RESTORE+: Addressing Landscape Restoration on Degraded/Marginal Land in Indonesia and Brazil

Introduction
Importance of restoration

Bonn Challenge and Global Partnership on Forest Landscape Restoration

Restoring 150 million hectares of deforested and degraded land by 2020, and additional 200 million hectares by 2030.

As means to achieve the

• CBD Aichi Target 15
• UNFCCC REDD+ goal
• Rio+20 land degradation neutrality goal
• Sustainable Development Goal 15
Complexity of forest landscape restoration

- Ongoing process of regaining **ecological functionality** and enhancing **human well-being**

- Most restoration opportunities are **found on or adjacent to agricultural or pastoral land**. In these situations, restoration must **complement** and not displace existing land uses.

- **Cross-sectoral, multi-stakeholders and cross-jurisdiction**

- Requires a **bottom-up approach** e.g. Restoration Opportunities Assessment Methodology (ROAM) by IUCN and WRI
WHAT TO RESTORE?

“Global estimates of total degraded area vary from less than 1 billion ha to over 6 billion ha, with equally wide disagreement in their spatial distribution.”

(Gibbs and Salmon, 2015)

UNEP Global Assessment of Soil Degradation (GLASOD): 1.2 billion ha
FAO's Global Assessment of Lands Degradation and Improvement project (GLADA): 2.7 billion ha
FAO Terrastat (Bot et al, 2000): 6 billion ha
How do we assess **large scale** (i.e. national or regional) landscape restoration potential?

Are **current targets** realistically ambitious (together with the expected co/multiple benefits)?

How should we formulate **operational restoration policies** that ensure environmental integrity and social benefits?
RESTORE+

Quick facts

- **Project duration**
  5 years (2017-2022)

- **Type of activities**
  Enhancement of methods, tools, datasets and institutional capacity

- **Partner institutions**
  Indonesia: Ministry of National Development Planning/BAPPENAS
  Brazil: Brazilian Cooperation Agency (Foreign Office), Ministry for the Environment

- **Funding support**
  Supported by:
  [Image of partner institutions]
  based on a decision of the German Bundestag

- **Project partners**
  [Image of partner logos]
Identifying degraded land:
- Exploring possible definitions of degraded land including social and biophysical consideration
- Assess land degradation through analysis of high resolution (satellite) imagery
- Big earth observation data analysis
- Crowdsourcing and grass-root engagement

Assess implication of varying degradation definitions and restoration preferences:
- Vegetation modelling to project carbon stock, potential yield under different restoration measures etc.
- Biodiversity assessment (priority areas, species, biodiversity modelling)

Trade-off analysis and policy recommendations:
- Restoration assessment covering diverse range of restoration potential and measures
- Land use/cover projection scenarios based on spatially explicit bottom-up informed economic models
- Trade-off analysis between production and trade of food, fiber and energy commodities vis-à-vis climate change mitigation and biodiversity
- Scalable financing mechanism for restoration
Identifying degrade land
Activities in Brazil – Innovative approaches to analyze abundantly available data

**Satellite image time series** are assessed with machine learning approach to define Land Cover/Use maps (SITS methodology)

**Legal reserve requirements** are analyzed together with the **Rural Environmental Cadaster/Registry (CAR)** to define legal reserve deficits and assess potential areas for restoration.
Identifying degrade land
Activities in Indonesia – Dealing with geographic challenges (1/2)

Land Cover/Use change analysis using available **optical satellite image** to define land cover classes

**ADVANTAGES:**
- Multiple data sources
- Easy to interpret
- Long legacy of usage

**DISADVANTAGES:**
- Infrequent data, affected by cloud/haze/smoke
- Difficult to detect subtle changes (e.g. degradation)

**Radar based (SAR) remote sensing** analysis to detect changes and better detect degradation

**ADVANTAGES:**
- Independent of cloud/smoke/haze and day-light conditions
- Possible to detect subtle changes (e.g. degradation).
- Dense time-series

**DISADVANTAGES:**
- Affected by ground/vegetation moisture conditions
- Difficult to interpret
Identifying degrade land
Activities in Indonesia – Dealing with geographic challenges (2/2)

Remote sensing analysis require training data and field data collection

Validation of Land Cover Maps (training samples)

Citizen-empowered Scientific Assessment

participation of multiple stakeholders in identifying degraded land and restoration option

Collecting high quality field data while strengthening the knowledge of local stakeholders on restoration
Biophysical modelling

Biophysical vegetation modelling (Environmental Policy Integrated Climate - EPIC)

- Complex agro-ecosystem model developed by USDA (Williams et al. 1996)
- Process-based model operating on daily basis using data on weather, site, soil, and crop management
  - 20 crops (>75% of harvested area)
  - 4 management systems (High input, Low input, Irrigated, Subsistence)
  - Crop yield intensification scenarios (BAU, Intensification, Improved crop cultivars)
BGC-MAN simulations for plots in every ecoregion are used in **G4M** for spatial modeling at 10 km spatial resolution for Indonesia.
Biophysical modelling
Biophysical tree crop productivity modelling - WaNuLCAS

Developed to represent **tree-crop/tree-tree interactions in** a wide range of agroforestry systems where trees and crops overlap in space and/or time (simultaneous and sequential agroforestry).

Spatial scale: **plot** (represents a four-layer soil profile, with four spatial zones.
Time scale: **daily**
Biophysical modelling - example
Climate Change impact assessment in Brazil

Climatological Averages → Linear Interpolation (5 years) → Normalization (max = 10) → Aggregated to LU (except BR)

For each crop, variable, and management system:

- 2 RCPs: RCP2p6 and RCP8p5
- 2 GGCMs: EPIC and LPJmL (ISIMIP)
- 5 GCMs: HadGEM2-ES, IPSL-CM5A-LR, GFDL-ESM2M, NorEMS1-M, MIROC-ESM-CHEM (ISIMIP)

20 scenarios

Displacement of the main producing regions
Main producing areas (shades) and changes in soybean, corn, and grassland projected by GGCMs (EPIC and LPJmL) considering RCP8.5 emission scenario
Multicriteria trade-off analysis
Economic land use decisions model (GLOBIOM)

• Global Biosphere Management Model
  • Developed by IIASA’s ESM-Program

• Partial equilibrium model
  • Agriculture, forestry, and bioenergy sectors
  • Global coverage, 57 world regions

• Bilateral trade flows
  • Spatial equilibrium approach

• Bottom-up approach
  • Detailed spatial resolution (>200k cells)
  • Explicit description of production technologies a la Leontief
  • Technologies specified by production system and grid cell (process-based models)

• Land use and land use change
  • 6 different land use types
  • Linear programming approach
  • Maximization of consumer and producer surplus
  • Optimization constraints
  • Base year: 2000. Time step: 5 or 10 years. Time horizon: 2050/2100

MODEL OUTPUTS

MAXIMIZE

Producers’ profits
Consumers’ utility

UNDER CONSTRAINTS

Market
Natural resources

Spatial

Land use area (Hectares)
Land use change area (Hectares)
Emissions (CO2 eq)

Regional

Prices (US$)
Demand quantities (Tons)
Production quantities (Tons)
Trade quantities (Tons)

Land cover data
Agricultural statistics
Biophysical data (EPIC, G4M, WaNuLCAS)
Model integration for Indonesia
Land use planning tool for sustainable landscapes (LUMENS)
Model integration for Indonesia
Allowing high resolution results for further analysis
Policy scenarios assessment
Forest code enforcement – Results example for Brazil

Scenarios definition
- Illegal deforestation control
- Zero deforestation agreements
- Environmental reserve quotas
- Forest restoration
  - 12 million hectares
- Intensification versus extensification
- Increase in biofuels use

Different level of compliance with the Forest Code.

Gradient of governance (a) and restoration targets (b) of the different scenarios.

Projected evolution of the Cropland area, Pasture area, and Net Emissions per year from the LUCF sector (2015 to 2050) according to the various scenarios.
Restoration and Biodiversity
Assessment of restoration impacts on biodiversity

Biodiversity Intactness Analysis for Cerrado

Connectivity modelling for South Sumatra
Scalable financing mechanisms for restoration

Opportunity cost assessment
(projected deforestation in Mato Grosso)

Deforestation from 2002 – 2016 (~ 8.2 M ha)
Projected Deforestation through 2030 (~ 3.4 – 4 M ha)

Restoration cost analysis

<table>
<thead>
<tr>
<th>Restoration method</th>
<th>Total Planting Seedlings</th>
<th>Assisted Natural Regeneration</th>
<th>Natural Regeneration</th>
<th>Total Planting Seeds</th>
<th>Dens and Enrich with Seedlings</th>
<th>Dens and Enrich with Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable Environmental Condition</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Total cost ($ per hectare)</td>
<td>2,116</td>
<td>4,981</td>
<td>468</td>
<td>679</td>
<td>51</td>
<td>643</td>
</tr>
</tbody>
</table>

Financial strategies for restoration
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