Challenges and Opportunities in Monitoring of Emission Reductions in World Bank Land Use Carbon Finance Programs

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OUR OBJECTIVES

Promote and reward reduced greenhouse gas emissions and increased sequestration through better land management, climate-smart agriculture, and smarter land use planning and policies.

• Integrate sub-national development agenda with low-carbon pathways.
• Support forest countries to maintain and improve livelihoods, conserve biodiversity and leverage significant private and public sector finance to achieve transformational change.
• Demonstrate approaches that can be applied nationally i.e., national low-carbon strategies and global mechanisms of support such as REDD+.
WORLD BANK FOREST CLIMATE FUNDS ($2.3 BILLION)

**Forest Carbon Partnership Facility (2008)**
- Readiness $365M
- Carbon Fund $692M
- $1.1B

**Forest Investment Program (FIP) (2009)**
- MDBs $787M
- World Bank $399M
- Investments (grants, co-financing), Preparation Grants, Dedicated Grant Mechanism
- Investments inside and outside forests; institutional capacity, forest governance, and information

**Initiative for Sustainable Forest Landscapes (ISFL)(2013)**
- Technical Assistance $98M
- Result-based payments $244M

**BioCF Tranche 1 & 2 (CDM and voluntary markets) (2004)**
- Result-based payments $83.3M
- Technical Assistance $6.3M

**For all MDB’s**

**BioCarbon Fund**
- $340M (ISFL)
- $90M (Classic)
BUSINESS MODEL

Enabling Environment
- Policy and strategy
- Capacity building
- Social inclusion
- Consultation

Development Action
- Investments in low carbon development
- Sustainable management of forests
- Climate-smart agriculture

Low-Carbon Development Benefits
- Poverty alleviation
- Shared prosperity
- Climate change mitigation and adaptation

We provide:
Grant Funding; Technical Assistance

Results-Based Finance for Emission Reductions

Private and Public Finance, including IDA, IBRD, GEF financing

We “crowd-in”:
In 2004 we began project-level pilots to change land-use (BioCF T1/2).

To scale-up impact, we now target landscape-level transformation (BioCF ISFL & FCPF Carbon Fund).

In parallel, we are supporting countries to be ready to take climate-smart land-use to national scale.

Average scale of intervention:
- 10,000 ha
- 10 million ha
- 100 million ha

Timeline:
- 2004
- 2015
- 2030

World Bank Group Climate Change
WHERE WE WORK

- **22 countries** with large scale climate-smart land-use programs
- **54 countries** with REDD+ readiness support or projects

Countries highlighted:
- Mexico, Dominican Republic, Guatemala, Nicaragua, Costa Rica, Colombia, Peru, Chile, Nepal, Lao PDR, Vietnam, Indonesia, Fiji, Ethiopia, Cameroon, Ghana, Cote d’Ivoire, Republic of Congo, DRC, Mozambique, Madagascar, Zambia, DRC.
WHERE WE WORK – LAND USE PROGRAMS

19 ER programs under FCFP Carbon Fund
3 ER programs under Carbon Fund - ISFL

- Mexico
- Guatemala
- Nicaragua
- Costa Rica
- Colombia
- Peru
- Chile
- Dominican Republic
- Cote d’Ivoire
- Ghana
- Cameroon
- Republic of Congo
- DRC
- Ethiopia
- Nepal
- Lao PDR
- Vietnam
- Indonesia
- Fiji
- Zambia
- Madagascar
- Mozambique
DIFFERENCE BETWEEN FCPF CF AND ISFL

REDD+ ≈ Forestry sector

Landscape ≈ AFOLU sector
ER programs have to present RL and MRV system designs compliant with methodological requirements

Some highlights:

- GHG emissions from forest degradation or FL-FL must be accounted for
- GHG emissions and removals have to be estimated with IPCC Tier 2, Tier 1 may be used exceptionally
- Uncertainties estimated via Monte Carlo methods
- Discounts are applied to ERs if HWCI >15% at 90% of confidence
**Reference Levels of ER Programs**

- 7 ER programs have presented Reference Levels so far
- Some figures…

![Pie chart showing the total area covered by various ER programs.]

- Vietnam, 5
- Mexico, 29
- Chile, 15.3
- Congo, 12.4
- DRC, 12.8
- Ghana, 5.92
- Costa Rica, 5.1

**Total Area = 86 Million HA**
REFERENCE LEVELS OF ER PROGRAMS

- 7 ER programs have presented Reference Levels so far
- Some figures…

NATURAL FOREST AREA = 51.6 MILL. HA
7 ER programs have presented Reference Levels so far
Some figures…

Deforestation = 89 million tCO2/year
Degradation = 65 million tCO2/year
HOW TO ESTIMATE EMISSION REDUCTIONS

• A simple case…

$$tCO_2 = \frac{ha}{year} \times \frac{tCO_2}{ha} \approx AD \times EF$$
HOW TO ESTIMATE EMISSION REDUCTIONS

• A simple case…

[Graph showing GHG emissions, deforestation, reference period, and monitoring period]
HOW TO ESTIMATE EMISSION REDUCTIONS

- A simple case...
HOW TO ESTIMATE EMISSION REDUCTIONS

• A simple case…

\[ \text{ER} = (\text{AD}_{rp} - \text{AD}_{mp}) \times \text{EF} = \text{Vector} \times \text{Constant} \]
HOW TO ESTIMATE EMISSION REDUCTIONS

• A simple case…

\[
\text{ER} = (\text{AD}_{rp} - \text{AD}_{mp}) \times \text{EF} = \text{Vector} \times \text{Constant}
\]

AD defines the sign of the change so it is critical for measuring performance.
ACTIVITY DATA ESTIMATION — CHALLENGES

• Activity data has been usually estimated with EO data with two approaches:
  • **Wall-to-wall approach**, i.e. maps
  • **Sampling approach**
• However, the use of maps has some issues…
### Activity Data Estimation – Challenges

- Example of probabilities matrix of change map

<table>
<thead>
<tr>
<th>Class</th>
<th>DF</th>
<th>AF</th>
<th>F</th>
<th>NF</th>
<th>Total</th>
<th>User's accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF</td>
<td>0.03</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.04</td>
<td>0.62</td>
</tr>
<tr>
<td>AF</td>
<td>0.00</td>
<td>0.03</td>
<td>0.00</td>
<td>0.01</td>
<td>0.04</td>
<td>0.75</td>
</tr>
<tr>
<td>F</td>
<td>0.01</td>
<td>0.02</td>
<td>0.50</td>
<td>0.04</td>
<td>0.57</td>
<td>0.88</td>
</tr>
<tr>
<td>NF</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.29</td>
<td>0.34</td>
<td>0.85</td>
</tr>
<tr>
<td>Total</td>
<td>0.06</td>
<td>0.06</td>
<td>0.53</td>
<td>0.35</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

**Map**

- **Producer's accuracy**: 0.49, 0.50, 0.94, 0.84
- **Overall accuracy**: 0.85

62% of pixels classified as deforested are actually deforested.

49% of area actually deforested has been mapped.

*DF = Deforestation, AF = Afforestation*
• Olofsson et al. (2014) is the first attempt to provide guidance in order to address the challenges of using maps to estimate Activity Data
• The approach is to use sample reference data and change maps for stratification, in order to obtain a stratified estimate (design-based inference)
**ACTIVITY DATA ESTIMATION — CHALLENGES**

Map = Strata

Sampling of reference data

Inference

\[ \hat{\mu}_{STR} = \sum_{h=1}^{N} w_h \hat{\mu}_h \]

<table>
<thead>
<tr>
<th>Change class</th>
<th>StRS estimate</th>
<th>U% 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF</td>
<td>0.407</td>
<td>3%</td>
</tr>
<tr>
<td>SNF</td>
<td>0.439</td>
<td>3%</td>
</tr>
<tr>
<td>AF</td>
<td>0.083</td>
<td>7%</td>
</tr>
<tr>
<td>DF</td>
<td>0.025</td>
<td>19%</td>
</tr>
<tr>
<td>FE</td>
<td>0.018</td>
<td>7%</td>
</tr>
<tr>
<td>FD</td>
<td>0.028</td>
<td>19%</td>
</tr>
</tbody>
</table>
Five out of seven programs of the CF have applied this guidance

Costa Rica has not applied it as it has applied complex Tier 3 integration frameworks for estimating the RL

However, some challenges have been faced when establishing their Reference Levels…
**ACTIVITY DATA ESTIMATION — CHALLENGES**

- **Challenge 1**: Too large statistical uncertainty

  Cause: Effect of one single sample in a large stratum
Challenge 2: Difficulty in the application when large complex classes (e.g. complex integrated methods)

Merging these two classes could bias the estimates of GHG emissions.
Challenge 2: Difficulty in the application when large complex classes (e.g. complex integrated methods)
Challenge 3: How to estimate ERs with precision?

This is one only one realization
**ACTIVITY DATA ESTIMATION — CHALLENGES**

- **Challenge 3:** How to estimate ERs with precision?

![Graph showing deforestation rates with error bars and two realizations with the same relative error but different outcomes.](image-url)

Two realizations with same relative error but different outcomes.
ACTIVITY DATA ESTIMATION – OPPORTUNITIES

1. How to reduce uncertainty of AD in design-based inference?
2. How to estimate uncertainty in complex legends or high integration methods?
   1. Options in design-based inference
   2. Options in model-based inference
3. How to estimate the change of AD and its uncertainty?
   1. Options of sampling designs
   2. Montecarlo simulations
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

• The methodological requirements of the CF/ISFL require accounting of GHG emissions from degradation
• ER programs have piloted different methods to estimate degradation
• ER programs have successfully estimated GHG emissions from degradation…
• …yet, still many uncertainties and limitations
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

- **Mexico, Vietnam and DRC**: Degradation detected as transitions between forest types (e.g. primary to secondary forest)
- **Some issues**: only detects high disturbance degradation, high uncertainty in the classification
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

- **Congo, Madagascar**: Degradation is detected through changes in vegetation indices in a temporal series of medium resolution imagery.
- **Some issues**: High commission errors, no VHR imagery available for validation.
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

• **Costa Rica, Madagascar**: Degradation is detected through changes in canopy cover observed in VHR imagery.

• **Some issues**: Coverage of VHR imagery, impossibility to detect small changes in canopy.
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

- **Chile**: Using stocking tables built with NFI data, and they are applied to spatial explicit stocking models
OTHER CHALLENGES AND OPPORTUNITIES - DEGRADATION

- **Ghana, Congo**: Using extracted timber volumes as proxies of degradation by multiplying volumes to damage factors.

- **Issues**: uncertain extracted volumes, volumes of illegal logging not available.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value (tCO₂/m³)</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission from Extracted Log</td>
<td>0.79</td>
<td>0.02</td>
</tr>
<tr>
<td>Logging Damage Factor</td>
<td>2.46</td>
<td>0.17</td>
</tr>
<tr>
<td>Logging Infrastructure Factor</td>
<td>0.50</td>
<td>0.13</td>
</tr>
<tr>
<td>Total Emission Factor</td>
<td>3.75</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Peatlands in the Congo basin store a quantity that is equivalent to 95% of the above-ground carbon stocks of the tropical forests of the entire Congo Basin.

These areas are not yet under threat.

However, research is needed in order to understand the carbon dynamics and estimate potential impact of future policies over these areas.
OTHER CHALLENGES – NEW RESEARCH
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THANK YOU