IPCC Guidelines and REDD Monitoring and Verification

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Expert Consultation on National Forest Monitoring and Assessment (NFMA): Meeting Evolving Needs

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Outline

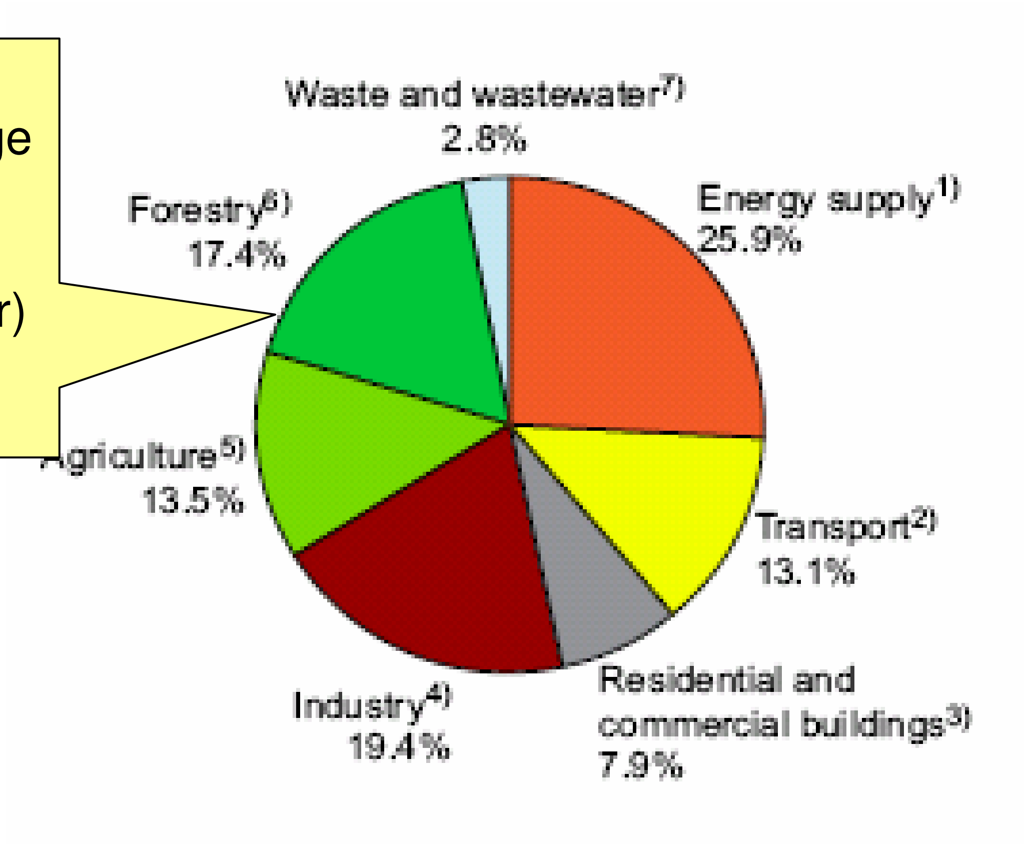
- Introduction
- Elements of a future REDD regime
- IPCC methodologies for estimation of emissions from land use and land use change
- Application of IPCC methodology to REDD
- Monitoring requirements for REDD
- Estimation of uncertainties and verification
- Next steps
- Conclusion

REDD: a bit of history

- **‘Reducing Emissions from Deforestation in Developing Countries’ (REDD)** was first discussed at COP11 at the request of PNG and Costa Rica that launched a 2 year process of discussions leading up to COP13 to deal with relevant scientific, technical and methodological issues as well as policy approaches and positive incentives
- COP13 charted a future roadmap for REDD discussions by its decision 2/CP.13
- Parties have exchanged views, shared information and had discussions on REDD issues in SB & AWG meetings and several workshops organized by the UNFCCC

Why REDD?

Forestry and land use change accounts for nearly 20% (5.6 GtCO2e/yr) of global emissions

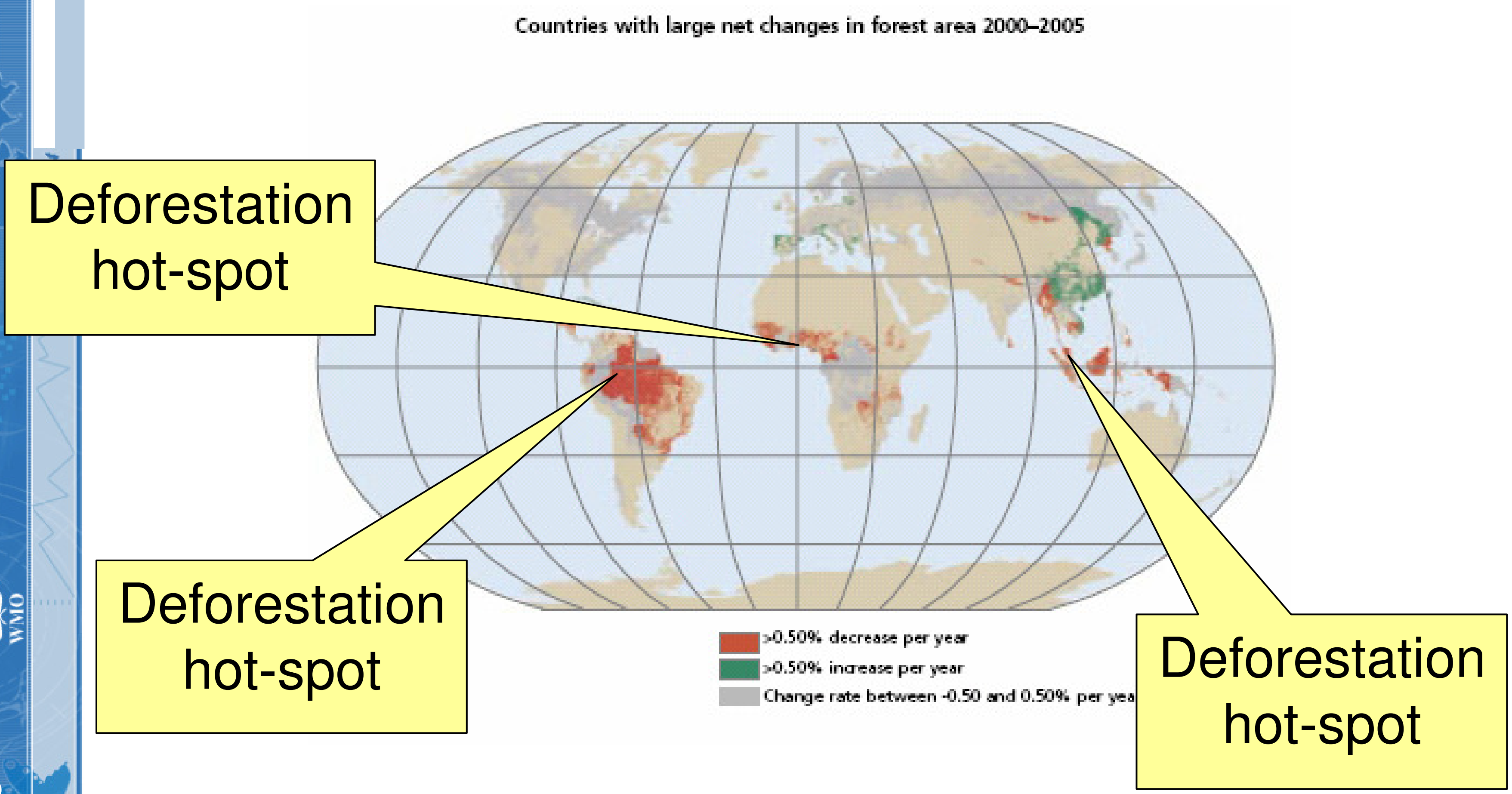


Source: IPCC AR4, 2007

Tropical deforestation

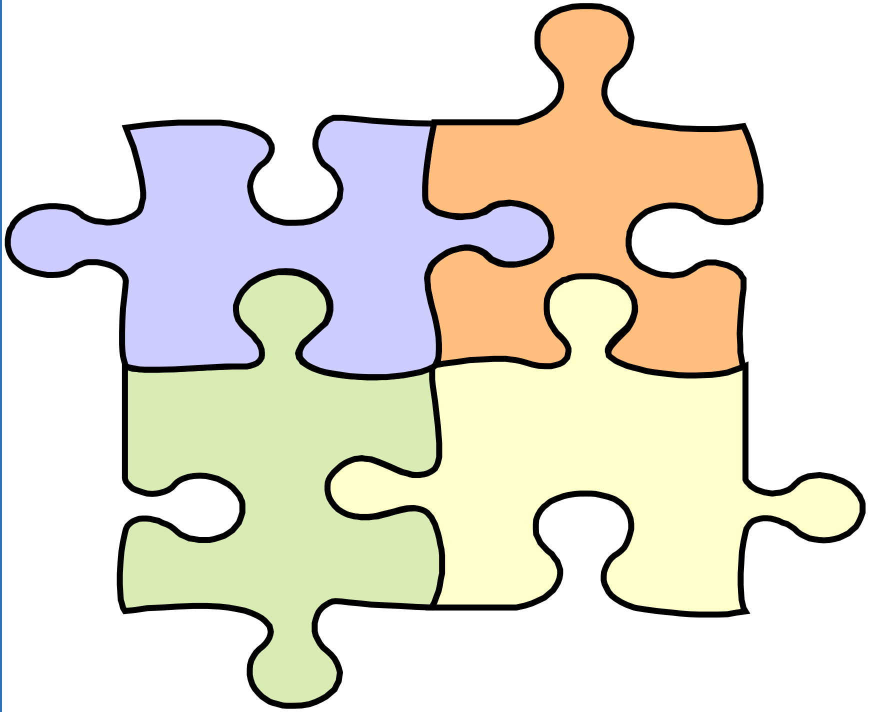
- Global gross and net deforestation are 13 and 7.3 million hectares per year respectively, mainly in the tropical countries (FRA 2005)
- Main hotspots of deforestation are in the tropics in South America, Africa and Asia
- Tropical deforestation also causes loss of biodiversity and livelihoods

Tropical deforestation(2)

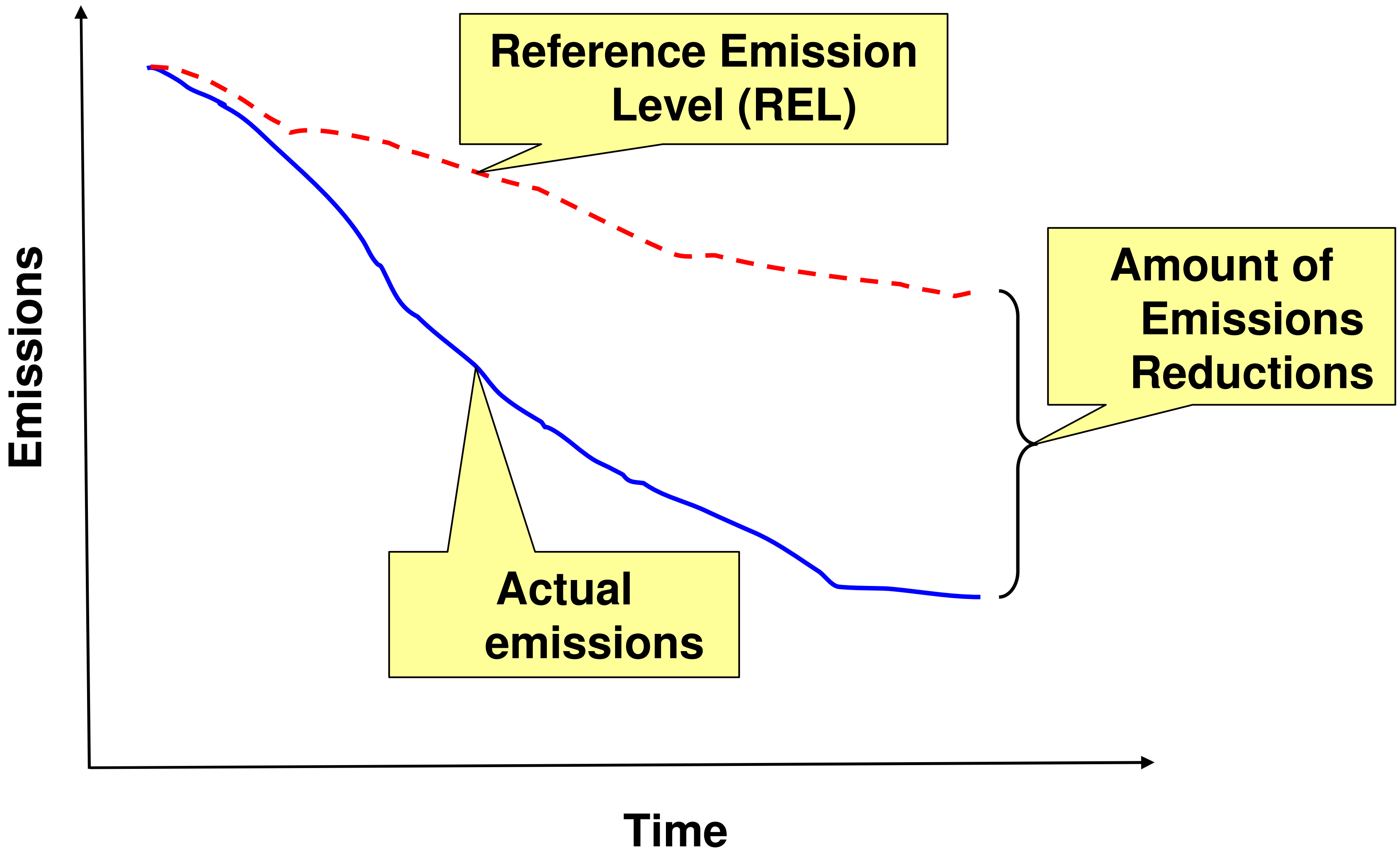


Source: FRA 2005

Elements of a future REDD regime



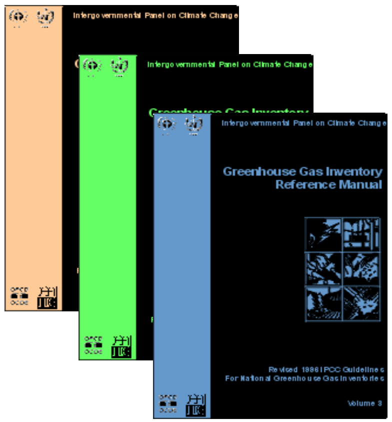
The concept of REDD

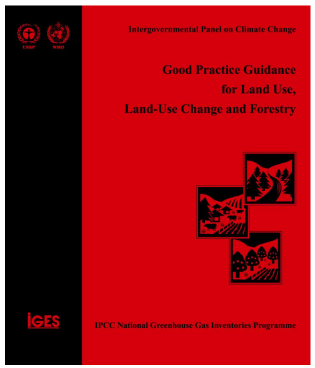


Reference scenario

- Reference scenario or Reference Emission Level (REL) refers to the situation without a particular policy intervention that is used as a reference case for comparing and quantifying a policy performance
- For REDD, some of the reference emissions scenario under discussion are based on or projected from past historical trends in emissions from deforestation and degradation
- REL is linked to the past trend in land use change and associated C stocks
- IPCC methodologies can be used to convert past or future land use change into associated emissions

IPCC Methodologies for Estimation of Emissions from Land Use and Land Use Change





IPCC Guidelines for National Greenhouse Gas Inventories

- *Revised 1996 Guidelines - Land-Use Change and Forestry (LUCF)*
- *2000 Good Practice Guidance and Uncertainty Management*
- *Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG LULUCF)*
- *2006 IPCC Guidelines for National Greenhouse Gas Inventories*

Evolution on IPCC Guidelines on Agriculture and Land-use

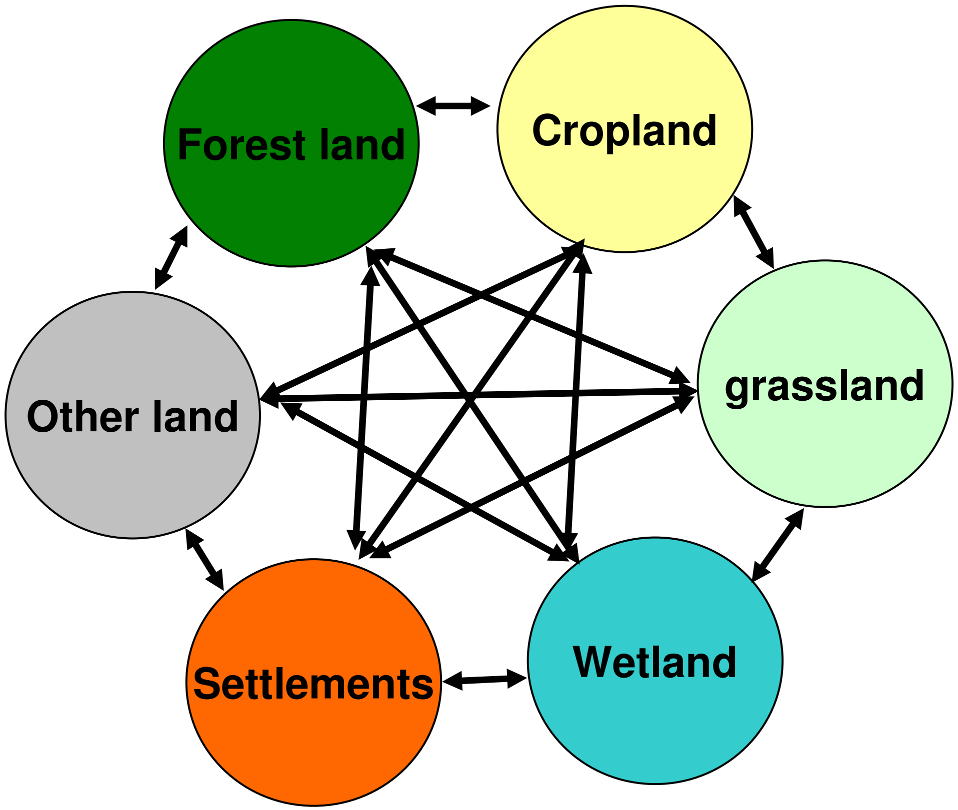
- *1996 Guidelines*
  - Agriculture and Land Use and Change and Forestry (LUCF) separate sectors
  - Focus on the most important activities resulting in GHG emissions/removals
  - Implicit assumption about estimating emissions and removals only over lands subject to human intervention
- *GPG2000 & GPG-LULUCF*
  - Specifically address *good practice* and uncertainty management in national GHG inventory development
  - *GPG* extended good practice to agriculture LUCF only (it was addressed later due to ongoing negotiations)
  - *GPG-LULUCF* re-organized all emissions and removals from land use activities into six broad land-use categories

Evolution on IPCC Guidelines on Agriculture and Land-use (2)

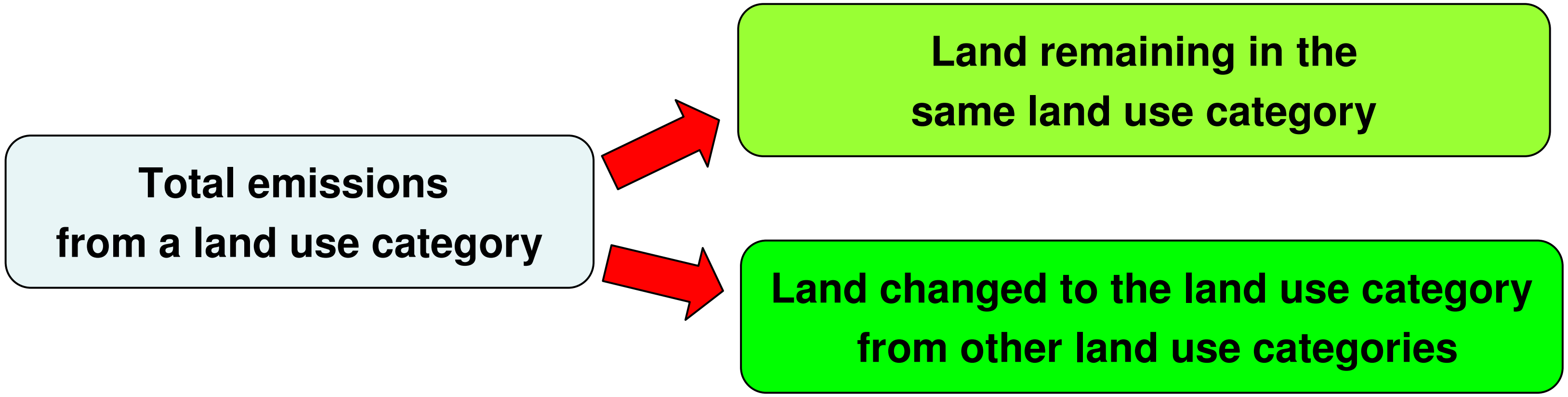
- *GPG-LULUCF (cont'd.)*
  - Guidance on different methodological tiers *(Tier 1,2 & 3)*
  - Defined 'anthropogenic' GHG emissions as those occurring on *managed* land thereby using managed land as a proxy for anthropogenic emission
  - Decision 2/CP.13 *encourages* the use of the most recent (GPG-LULUCF) reporting guidelines as a basis for reporting greenhouse gas emissions from deforestation

- *2006 Guidelines*
  - Retained the basic structure of *GPG-LULUCF*
  - Retained and made more explicit the concept of managed land as a proxy for anthropogenic emissions
  - Inclusion and consolidation of several previously optional categories(e.g.N2O emissions from peat lands, C stocks in settlements)
  - Improved guidance on HWP
  - Refinement of methods and improved defaults

Six Land Use Categories



Emissions and removals from a land use category

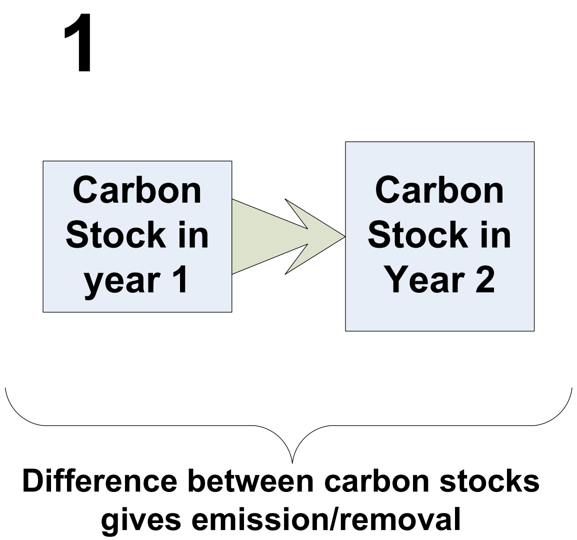


Emissions from a land use category are reported under the final land use category

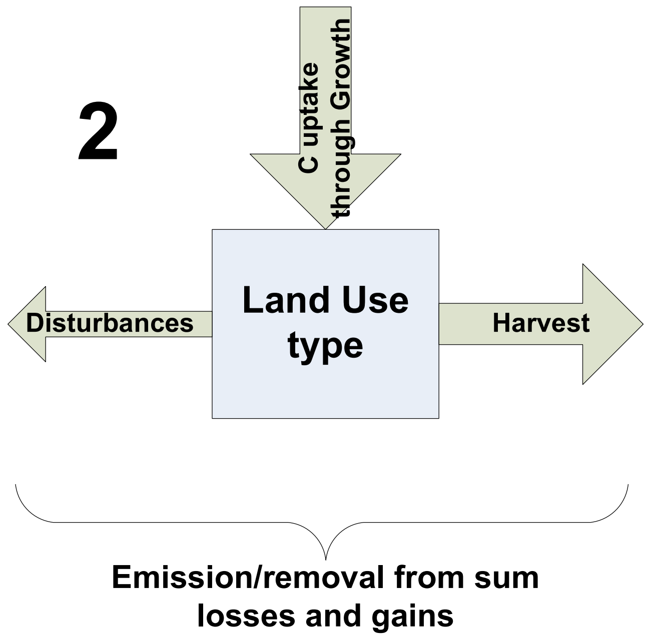
Basic approach in IPCC Guidelines for land use and land use change emissions

- C fluxes occur at widely varying spatial and temporal scales
- Direct Measurement of C fluxes extremely difficult due to heterogeneity of terrestrial ecosystems and uncertainty in measurements
- A practical first order approach makes two assumptions:
  - **Flux of C = changes in carbon stocks in carbon pools**
  - **Change in carbon stocks can be estimated from land use and management at various points in time, their impacts on carbon stocks and the biological response to them**

Estimating Carbon Stock Changes

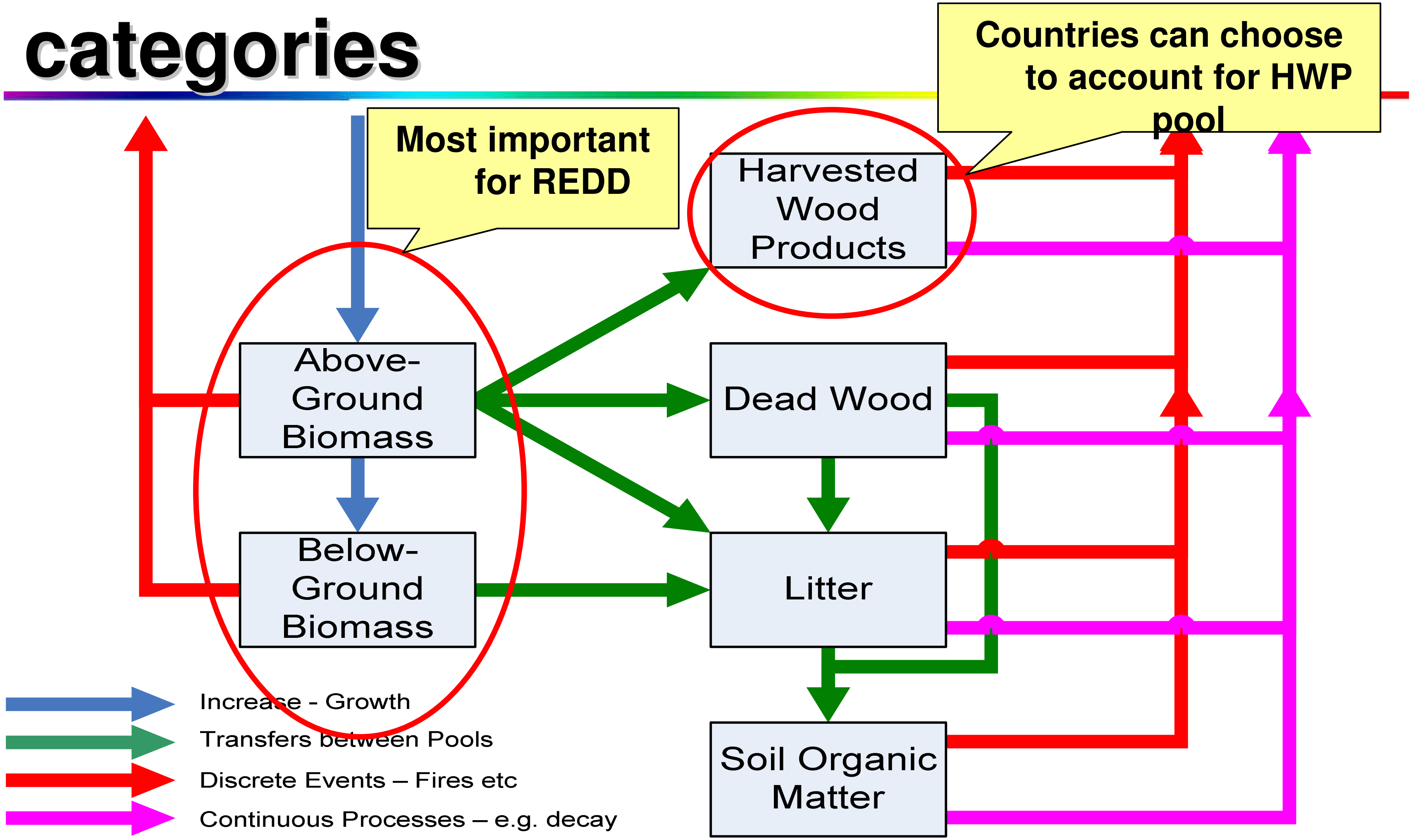


(a) Stock change method



(b) Gain loss method

C Pools in different land use categories



How does the Carbon add up?

Annual carbon stock changes for a stratum of a land use category:

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

Annual C stock changes for a land use category:

$$\Delta C_{LU} = \Sigma \, \Delta C_{LU\,i}$$

Annual carbon stock changes from all land use categories:

$$\Delta C_{AFOLU} = \Delta C_{FL} + \Delta C_{CL} + \Delta C_{GL} + \Delta C_{WL} + \Delta C_{SL} + \Delta C_{OL}$$

Three methodological Tiers

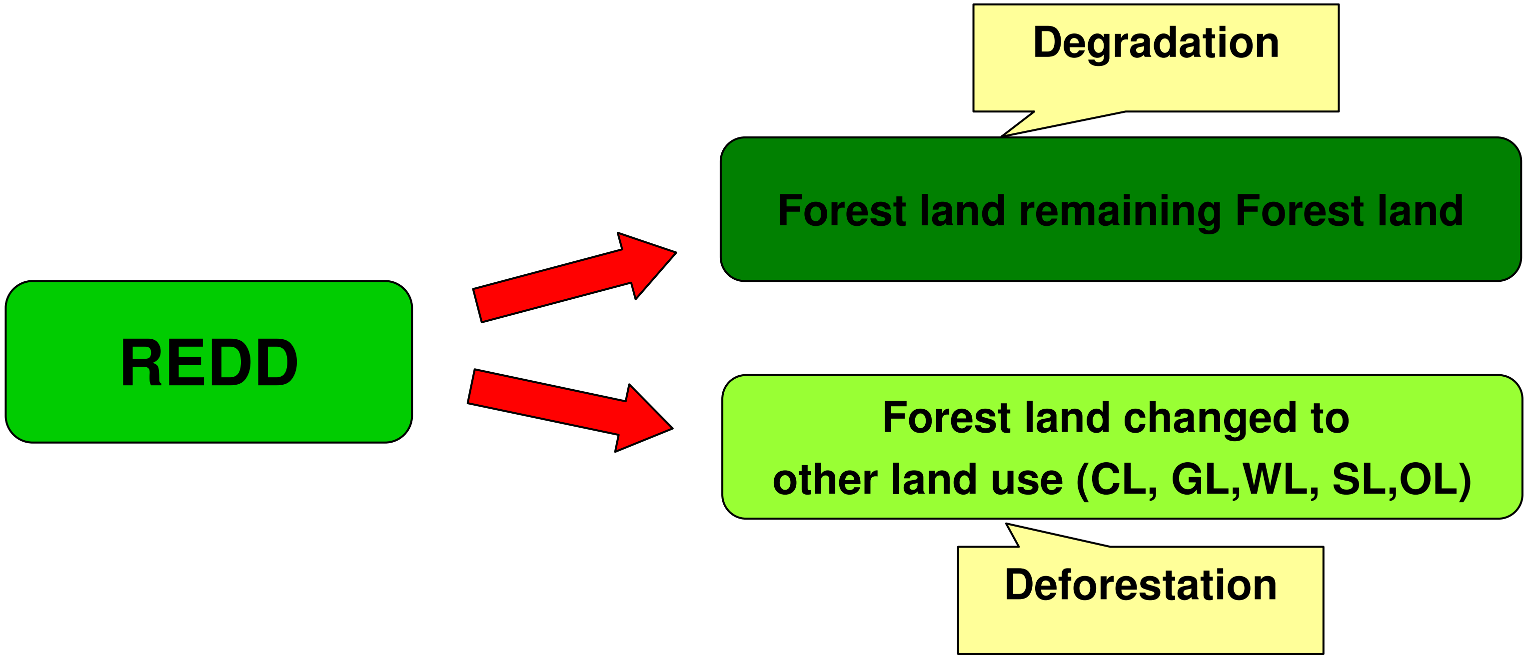
- IPCC Guidelines provide **three methodological tiers** varying in complexity to be chosen on the basis of national circumstances
- **Tier1** :
  - **Simple first order approach**
  - spatially coarse default data based on globally available data
  - large uncertainties
  - methods involving several simplifying assumptions.
  - default values of the parameters from the IPCC guidelines
- **Tier 2**:
  - **A more accurate approach**
  - country or region specific values for the general defaults
  - more disaggregated activity data
  - relatively smaller uncertainties
- **Tier 3**:
  - **Higher order methods**
  - detailed modeling and/or inventory measurement systems
  - data at a greater resolution
  - lower uncertainties than the previous two methods
- **Higher Tier methods (Tier 2&3)**are required for **key source categories**, source or sink categories that contribute substantially to the overall national inventory level, trend or uncertainty
- Higher tier methods will likely be used for REDD estimates especially for significant pools

Three approaches for area change representation

Approach 1	Net area of land use for various land use categories; no tracking of land use conversions	Net-Net changes between categories
Approach 2	Tracking of land use conversion on a non-spatially basis	Gross-net changes between categories
Approach 3	Tracking of land use conversion on a spatially explicit basis	Gross-net changes between categories & within categories

Application of IPCC Methodology to REDD

Emission Estimation from deforestation and degradation



IPCC methodologies can be used for estimating both

Deforestation

- Generally defined as **long term human induced** conversion of forest land to non-forest land use
- Under UNFCCC, Decision 11/CP.7 defined deforestation as, *"…the direct, human-induced conversion of forested land to non-forested land."*
- Depends on the thresholds used to define forest land
- Under the Kyoto Protocol (KP), Parties can choose a specific threshold value from the following range of minimum area, tree height and crown cover to define their forests (Decision 16/CMP.1):
  - **Minimum forest area: 0.05 to 1 ha**
  - **Potential to reach a minimum height at maturity *in situ* of 2-5 m**
  - **Minimum tree crown cover (or equivalent stocking level): 10 to 30 %**

Degradation

- Generally defined as a **long term** decrease in canopy cover, carbon stock or other forest values of a forest not qualifying as deforestation
- There are many definitions of degradation
- *IPCC Special Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-Induced Degradation of Forests and Devegetation of Other Vegetation Types, 2003* gave the following framework definition for KP*:* "**A direct, human-induced, long-term loss (persisting for X years or more) or at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation**" while not agreeing to any of the 5 criteria.
- However, the thresholds for carbon stock loss, minimum area affected and time period need to be clearly defined to operationalize any such definition

Two elements of REDD monitoring and verification

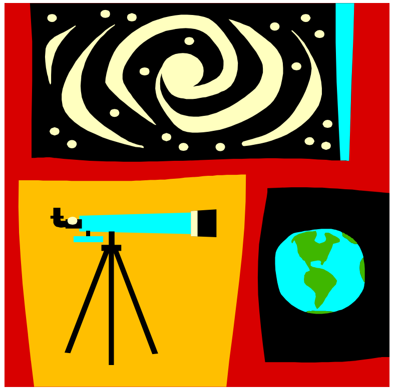
REDD M&V

Monitoring of area change for deforestation and degradation (Activity Data)

Estimation of associated carbon stocks (Emission Factors)

AD X EF = Emissions

Monitoring Requirements for REDD



Monitoring of area changes

- REDD requires systematic **long-term** monitoring of forests and other land use for assessing and comparing the historical and future rates of deforestation and degradation
- Important issues that need to be considered for a monitoring system to be applicable to REDD:
  - Time series availability of data(1990, 2000, 2005)
  - Resolution
    - Suitable for national forest definition based on UNFCCC definition of forest
  - Consistency
  - Robustness
  - Comprehensiveness (wall-to-wall/sampling)
  - Cost-effectiveness

Monitoring of area changes (2)

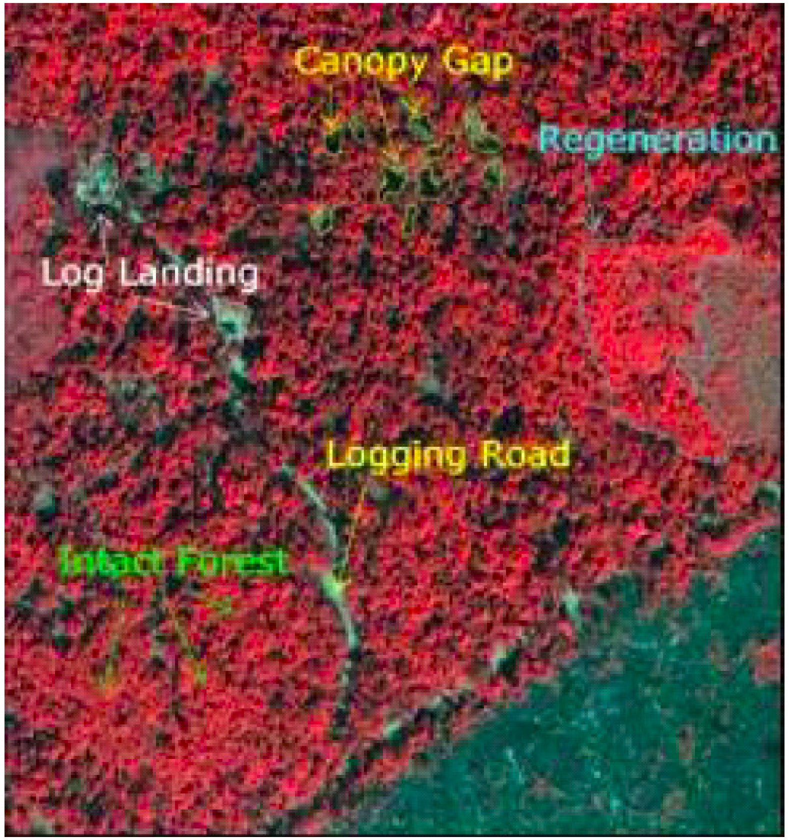
Sensor & resolution	Examples of current sensors	Minimum mapping unit (change)	Cost	Utility for monitoring	
Coarse (250-1000 m)	SPOT-VGT (1998-) Terra-MODIS (2000-) Envisat-MERIS (2004 -)	~ 100 ha ~ 10-20 ha	Low or free	Consistent pan-tropical annual monitoring to identify large clearings and locate "hotspots" for further analysis with mid resolution	**Hotspot monitoring**
Medium (10-60 m)	Landsat TM or ETM+, Terra-ASTER IRS AWiFs or LISS III CBERS HRCCD DMC SPOT HRV	0.5 - 5 ha	Landsat & CBERS will be free from 2009 <$0.001/km² for historical data $0.02/km² to $0.5/km2 for recent data	Primary tool to map deforestation and estimate area change	**Primary RS tool**
Fine (<5 m)	IKONOS QuickBird Aerial photos	< 0.1 ha	High to very high $2 -30 /km²	Validation of results from coarser resolution analysis, and training of algorithms	**Validation**

Source: GOFC-GOLD REDD Source book

- The most feasible approach is a hybrid system of remote sensing supported by ground-based observations (field inventories)
- REDD would require assessment of area changes using at least approach 2 or 3

Monitoring of area changes (3)

- Monitoring of degradation is more difficult than deforestation and depends on the individual drivers of degradation (selective logging, fuel-wood removal, fires etc.)
- Monitoring can be done either by detecting gaps in canopy cover (difficult unless severely degraded) or other proxies such as roads or log landings ('hot spot' detection)
- 'Hot spots' can be detected by coarse resolution sensors followed by analysis with mid or high resolution



Source: GOFC-GOLD REDD Sourcebook

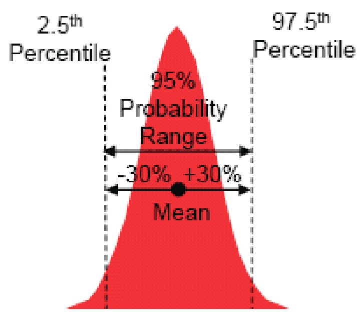
Estimation of carbon stocks

- Carbon stocks in different pools in forest vary by:
  - Forest type (coniferous, broadleaf etc.)
  - Climate (temperate, tropical, boreal…)
  - Elevation
  - Soil type
  - Age
  - Degree of disturbance (primary, secondary, logged…)
- Stratification of forests is necessary to capture the differences on C stocks in different pools

Estimation of carbon stocks(2)

- IPCC defaults applicable for tier 1 provide average values of C stocks for different ecological zones at continental scale and do not capture the differences due to human induced disturbances etc.
- Tier 2/3 data from national inventories and/or modeling approaches required for REDD estimations
- REDD requires setting up and strengthening of national forest inventory systems for accurate C stock measurements at suitable level of disaggregation (role of NFMA)
- Recent advances in remote sensing such as lidar technology have some potential for C stock estimation through correlation between lidar canopy metrics and biomass

Estimation of Uncertainty and Verification



Uncertainty estimation

- In line with concept of *good practice* in IPCC Guidelines, estimate of REDD emissions should *neither over nor underestimate so far as can be judged*, and the **uncertainties in these estimates should be *reduced as far as practicable***
- Uncertainty in REDD emission estimates can arise both from uncertainty in estimation of area changes and carbon stocks
- Over-all uncertainty in a REDD emission estimate can be obtained by combining the two uncertainties either by error propagation equation (tier 1):

$$U_{overall}=\sqrt{\{U^2_{carbon} + U^2_{area}\}}$$

Where U = ½(95% confidence interval)/mean

Or by stochastic simulation (Tier 2/3:Monte Carlo method)

Sources of uncertainty

- Sources of error in land use change estimation are quality of remotely sensed data, image processing & interpretation errors, error due to technical issues such as interoperability of different sensors and different thematic standards and error due to lack of reference data for calibration etc.
- Sources of error in the estimation of carbon stocks are wrong stratification, improper sampling design, sampling and measurement errors

Verification

- A robust system of accuracy assessment and of area changes and carbon stocks is essential for REDD
- It should include validation by samples of independent and higher quality data sets and ground-truthing
- An international review process similar to the Annex I NIRs and CDM should be set up building up on experiences with these

Next Steps

A comprehensive program of readiness activities for REDD needs to be initiated consisting of

- national capacity building
- ensuring access to high quality remote sensing data
- setting up of robust national monitoring systems
- development of emission factors/stock change factors specific to local conditions
- Demonstration projects to gather experience
- robust verification system for accuracy assessment and quantification of uncertainties

Conclusion

- REDD requires estimation of actual emission reductions from a reference emission level
- IPCC methodologies can be applied to the estimation of REDD emission
- Data requirements for REDD are the area of land use change and the associated C stocks
- Remote sensing along with ground based systems can potentially provide the required data at suitable resolutions
- REDD requires a robust system of estimating and reporting uncertainties and verification
- A comprehensive program of readiness activities needs to be initiated

Thank You