundamental to know:

- **How the estimate has been prepared, meaning**
  - **The assumptions**
  - **The inferences**
  - **The input data**

if you want to answer all the questions above

ALL the methodological and data information that allows to prepare the estimation and to reconstruct the estimate.

Transparency

Transparency is the MOST important principle to be followed when preparing estimates

1. A non-transparent estimate = non-estimate
2. Without transparency, it cannot be assessed whether an estimate follows good practices and reporting principles.

There are not national circumstances that may justify a lack of transparency

Consistency

C means that an a GHG inventory should be internally consistent for all **reported years** in all its **elements** across **sectors, categories and gases.**

An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate GHG emissions and removals.

An inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC Guidelines and Guidance.

A trend in a time series of annual GHG estimates MUST not be determined by differences in methods used or in the quality of data used.

Consistency

A time series of estimates is said consistent if same data quality and methodology are applied along the time series

or,

when differences occurs among years, methods are applied to avoid that differences in data quality and/or methodology are counted as differences in emissions/removals levels

Inconsistencies among data and methods always result in differences, among years, in the reported levels of emissions/removals and therefore in the trend of the time series

Considering that the times series of estimates is needed to assess the impact of implemented policies and measures, inconsistencies may deeply undermine the efficiency of monitoring mitigation actions

Consistency

To ensure consistency, the IPCC guidelines provide different methods:

- Overlap method: GHG emissions/removals of the same period are estimated with two different methods, and the time series reconstructed accordingly;
- Surrogate data: data from a proxy can be used to estimate the level and trend of emissions/removals of the source/sink to be estimated;
- Interpolation: spatial and temporal gap-filling;
- Extrapolation: spatial and temporal projection;
- A combination of those methods;
- Or customized approaches

Comparability

... means, that estimates of GHG emissions and removals reported should be comparable among Parties. For that purpose, Parties should use the methodologies and formats agreed by the COP for making estimations and reporting their inventories. The allocation of different source/sink categories should follow the Common Reporting Formats provided by UNFCCC.

IPCC default methods and data build the first step of comparability (all countries with same methods and factors).

However higher level of comparability can be achieved by improving completeness and accuracy of estimates by applying country-specific methods and data that better cope with IPCC

Comparability

For BUR Parties are requested to use (Annex III to Decision 2/CP.17)

1. IPCC Good Practice Guidance for LULUCF
2. 2006 IPCC Guidelines for National GHG Inventories

Completeness

Completeness means that an annual GHG inventory covers at least all **sources and sinks**, as well as **all gases**, for which methodologies are provided in IPCC Guidelines.

- Estimates have to have full **spatial** (geographical) and **time** (annual) coverage
- A time series of annual GHG inventory should be provided (to have trends)

Completeness

The estimate has to fit the category/pool boundaries set by the definition

- Are all **carbon stocks been included in the pool**?
  E.g. does dead biomass includes dead standing and ground biomass?
- Are all **carbon pools reported**?
  Live Aboveground – Live Belowground – SOC – litter – Dead wood – H &WP
- Does the estimates cover **all the land area**?
- Do all the **gains and losses** occurred in the pool considered?

The estimate has to include all emissions/removals from the category/pool

Accuracy

Accuracy means that GHG estimates are **systematically neither over nor under true value**, as far as can be judged, and that **uncertainties are reduced as far as practicable**

- Appropriate good practices should be used, in accordance with the IPCC Guidelines, to promote accuracy in inventories.
- Accuracy of inventories tend to improve year by year because at each inventory cycle more data and knowledge may be available.

Accuracy

The final goal when preparing an estimate is to "reproduce" the true value, without directly measuring it.

- Accuracy measures how far the estimate is from the true value;
- Differences between the true value and the estimate are due to:
  1. **biases** in the method and in the data,
  2. **random errors** (even if they tend to cancel out)

Accuracy

When the true value is unknown, avoiding biases in methods and input data allows us to have an accurate estimate (an estimate that coincide with the true value) as far as can be judged, within the uncertainty boundaries

Or when the true value is known, even if only for a subset of the population, it can be used to calculate the accuracy of an estimate (i.e. verification). (this is the case when ground truthing is used with remotely sensed classified images)

Accuracy

Inaccuracies may stem from **methods, activity data** and **emissions factors**

1. **Inaccuracies related to method :**

Assumptions
Are the assumptions reliable? Have assumptions an impact on calculated estimates (e.g. equilibrium models)?

Inferences
Do inferences capture real dynamic and magnitude of C stocks?

Parameters
Are the parameters appropriate for the selected inferences? Have the parameters been validated?

Accuracy

2. **Inaccuracies related to activity data:**

Definition of the Categories
Do definitions overlap? Do categories cover the entire variability?

Classification methodology
Does the methodology avoid double classification of any land?
Does the methodology avoid the exclusion of any land?

Data consistency
Are the data in a time series consistent each other?
Are the data consistent with method needs?

Data co-registration
Are the different sources of data, -e.g. remotely sensed, ground data- correctly referred to the area where they have been collected?

Sampling design
Are the samples randomly collected? Do they properly represent the entire variability? Are errors minimized?

Accuracy

3. **Inaccuracies related to emission factors :**

Measurement instruments and methods
Are the instruments properly working?
Are instruments properly used?

Consistency
Are the factors in a time series consistent each other?
Are the factors consistent with method needs?

Sampling design
Are the samples randomly collected? Do they properly represent the entire variability? Are errors minimized?

Association to category/land
Are factors representing the entire variability of the category/land to which they are applied?

Accuracy

Without considering here biases due to measuring
(e.g. systematic errors in the instruments, systematic errors when using the instruments, systematic errors in the measurement protocol)

- Sampling means measuring a small portion of the whole to derive information on the whole (this make possible to obtain information in an economic, feasible, and accurate way);
- The sampling design is one of the most relevant element for achieving accuracy of estimates;
- Sampling design provides the information on:
  How sample are selected (including considerations on re-sampling)?
  How many sample (including their distribution across the population)?

Accuracy

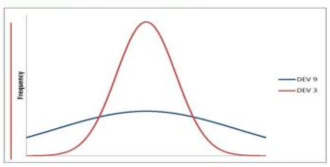
The average value of a set of samples is an unbiased estimator of the population average if:

- The set of samples have been collected from the population with a sampling design that ensures that each single element of the population has a positive and equal probability to be extracted
- The sample size is large enough, so that the probability density function of the variable represents the actual distribution of frequency and values (i.e. the variance of the sample is an unbiased estimator of the variance of the population)

Accuracy

Assuming that for both (blue and brown) distributions the average value is an unbiased estimator, they are unbiased and therefore reliable/trustable.
And whether the uncertainties has been reduced as far as it was practicable, both estimates are accurate

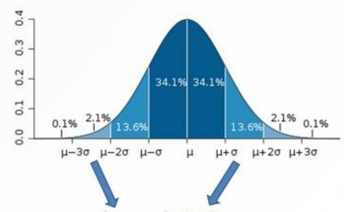
Of course the blue distribution has higher uncertainty and therefore it is likely that the country should prioritize improvements for that estimate.



Accuracy

Some properties of the normal distribution are:

1. It is symmetrical about its mean, μ;
2. Mode and median are both equal to the mean, μ;
3. Turning points of the curve are given for x = μ - σ and x = μ + σ.



[μ - σ, μ + σ] = 68.27%
[μ - 2σ, μ + 2σ] = 95.45%;
[μ - 3σ, μ + 3σ] = 99.73 %

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Thank you for your attention!

[GHG TA member – Presenter]
[Training Activity Name]
Friday, June 12, 2015
[Country – Location – Venue]

Theoretical course

Methodological Principles

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- [GHG TA member – Presenter]
- *[Training Activity Name]*
- *3/6/15*
- *[Country – Location – Venue]*

Theoretical course

Version 1.1. Basic training on GHG inventory preparation for the LULUCF/AFOLU sectors

Outline

- What to estimate (GHG estimates)
  - Tiers
  - Approaches
- Carbon Stock Change Methods
- Pools
  - Aboveground Biomass
  - Belowground Biomass
  - Dead wood
  - Litter
  - Soil Oraginc Carbon
  - HWP
- Key Category Analysis

What is a GHG-estimate?

The amount of GHG emitted or removed from an element (e.g. a carbon pool, a land category, a power plant, transports) is not measured directly (over time e space)

Therefore, an estimate is prepared to quantify emissions or removals produced by a source or sink in a year

To prepare an estimate three elements are needed:

- Assumptions
- Inferences
- Input data

What is a GHG-estimate?

An assumption has to be proven reliable or the estimate has not to be affected by it (e.g. equilibrium models)

Inferences grows in complexity from IPCC methods to country-specific methods -i.e. from a simple multiplicative models (with constant factors) to complex net of models with a number of parameters

Input data may be divided in:

- Activity Data (AD), may show significant change year by year according with changes in the activity e.g. area subject to a specific management activity, as no-tillage, or amount of harvested wood
- Emissions (or Carbon-Stock-Change) factors (EF – CSCF) allow the inference of emissions/removals from the activity data and tend not to change significantly year by year

Methods for GHG estimation

The most simple method for estimating GHG fluxes from a source/sink is:

Activity Data * Emission Factor = annual GHG flux

For carbon pools the equation could be:

Activity Data * Carbon Stock Change Factor = annual carbon stock change

This method assumes that there is a constant relation (the CSCF) between the GHG flux caused by an activity (e.g. deforestation) and another element of that activity (e.g. area deforested)

The method also assumes that the CSCF is, as far as can be judged, an unbiased estimator of carbon content of lands before these lands were deforested

The inference is the simple multiplication: **Activity Data * Constant Factor**

Methods for GHG estimation

IPCC Guidelines provides **default methods** for each source/sink category (So-called tier 1 methods)

An IPCC default method is based on **assumptions** and **inferences** considered quite robust and able to produce GHG estimates in any region of the World, with an **acceptable level of uncertainties** (deemed at producing accurate assessment of trends)

An IPCC method does not set a **standard.** It is rather built on **good practices**, it provides an **option**, as **robust** as possible

A standard is a **rigid threshold** that excludes everything does not match it

A **good practice** is an instruction that could be followed for achieving the target (preparing national GHG estimates) by anybody under any different national circumstances

Methods for GHG estimation

What's the **best method** to be applied (Tiers 1, 2 and/or 3)?

The best method is the one that provides GHG estimates:

1) with the **highest accuracy**
2) at a level of resource-needs compatible with country's **financial and technical capability**

Potentially, there are no limits to options applicable to methods for preparing GHG estimates

However, the methods to be used for GHG flux estimations for UNFCCC reporting should have some characteristics

Estimates: 3 approaches for land representation

Different levels of methodological complexity for Land representation 3 approaches exist:

Approach 1

identifies the total area for each land category - typically from non-spatial country statistics - but does not provide information on the nature and area of conversions between land uses, i.e. it only provides "net" area changes (e.g. deforestation minus forestation). It cannot track use of land.

Estimates: Approach 1 - sample

TABLE 3.2
EXAMPLE OF APPROACH 1: AVAILABLE LAND USE DATA WITH COMPLETE NATIONAL COVERAGE

Time 1			Time 2			Net land-use conversion between Time 1 and Time 2		
F	=	18	F	=	19	Forest Land	=	+1
G	=	84	G	=	82	Grassland	=	-2
C	=	31	C	=	29	Cropland	=	-2
W	=	0	W	=	0	Wetlands	=	0
S	=	5	S	=	8	Settlements	=	+3
O	=	2	O	=	2	Other Land	=	0
Sum	=	140	Sum	=	140	Sum	=	0

Note: F = Forest Land, G = Grassland, C = Cropland, W = Wetlands, S = Settlements, O = Other Land. Numbers represent area units (Mha in this example).

Estimates: 3 approaches for land representation

Approach 2

involves tracking of land conversions between categories, resulting in a non-spatially explicit land-use conversion matrix. It can track use of land between two points in time only.

Approach 3

extends Approach 2 by using spatially explicit land conversion information, derived from sampling or wall-to-wall mapping. It can tracks use of land across a timeseries.

i.e. it is likely that Approach 3, or Approach 2 with additional information on land use dynamic, are needed for REDD+ implementation.

Estimates: Approach 2 - sample

TABLE 3.4
ILLUSTRATIVE EXAMPLE OF TABULATING ALL LAND-USE CONVERSION FOR APPROACH 2 INCLUDING NATIONALLY DEFINED STRATA

Initial land use	Final land use	Land area, Mha	Inclusions/Exclusions
Forest Land (Unmanaged)	Forest Land (Unmanaged)	5	Excluded from GHG inventory
Forest Land (Managed, temperate continental)	Forest Land (Managed, temperate continental)	4	Included in GHG inventory
Forest Land (Managed, temperate continental)	Grassland (Unimproved)	2	Included in GHG inventory
Forest Land (Managed, temperate continental)	Settlements	1	Included in GHG inventory
Forest Land (Managed, boreal coniferous)	Forest Land (Managed, boreal coniferous)	6	Included in GHG inventory
Grassland (Unimproved)	Grassland (Unimproved)	61	Included in GHG inventory
Grassland (Unimproved)	Grassland (Improved)	2	Included in GHG inventory

Estimates: Approach 2 - sample

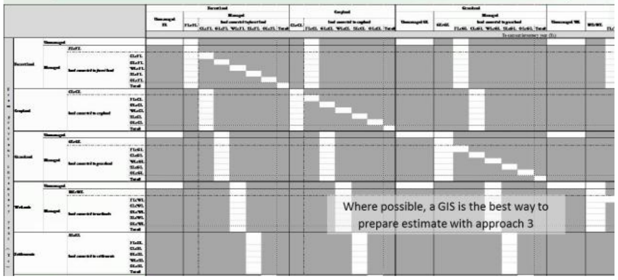
TABLE 3.6
SIMPLIFIED LAND-USE CONVERSION MATRIX FOR APPROACH 2 EXAMPLE

Net land-use conversion matrix

Final \ Initial	F	G	C	W	S	O	*Final sum*
F	15	3	1				*19*
G	2	80					*82*
C			29				*29*
W				0			*0*
S	1	1	1		5		*8*
O						2	*2*
Initial sum	*18*	*84*	*31*	*0*	*5*	*2*	*140*

Note:
F = Forest Land, G = Grassland, C = Cropland, W = Wetlands,
S = Settlements, O = Other Land
Numbers represent area units (Mha in this example).

Estimates: Approach 3 - sample



Carbon Pools

6 carbon pools are reported under the UNFCCC:

- Above-ground Biomass, Below-ground Biomass } Biomass
- Dead Wood, Litter } Dead Organic Matter (DOM)
- Soil Organic Matter (SOM) { mineral soils, organic soils
- Harvested Wood Product (HWP)

Living Biomass (LB = AGB + BGB)

Aboveground biomass

All biomass of living vegetation, both woody and herbaceous, above the soil including stems, stumps, branches, bark, seeds, and foliage.

Note: In cases where forest understory is a relatively small component of the above-ground biomass carbon pool, it is acceptable for the methodologies and associated data used in some tiers to exclude it, provided the tiers are used in a consistent manner throughout the inventory time series.

Belowground biomass

All biomass of live roots. Fine roots of less than (suggested) 2mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.

Dead Organic Matter (DOM = DW + L)

Dead wood

Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps, larger than or equal to 10 cm in diameter (or the diameter specified by the country).

Litter

Includes all non-living biomass with a size greater than the limit for soil organic matter (suggested 2 mm) and less than the minimum diameter chosen for dead wood (e.g. 10 cm), lying dead, in various states of decomposition above or within the mineral or organic soil. This includes the litter layer as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.

Soil Organic Matter (SOM = MS + OS)

Soil organic matter

Includes organic carbon in mineral soils to a specified depth chosen by the country and applied consistently through the time series. Live and dead fine roots and DOM within the soil, that are less than the minimum diameter limit (suggested 2 mm) for roots and DOM, are included with soil organic matter where they cannot be distinguished from it empirically. The default for soil depth is 30 cm.

1 Includes organic material (living and non-living) within the soil matrix, operationally defined as a specific size fraction (e.g., all matter passing through a 2 mm sieve). Soil C stock estimates may also include soil inorganic C if using a Tier 3 method. CO_2 emissions from liming and urea applications to soils are estimated as fluxes using Tier 1 or Tier 2 method.

2 Carbon stocks in organic soils are not explicitly computed using Tier 1 or Tier 2 method, (which estimate only annual C flux from organic soils), but C stocks in organic soils can be estimated in a Tier 3 method. Definition of organic soils for classification purposes is provided in Chapter 3.

Harvested Wood Products (HWP)

Harvested wood products

Any wooden product with a lifetime longer than 1 year (so fuelwood/charcoal excluded)

HWPs could be reported applying instantaneous oxidation (total C stock lost and accounted as CO_2 emissions to the atmosphere when the biomass is harvested)

Carbon Stock Changes in Land Use Categories

For **each land use category**, carbon stock changes are estimated for **all strata** or subdivisions of land area

Subdivisions should be done according to **differences in the carbon dynamic** and in the **magnitude of ecosystem C stocks** (e.g. forest typology, ecotype, soil type, management regime etc.) within a land use category

EQUATION 2.2
ANNUAL CARBON STOCK CHANGES FOR A LAND-USE CATEGORY AS A SUM OF CHANGES IN EACH STRATUM WITHIN THE CATEGORY

$$\Delta C_{LU} = \sum_i \Delta C_{LU_i}$$

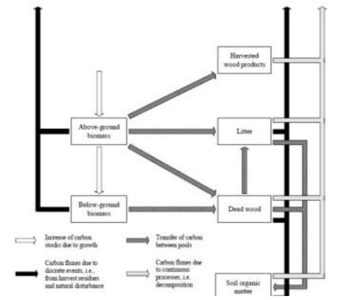
Where:

ΔC_{LU} = carbon stock changes for a land-use (LU) category as defined in Equation 2.1.

i = denotes a specific stratum or subdivision within the land-use category (by any combination of species, climatic zone, ecotype, management regime etc., see Chapter 3), i = 1 to n.

Carbon stock changes within a stratum are estimated by considering C cycle among the 6 carbon pools

Figure 2.1 Generalized carbon cycle of terrestrial AFOLU ecosystems showing the flows of carbon into and out of the system as well as between the five C pools within the system.



Carbon Stock Changes

The carbon cycle includes changes in carbon stocks due to both continuous processes (i.e., growth, decay) and discrete events (i.e., disturbances like harvest, fire, insect outbreaks, land-use change and other events).

Continuous processes can affect carbon stocks in all areas in each year, while discrete events (i.e., disturbances) cause emissions and redistribute ecosystem carbon in specific areas (i.e., where the disturbance occurs) and in the year of the event.

Carbon Stock Changes in Carbon Pools

Carbon stock changes are summarized by the following equation

$$\Delta C_{LUi} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SO} + \Delta C_{HWP}$$

Where:

ΔC_{LUi} = carbon stock changes for a stratum of a land-use category

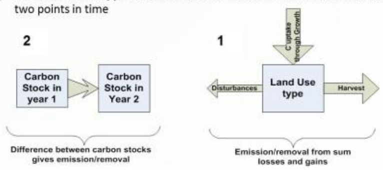
Subscripts denote the following carbon pools:

AB = above-ground biomass
BB = below-ground biomass
DW = deadwood
LI = litter
SO = soils
HWP = harvested wood products

Carbon Stock Changes Estimation

There are two fundamentally different and equally valid approaches to estimating stock changes:

1) the **process-based approach**, which estimates the net balance of additions to and subtraction from a carbon stock
2) the **stock-based approach**, which estimates the difference in carbon stocks at two points in time



Carbon Stock Changes Estimation

If the C stock changes are estimated on a per hectare basis, then the value is multiplied by the total area within each stratum to obtain the total stock change estimate for the pool

When using the Stock-Difference Method, it is important to ensure that the area on which carbon stock at time t_1 is calculated is identical at that on which carbon stock has been calculated at time t_2

It is good practice to use the area at the end of the inventory year (t_2) to define the area of land remaining in a land-use category

Gain Loss Method

EQUATION 2.4
ANNUAL CARBON STOCK CHANGE IN A GIVEN POOL AS A FUNCTION OF GAINS AND LOSSES (GAIN-LOSS METHOD)

$$\Delta C = \Delta C_G - \Delta C_L$$

Where:

ΔC = Annual carbon stock change in the pool, tonnes C yr^{-1}

ΔC_G = Annual gain of carbon, tonnes C yr^{-1}

ΔC_L = Annual loss of carbon, tonnes C yr^{-1}

Stock Difference Method

EQUATION 2.5
CARBON STOCK CHANGE IN A GIVEN POOL AS AN ANNUAL AVERAGE DIFFERENCE BETWEEN ESTIMATES AT TWO POINTS IN TIME (STOCK-DIFFERENCE METHOD)

$$\Delta C = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$

Where:

ΔC = Annual carbon stock change in the pool, tonnes C yr^{-1}

C_1 = Carbon stock in the pool at time t_1, tonnes C

C_2 = Carbon stock in the pool at time t_2, tonnes C

Key Category: Definition

A **key category** is one that is prioritised within the national inventory system because it is significantly important for one or a number of gases in terms of:

- magnitude in any one year (Level)
- change in emissions year to year (Trend)
- high uncertainty

Key Category: Identification

2006 IPCC Guidelines for National Greenhouse Gas Inventories

- **Quantitative analysis** in terms of both the level and the trend:
  - Approach 1
  - Approach 2 which accounts for uncertainties
- **Qualitative criteria**

Key Category: Analysis

The analysis should be performed at the **appropriate disaggregation level** of the IPCC categories or subcategories (Table 4.1 of the IPCC 2006 Guidelines)

Disaggregation to **very low levels should be avoided** since it may split an important aggregated category into many small subcategories that are no longer key

Each greenhouse gas from each category should be considered **separately**, unless there are specific methodological reasons for treating gases collectively

For LULUCF, **CO_2, CH_4 and N_2O** should be considered separately, because the methods, emission factors and related uncertainties differ for each gas

If data are available, the analysis should be performed for **emissions and removals separately** within a given category

Key Category: Analysis

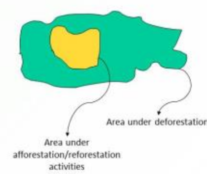
The land use categories and the pool estimates can include emissions and removals that may cancel out at the aggregated level for the categories

In this case, the outcomes of the category by category description should be analysed in order to identify if there is the need to perform the key category analysis with further disaggregated subcategories

The category by category description identifies **two different areas**, in the territory under investigation, where :

- carbon stock **decreases** (deforestation or fires)
- carbon stock **increases** (afforestation/reforestation activities)

In this case, the inventory compiler should decide to perform the key category analysis **disaggregating the category into the two areas**



Key Category: Analysis

Another method to identify whether it may be necessary to **split the key category into subcategories** is:

- Rank the subcategories according to their **contribution** to the aggregate key category
- Subcategories that contribute together **more than 60%** to the key category can be treated as particularly significant

Uncertainty Analysis

Uncertainty estimates are an **essential** element of a complete inventory

Uncertainties should be addressed to avoid the **potentially severe consequences** of inaccurate information and ensure the monitoring against targets (i.e. accurate and comparable)

When focusing efforts to reduce uncertainty, priority should be given to **those inputs that have the most impact** on the overall uncertainty of the inventory but also a relevant contribution

Uncertainty Analysis

The IPCC 2006 Guidelines define **two approaches** to estimating uncertainties:

- Approach 1: **Error propagation** equations
- Approach 2: **Monte Carlo** simulations

When measurements are not available to quantify uncertainties every approach is **highly affected** by expert judgement

Approach 1 is simple enough and transparent for the purpose of an emission inventory

Source of Uncertainty

Activity data

1. Gaps in **time series**
2. Use of **surrogate or proxy** variables
3. Lack of **references** (calculation or estimation methods, representativeness at local or national level)

Emission Factors

Scarcity of quantitative information (measurements, sample representativeness)

Reporting and Documentation

It is **good practice** to:

1. clearly **document the results** of the key category analysis in the inventory report
2. Specify the **criteria** by which each category was identified as **key** (e.g., level, trend, or qualitative), and the **method** used to conduct the quantitative key category analysis (e.g., Approach 1 or Approach 2)
3. Describe **individual improvements** identified for each key category (methodologies, more accurate activity data etc.)
4. Prioritize **the most important** improvements
5. Identify and describe **projects that would lead to inventory improvements**

TABLE 4.4
SUMMARY OF KEY CATEGORY ANALYSIS

Quantitative method used: Approach 1/Approach 1 and Approach 2				
A	B	C	D	E
IPCC Category Code	IPCC Category	Greenhouse Gas	Identification criteria	Comments

Thank you for your attention!

- [GHG TA member – Presenter]
- *[Training Activity Name]*
- *3/6/15*
- *[Country – Location – Venue]*

Theoretical course

The National System

Matieu Henry

Training on GHG-I and Emission Factors estimation for the AFOLU/LULUCF sector in Pakistan

9/3/15 - Islamabad, Pakistan

Theoretical course

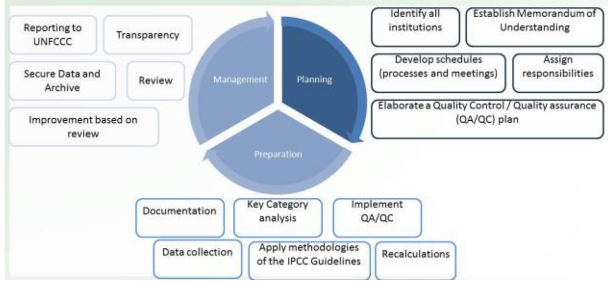
Outline

1. Importance of a national system
2. The GHG Inventory process
   - 2.1. Inventory planning
   - 2.2. Preparation
   - 2.3. Management
3. Source of Data
4. Relationship between institutions
5. Arrangements
6. Roles and responsibilities
7. Examples of National Systems
   - 7.1. Brazil
   - 7.2. India
   - 7.3. Vietnam
8. Review and management
9. References

1. Importance of a national system

Continuity of capacity	**Technical support vs. decision making**	**Tangible body for responses to outside world**
Ensure quality	**Consistent approach RELs/NFI/GHG/NC/BUR/INDC/etc.**	**Fundamental for reporting**

2. The GHG Inventory process



2.1. Inventory planning

Identify all institutions to be involved

- Appoint **national inventory agency**
- Allocate **responsibilities** for inventory preparation and management
- Define **official approval process** within government

Develop schedule

- **Timeframe** and specific **milestones**
- **Make arrangements** to collect data from statistical agencies, companies, industry associations, etc.

Create Quality Assurance / Quality Control plan

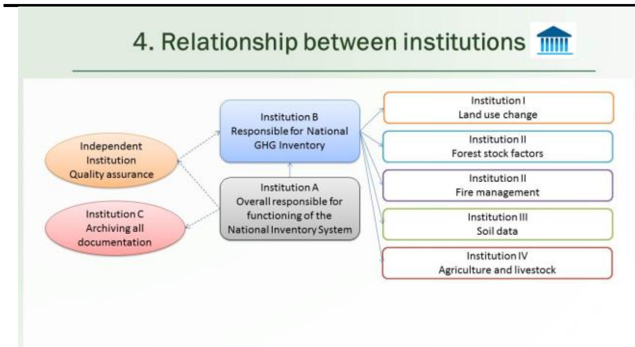
Integrate continuous improvement

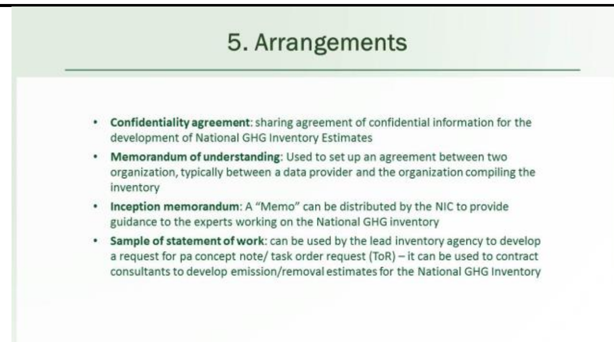
2.2. Inventory preparation

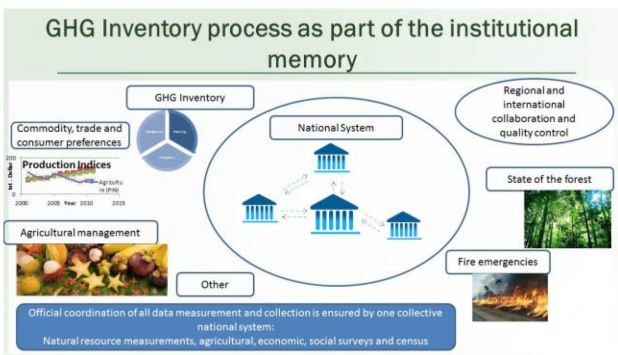
- Identify **key categories** and significant subcategories
- Select **methods and emission factors**
- Collect **activity data**
- Manage **recalculations**
- Implement **QA/QC plan**
  - Basic checks should be completed on entire inventory (Tier 1)
  - More in-depth investigations into key categories (Tier 2)
- Implement **documentation** plans


2.3. Inventory management
Implement inventory review processes (e.g., expert review, public review)
Obtain formal approval of final results and report within government
Submission of report to UNFCCC
Archive all documentation and results and continuously improve
Make inventory information available to stakeholders and respond to information requests
Quality assurance through an International Consultation Analysis carried out by a team of technical experts from the UNFCCC Roster of Experts
Check your reporting requirements
Identify your place and format of archiving


3. Source of Data
Reference libraries (National Libraries)
Statistical ministry
Sectoral experts, stakeholder organisations
Other national experts
STATISTICAL YEAR BOOK
FAOSTAT
Food and Agriculture Organization of the United Nations
International organisations publishing statistics e.g., United Nations, Eurostat or the International Energy Agency, OECD and the IMF (which maintains international activity as well as economic data)
Scientific and technical articles in environmental books, journals and reports.
Universities
Other international experts
National Inventory Reports from Parties to the United Nations Framework Convention on Climate Change
Emission factor database
Web search for organisations & specialists


4. Relationship between institutions
Independent Institution Quality assurance
Institution C Archiving all documentation
Institution B Responsible for National GHG Inventory
Institution A Overall responsible for functioning of the National Inventory System
Institution I Land use change
Institution II Forest stock factors
Institution II Fire management
Institution III Soil data
Institution IV Agriculture and livestock


5. Arrangements
Confidentiality agreement: sharing agreement of confidential information for the development of National GHG Inventory Estimates
Memorandum of understanding: Used to set up an agreement between two organization, typically between a data provider and the organization compiling the inventory
Inception memorandum: A "Memo" can be distributed by the NIC to provide guidance to the experts working on the National GHG inventory
Sample of statement of work: can be used by the lead inventory agency to develop a request for pa concept note/ task order request (ToR) – it can be used to contract consultants to develop emission/removal estimates for the National GHG Inventory


GHG Inventory process as part of the institutional memory
GHG Inventory
Commodity, trade and consumer preferences
Production Indices
National System
Regional and international collaboration and quality control
State of the forest
Agricultural management
Other
Fire emergencies
Official coordination of all data measurement and collection is ensured by one collective national system:
Natural resource measurements, agricultural, economic, social surveys and census


6. Roles and responsibilities
GHG Coordinator
Manage and support national staff
Identify and oversee all lead sectors
Assign roles and responsabilities
Maintain and implement the improvement plan
Sectoral Leads (LULUCF and Agriculture)
Contact federal agencies/ministries or non-governmental organizations
Lead working group to review calculations and perform initial QA/QC
Coordinate QA responses and updates
Oversee uncertainty analysis
Consider potential improvements (carry out a Key Category Analysis)
Document and identify improvements of data-sets

7. Examples of National Systems: Brazil

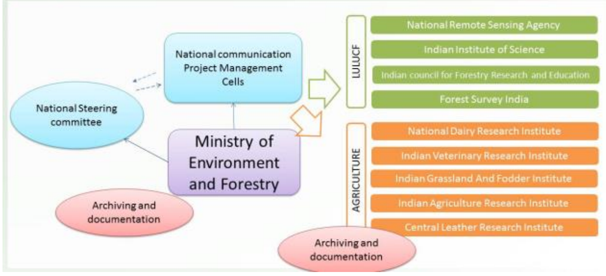
The overall responsible for the national GH Inventory is Ministry of Science and Technology

- The General Coordination on Global Climate Change was created, within the structure of the Ministry of Science and Technology (MST), in August 1994

The 2nd national communication received contributions from over **600 different institutions and 1,200 experts**, compared to 150 institutions and 700 experts during the development of the initial national communication:

- Ministry of Environment; Ministry of Agriculture, Livestock and Food Supply; Ministry of Mines and Energy; Ministry of Development, Industry and Foreign Trade - MIDIC, etc.
- Federal institutions and state institutions
- Trade associations, NGOs, universities and research centers.

7. Examples of National Systems: India



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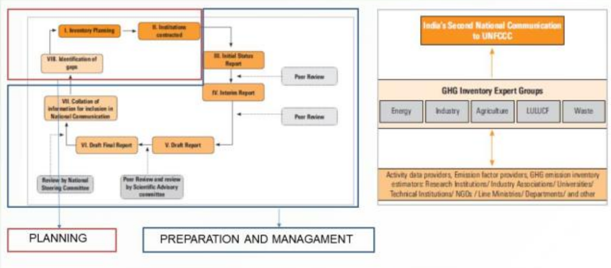
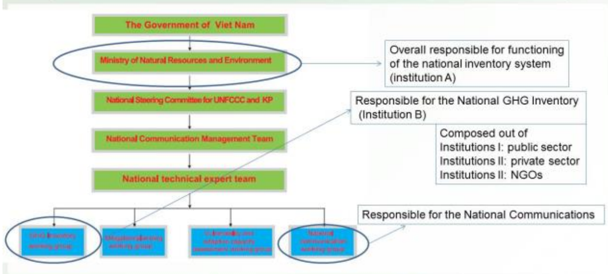
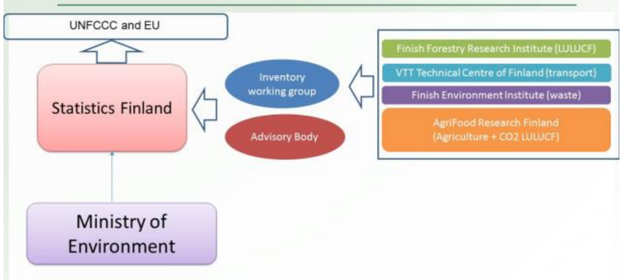


7. Examples of National Systems: Vietnam



7. Examples of National Systems: Finland



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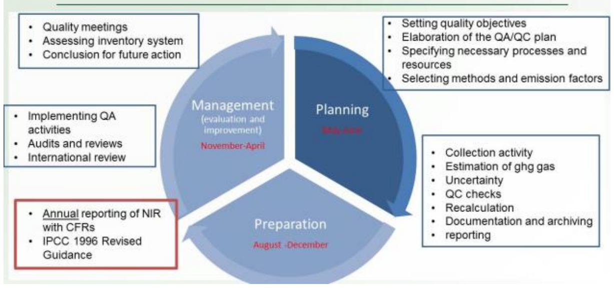
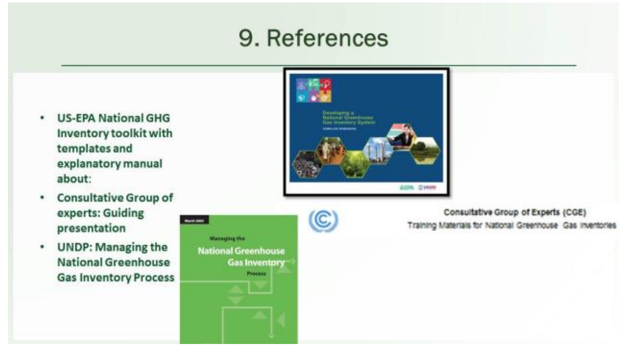
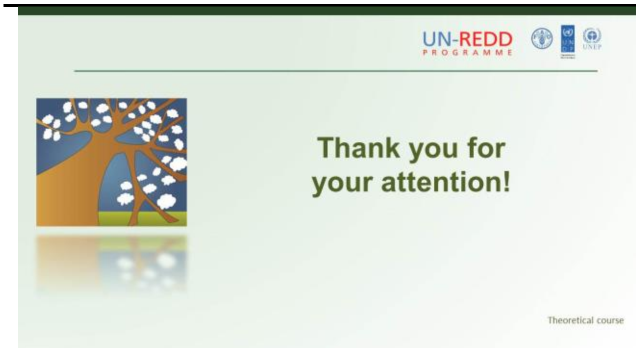



8. Review and management:
What is quality?
Transparency
Comparability
Consistency
Completeness
Accuracy


9. References
• US-EPA National GHG Inventory toolkit with templates and explanatory manual about:
• Consultative Group of experts: Guiding presentation
• UNDP: Managing the National Greenhouse Gas Inventory Process
Managing the National Greenhouse Gas Inventory Process
Consultative Group of Experts (CGE)
Training Materials for National Greenhouse Gas Inventories


UN-REDD PROGRAMME
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1. Importance of a national system

- Coordinate
- Sustainability and continuity of capacity
- Technical support vs. decision making
- Tangible body for responses to outside world
- To inform International, national and local policy making
- Ensure quality
- Consistent approach RELs/NFI/GHG/NC/BUR /etc.
- Fundamental for reporting

Who needs national arrangements?

Decision makers and policy advisors

International climate change community

Provincial and local agencies

Scientist

The public and interest groups (e.g., NGOs)

Businesses

2. The GHG Inventory process

- Reporting to UNFCCC
- Transparency
- Secure Data and Archive
- Review
- Improvement based on review
- Identify all institutions
- Establish Memorandum of Understanding
- Develop schedules (processes and meetings)
- Assign responsibilities
- Elaborate a Quality Control / Quality assurance (QA/QC) plan
- Documentation
- Key Category analysis
- Implement QA/QC
- Data collection
- Apply methodologies of the IPCC Guidelines
- Recalculations

2.1. Inventory planning

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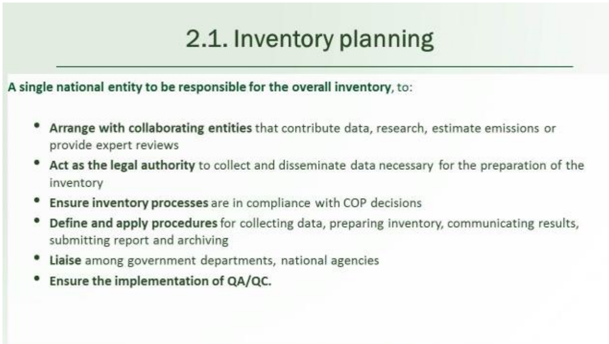
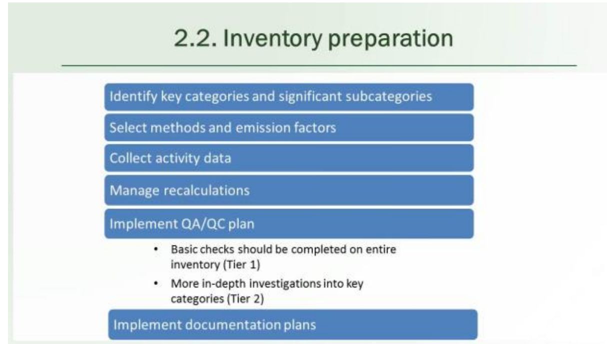
Develop schedule

- **Timeframe** and specific **milestones**
- **Make arrangements** to collect data from statistical agencies, companies, industry associations, etc.

Create Quality Assurance / Quality Control plan

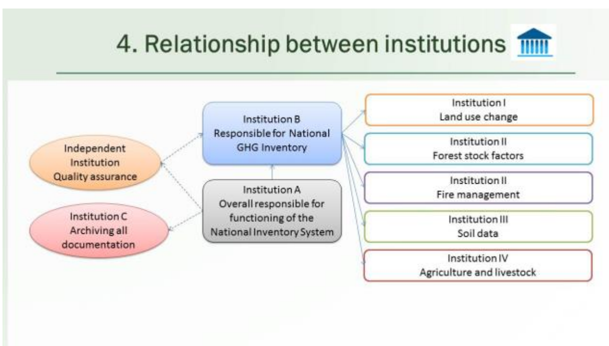
Integrate continuous improvement

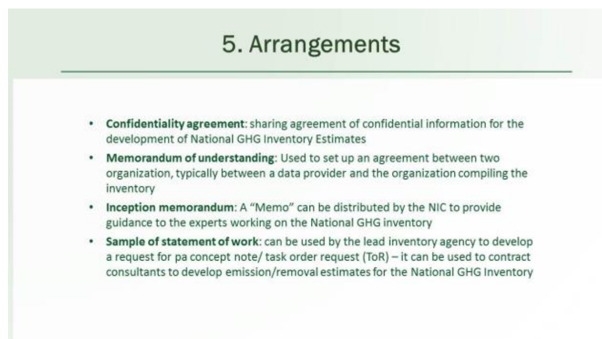

2.1. Inventory planning
A single national entity to be responsible for the overall inventory, to:
• Arrange with collaborating entities that contribute data, research, estimate emissions or provide expert reviews
• Act as the legal authority to collect and disseminate data necessary for the preparation of the inventory
• Ensure inventory processes are in compliance with COP decisions
• Define and apply procedures for collecting data, preparing inventory, communicating results, submitting report and archiving
• Liaise among government departments, national agencies
• Ensure the implementation of QA/QC.

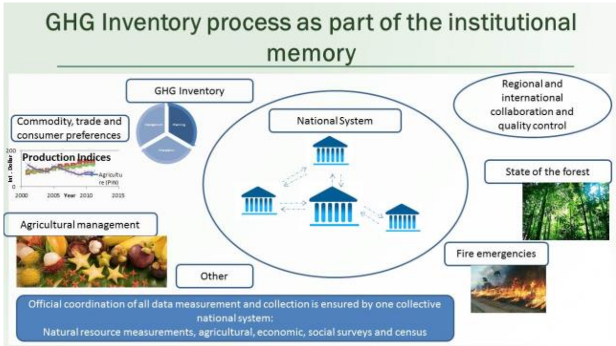

2.2. Inventory preparation
Identify key categories and significant subcategories
Select methods and emission factors
Collect activity data
Manage recalculations
Implement QA/QC plan
• Basic checks should be completed on entire inventory (Tier 1)
• More in-depth investigations into key categories (Tier 2)
Implement documentation plans


2.3. Inventory management
Implement inventory review processes (e.g., expert review, public review)
Obtain formal approval of final results and report within government
Submission of report to UNFCCC
Archive all documentation and results and continuously improve
Make inventory information available to stakeholders and respond to information requests
Quality assurance through an International Consultation Analysis carried out by a team of technical experts from the UNFCCC Roster of Experts
Check your reporting requirements
Identify your place and format of archiving

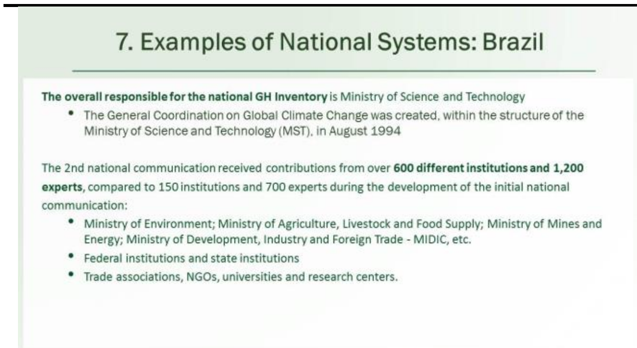

3. Source of Data
Reference libraries (National Libraries)
Statistical ministry
Sectoral experts, stakeholder organisations
Other national experts
STATISTICAL YEAR BOOK
FAOSTAT
International organisations publishing statistics e.g., United Nations, Eurostat or the International Energy Agency, OECD and the IMF (which maintains international activity as well as economic data)
Universities
Scientific and technical articles in environmental books, journals and reports.
Other international experts
National Inventory Reports from Parties to the United Nations Framework Convention on Climate Change
Emission factor database
Web search for organisations & specialists

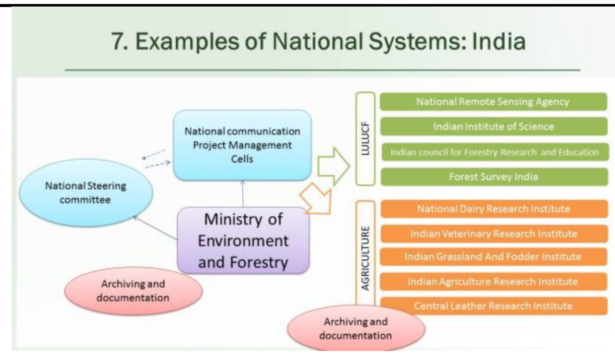

4. Relationship between institutions
Independent Institution Quality assurance
Institution C Archiving all documentation
Institution B Responsible for National GHG Inventory
Institution A Overall responsible for functioning of the National Inventory System
Institution I Land use change
Institution II Forest stock factors
Institution II Fire management
Institution III Soil data
Institution IV Agriculture and livestock

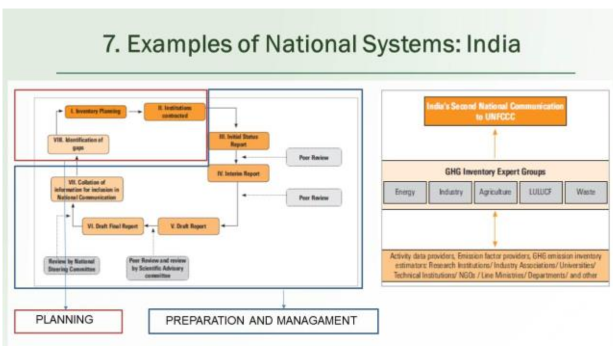

5. Arrangements
• Confidentiality agreement: sharing agreement of confidential information for the development of National GHG Inventory Estimates
• Memorandum of understanding: Used to set up an agreement between two organization, typically between a data provider and the organization compiling the inventory
• Inception memorandum: A "Memo" can be distributed by the NIC to provide guidance to the experts working on the National GHG inventory
• Sample of statement of work: can be used by the lead inventory agency to develop a request for pa concept note/ task order request (ToR) – it can be used to contract consultants to develop emission/removal estimates for the National GHG Inventory

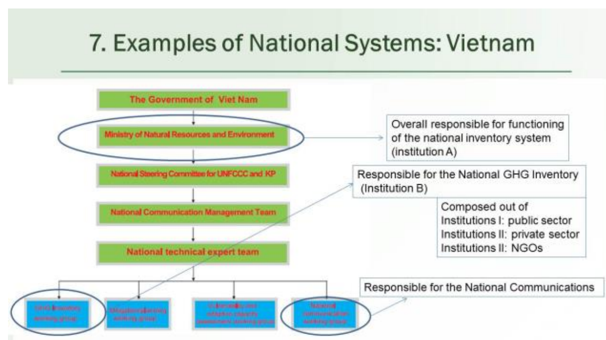

GHG Inventory process as part of the institutional memory
GHG Inventory
Commodity, trade and consumer preferences
Production Indices
National System
Regional and international collaboration and quality control
State of the forest
Agricultural management
Fire emergencies
Other
Official coordination of all data measurement and collection is ensured by one collective national system:
Natural resource measurements, agricultural, economic, social surveys and census

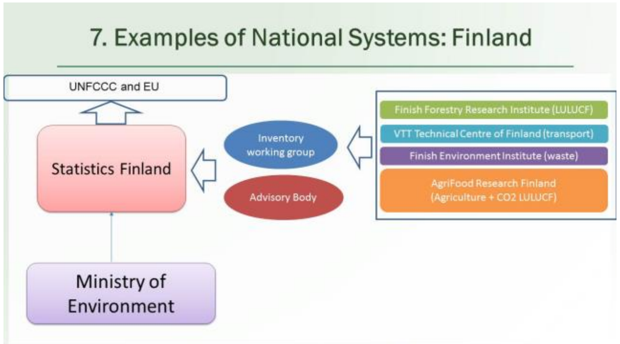

6. Roles and responsibilities
GHG Coordinator
Manage and support national staff
Identify and oversee all lead sectors
Assign roles and responsabilities
Maintain and implement the improvement plan
Sectoral Leads (LULUCF and Agriculture)
Contact federal agencies/ministries or non-governmental organizations
Lead working group to review calculations and perform initial QA/QC
Coordinate QA responses and updates
Oversee uncertainty analysis
Consider potential improvements (carry out a Key Category Analysis)
Document and identify improvements of data-sets


7. Examples of National Systems: Brazil
The overall responsible for the national GH Inventory is Ministry of Science and Technology
The General Coordination on Global Climate Change was created, within the structure of the Ministry of Science and Technology (MST), in August 1994
The 2nd national communication received contributions from over 600 different institutions and 1,200 experts, compared to 150 institutions and 700 experts during the development of the initial national communication:
Ministry of Environment; Ministry of Agriculture, Livestock and Food Supply; Ministry of Mines and Energy; Ministry of Development, Industry and Foreign Trade - MIDIC, etc.
Federal institutions and state institutions
Trade associations, NGOs, universities and research centers.

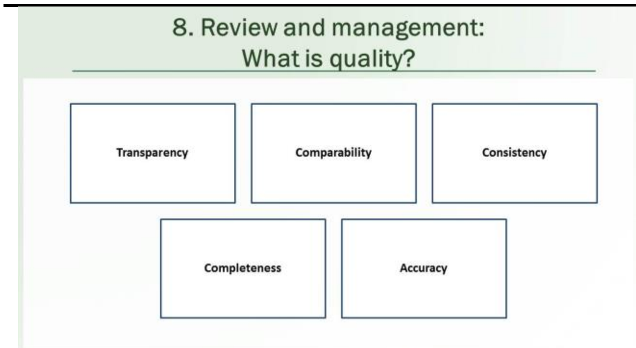

7. Examples of National Systems: India
National communication Project Management Cells
National Steering committee
Ministry of Environment and Forestry
Archiving and documentation
LULUCF
National Remote Sensing Agency
Indian Institute of Science
Indian council for Forestry Research and Education
Forest Survey India
AGRICULTURE
National Dairy Research Institute
Indian Veterinary Research Institute
Indian Grassland And Fodder Institute
Indian Agriculture Research Institute
Central Leather Research Institute
Archiving and documentation


7. Examples of National Systems: India
I. Inventory Planning
II. Institutions contracted
III. Initial Status Report
IV. Interim Report
V. Draft Report
VI. Draft Final Report
VII. Collation of information for inclusion in National Communication
VIII. Identification of gaps
Peer Review
Peer Review
Review by National Steering Committee
Peer Review and review by Scientific Advisory committee
India's Second National Communication to UNFCCC
GHG Inventory Expert Groups
Energy
Industry
Agriculture
LULUCF
Waste
Activity data providers, Emission factor providers, GHG emission inventory estimators: Research Institutions/ Industry Associations/ Universities/ Technical Institutions/ NGOs / Line Ministries/ Departments/ and other
PLANNING
PREPARATION AND MANAGAMENT


7. Examples of National Systems: Vietnam
The Government of Viet Nam
Ministry of Natural Resources and Environment
National Steering Committee for UNFCCC and KP
National Communication Management Team
National technical expert team
Overall responsible for functioning of the national inventory system (institution A)
Responsible for the National GHG Inventory (Institution B)
Composed out of
Institutions I: public sector
Institutions II: private sector
Institutions II: NGOs
Responsible for the National Communications


7. Examples of National Systems: Finland
UNFCCC and EU
Statistics Finland
Inventory working group
Advisory Body
Finish Forestry Research Institute (LULUCF)
VTT Technical Centre of Finland (transport)
Finish Environment Institute (waste)
AgriFood Research Finland (Agriculture + CO2 LULUCF)
Ministry of Environment


7. Examples of National Systems: Finland
Quality meetings
Assessing inventory system
Conclusion for future action
Setting quality objectives
Elaboration of the QA/QC plan
Specifying necessary processes and resources
Selecting methods and emission factors
Implementing QA activities
Audits and reviews
International review
Management (evaluation and improvement)
November-April
Planning
Collection activity
Estimation of ghg gas
Uncertainty
QC checks
Recalculation
Documentation and archiving
reporting
Annual reporting of NIR with CFRs
IPCC 1996 Revised Guidance
Preparation
August -December


8. Review and management:
What is quality?
Transparency
Comparability
Consistency
Completeness
Accuracy


9. References
US-EPA National GHG Inventory toolkit with templates and explanatory manual about:
Consultative Group of experts: Guiding presentation
UNDP: Managing the National Greenhouse Gas Inventory Process
Consultative Group of Experts (CGE)
Training Materials for National Greenhouse Gas Inventories
National Greenhouse Gas Inventory


UN-REDD PROGRAMME
Thank you for your attention!
Theoretical course