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

Introduction

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Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

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

BONN CHALLENGE

THE GLOBAL PARTNERSHIP ON FOREST AND LANDSCAPE RESTORATION

RIO+20 United Nations Conference on Sustainable Development

REDD+

REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION IN DEVELOPING COUNTRIES

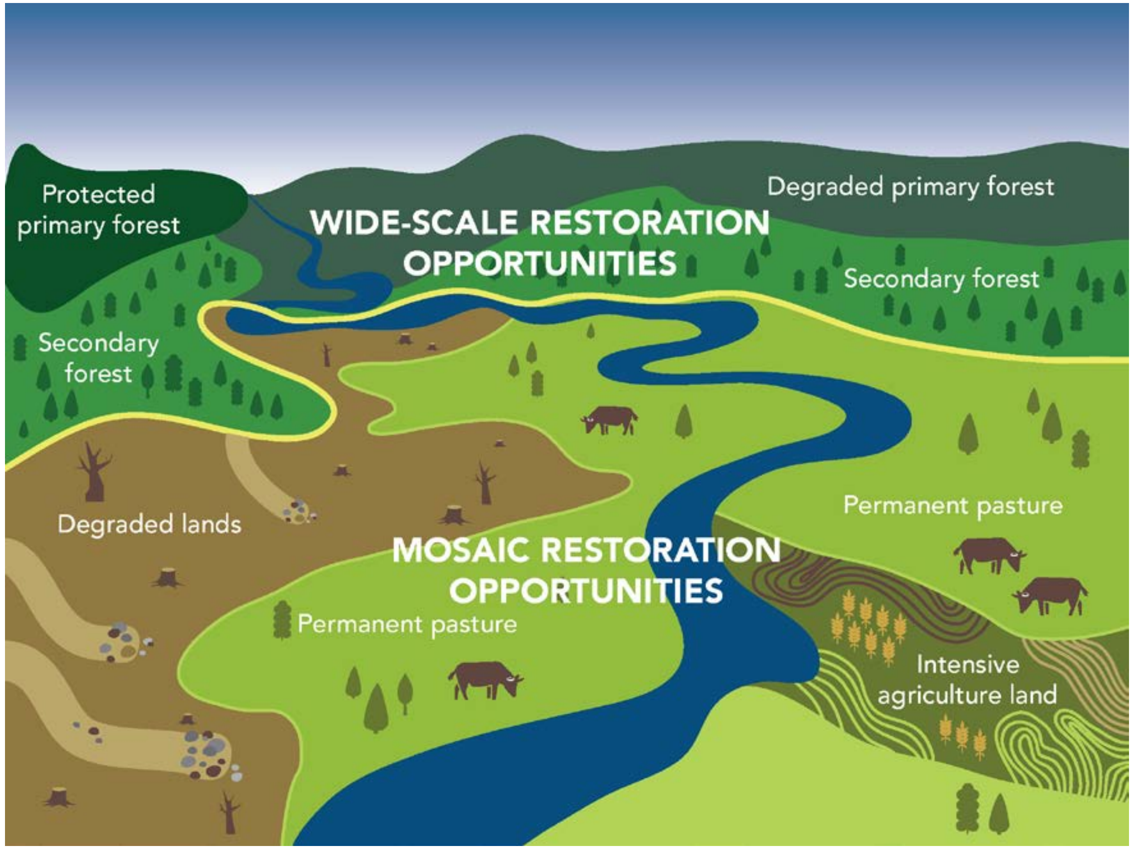
2011-2020 United Nations Decade on Biodiversity

SUSTAINABLE DEVELOPMENT GOALS

15 LIFE ON LAND

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***

RESTORE+ DRIVING QUESTIONS

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?

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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**

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- **Project partners**

  IIASA
  World Agroforestry Centre
  INPE
  UN environment
  WCMC
  ipea Instituto de Pesquisa Econômica Aplicada
  MCC
  EDF
  WRI INDONESIA
  WWF
  LSE

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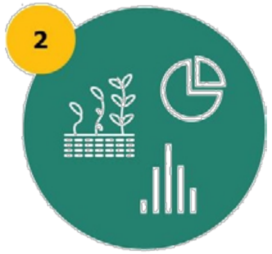
Approach

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)

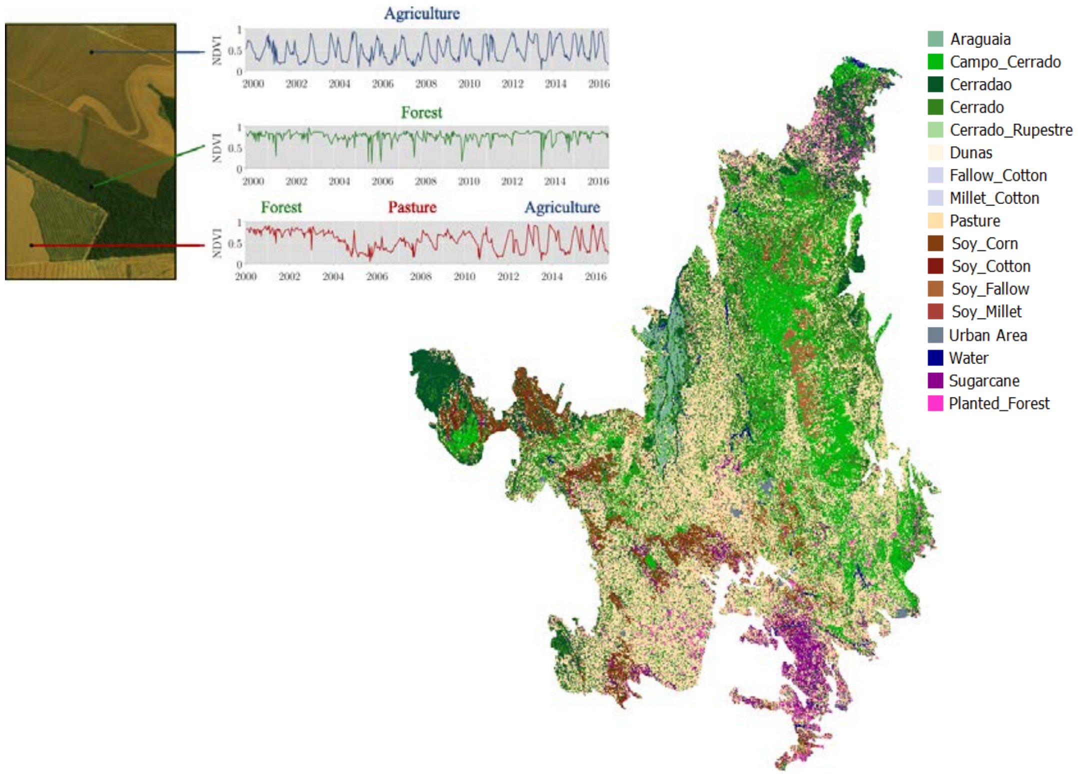
Trade-off analysis and policy recommendations:

- 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

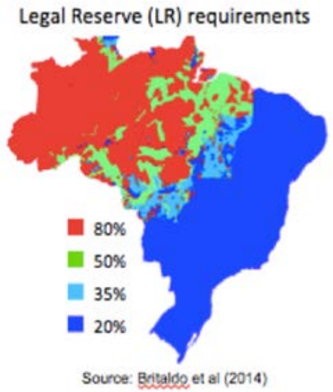
Identifying degrade land

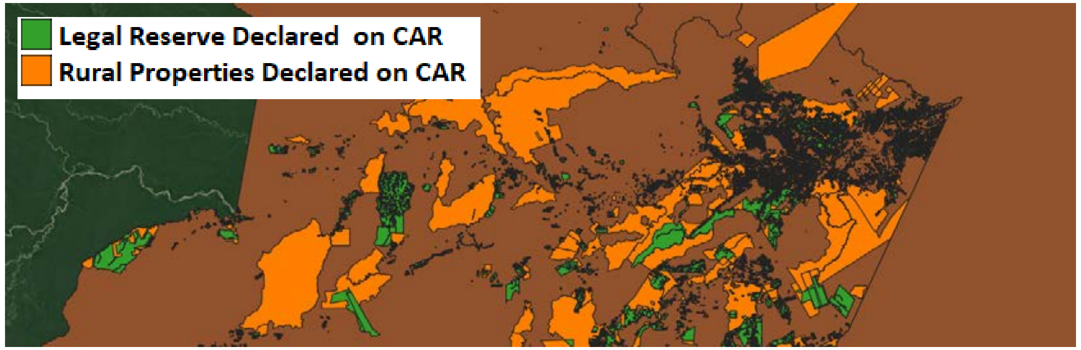
Activities in **Brazil –** Innovative approaches to analyze abundantly available data

Satellite image time series are assessed with machinle 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)

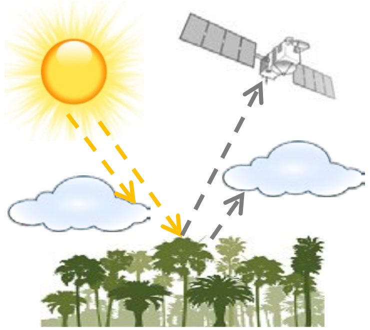
Radar based (SAR) remote sensing analysis to detect changes and better detect degradation

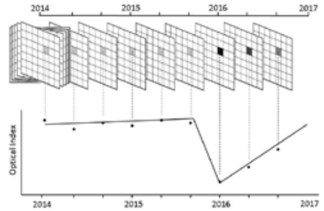
ADVANTAGES:

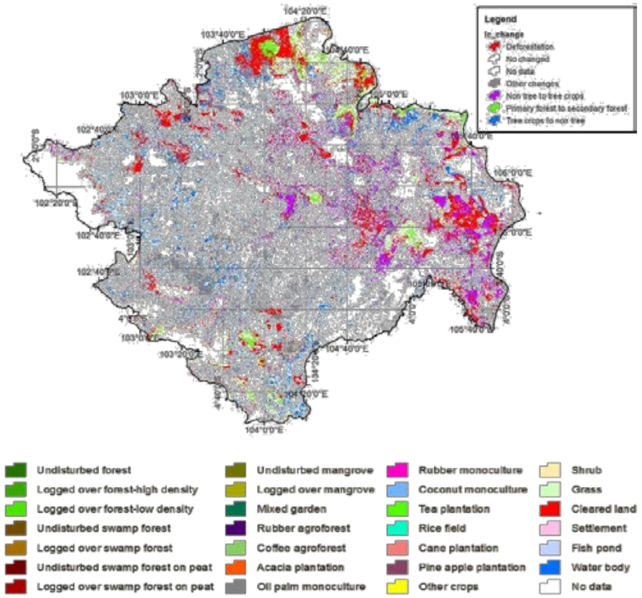
- Independent of cloud/smoke/haze and day-light conditions
- Possible to detect subtle changes (e.g. degradation).
- Dense time-series

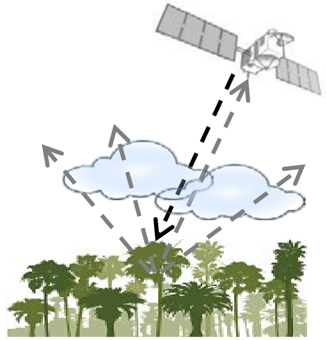
DISADVANTAGES:

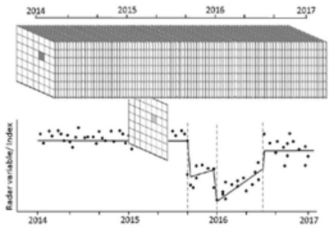
- Affected by ground/vegetation moisture conditions
- Difficult to interpret











3010 areas of change **400,000** ha in South Sumatra

547 Fire Events	834 Canal	1624 LUC

954 areas of other/mixed/unknown causes of change

Identifying degrade land

Activities in **Indonesia** – Dealing with geographic challenges (2/2)

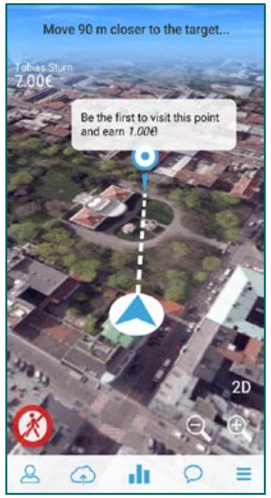
Remote sensing analysis require training data and field data collection

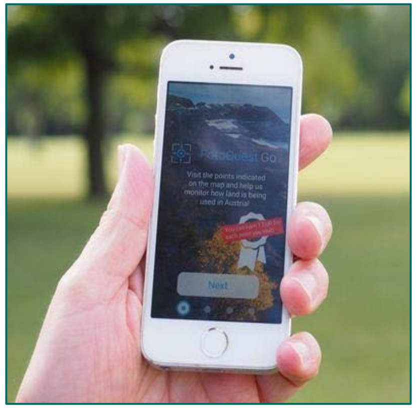
Citizen-empowered Scientific Assessment

Validation of Land Cover Maps (training samples)

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

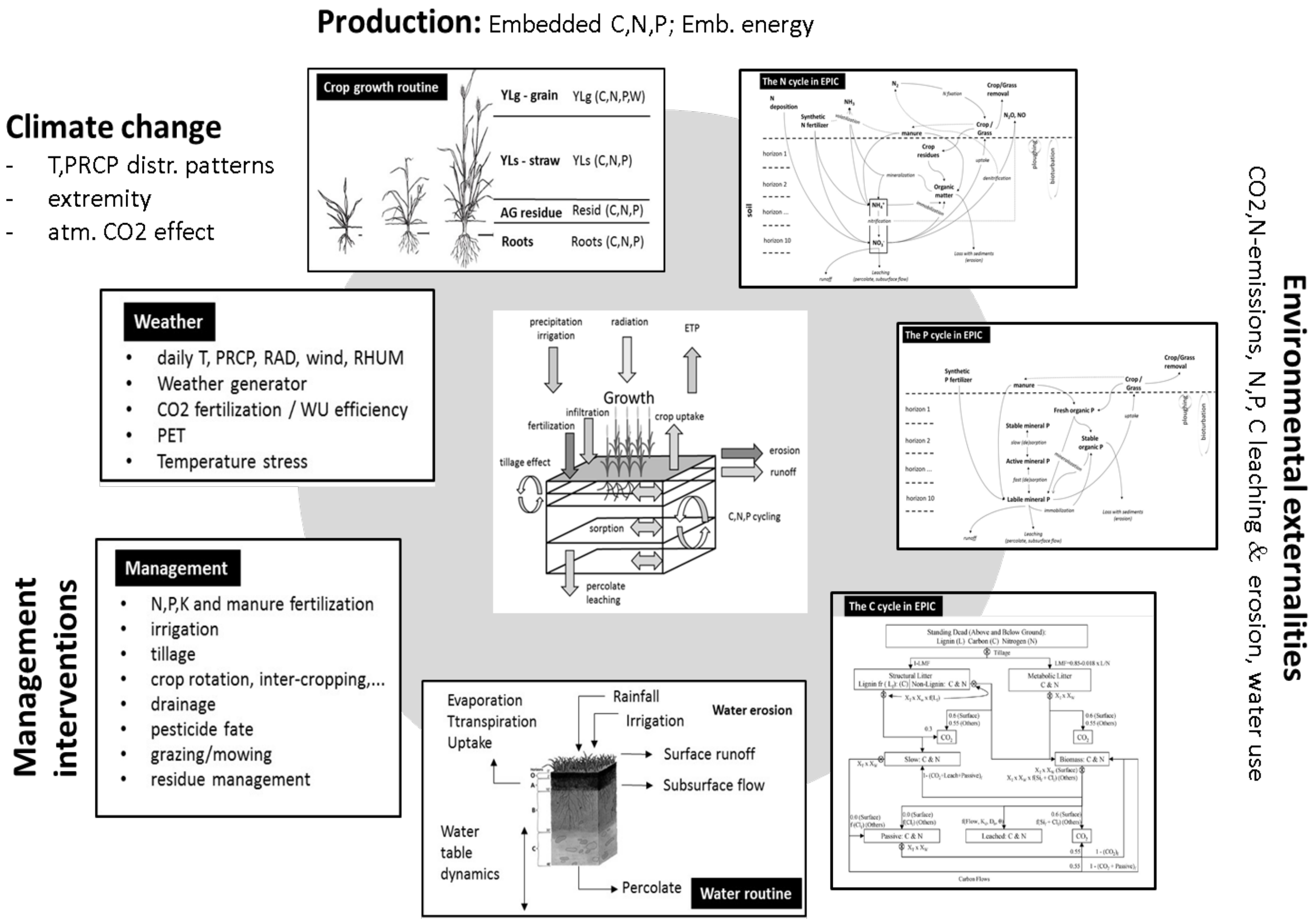




Biophysical modelling

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
  - o 20 crops (>75% of harvested area)
  - o 4 management systems (High input, Low input, Irrigated, Subsistence)
  - o Crop yield intensification scenarios (BAU, Intensification, Improved crop cultivars)



Biophysical modelling

Modelling forestry dynamics (G4M & BGC-MAN)

BGC-MAN simulations for plots in every ecoregion are used in **G4M** for spatial modeling at 10 km spatial resolution for Indonesia

Inputs
(i.e. Soils, Climate, Management)

BGC-MAN
(Bio-geo-chemistry)

Outputs
(i.e. NPP, NEE, Biomass)

Database
(hyper forest)

Calibration
NPP, NEE, Biomass
=
FUNCTIONS
(Soil, Climate, Management)

G4M
(Spatially explicit modeling)

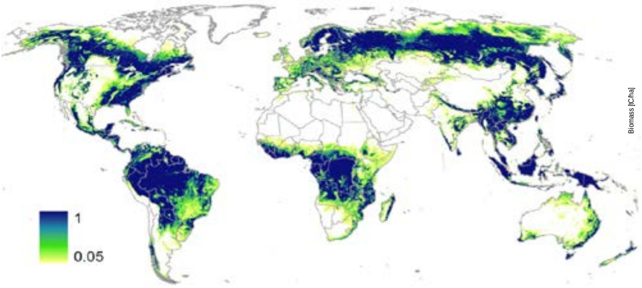
Plot data from ICRAF

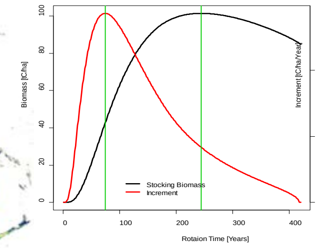
Calibration

BGC-MAN

Response functions

Global Forestry Model (G4M)





Input: climate, soil, land cover, forest type, management

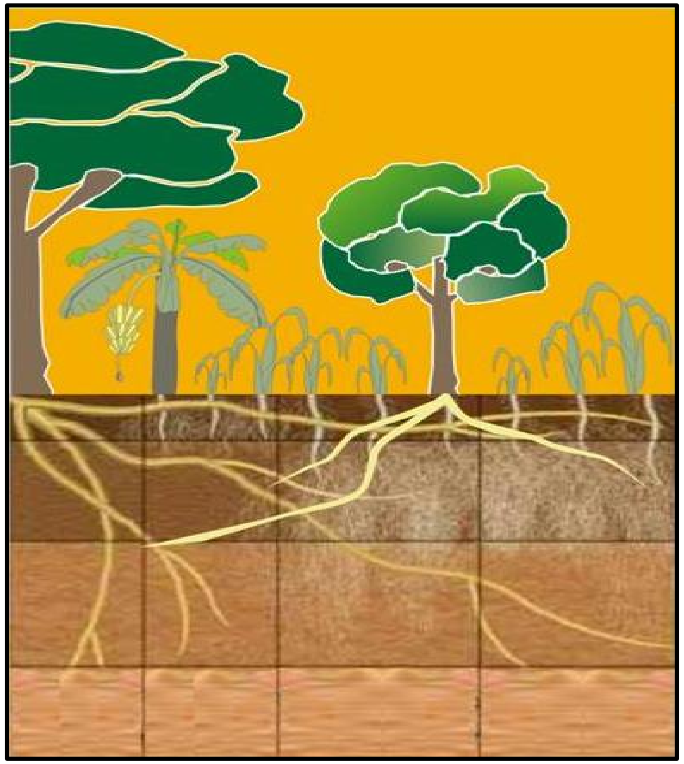
Biophysical modelling

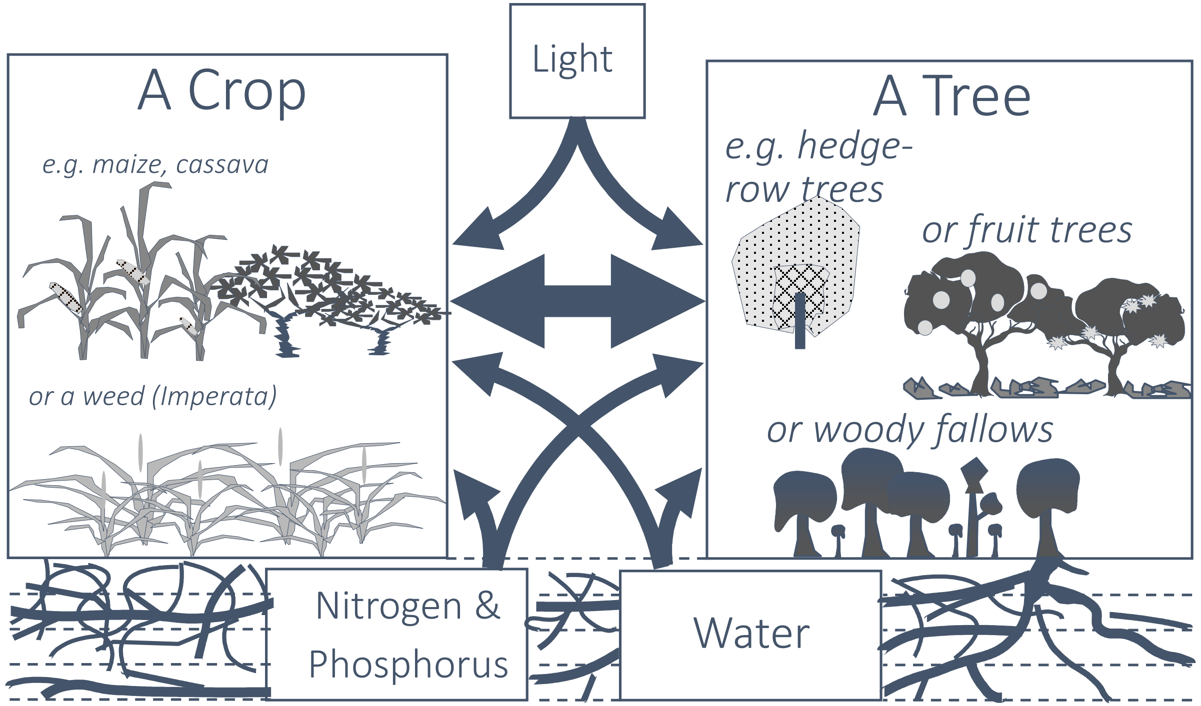
Biophysical tree crop productivity modelling - **WaNuLCAS**

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) → Estimating Missing crops → Variables and Management Systems

For each crop, variable, and management system:

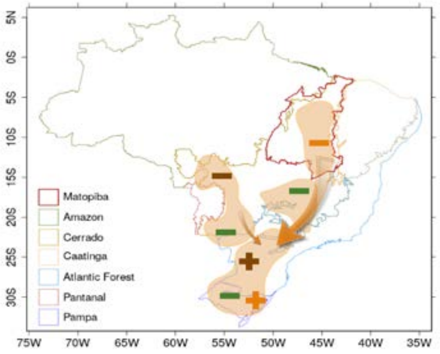
2 RCPs: RCP2p6 and RCP8p5
2 GGCMs: EPIC and LPJmL (ISIMIP)
5 GCMs: HadGEM2-ES, IPSL-CM5A-LR, GFDL-ESM2M, NorEMS1-M, MIROC-ESM-CHEM (ISIMIP)

20 scenarios

Displacement of the main producing regions

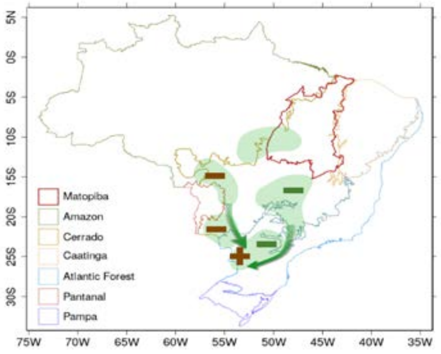
Main producing areas (shades) and changes in soybean, corn, and grassland projected by GGCMs (EPIC and LPJmL) considering RCP8.5 emission scenario

Soybean



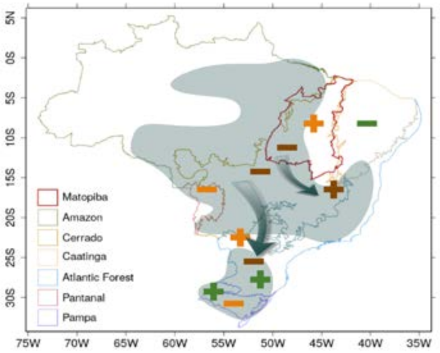
(a) Soybean

Corn



(b) Corn

Grassland



Multicriteria trade-off analysis

Economic land use decisions model (GLOBIOM)

- Global Biosphere Management Model
  - Developed by IIASAs 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

MAXIMIZE

- Producers' profits
- Consumers' utility

UNDER CONSTRAINTS

- Market
- Natural resources

MODEL OUTPUTS

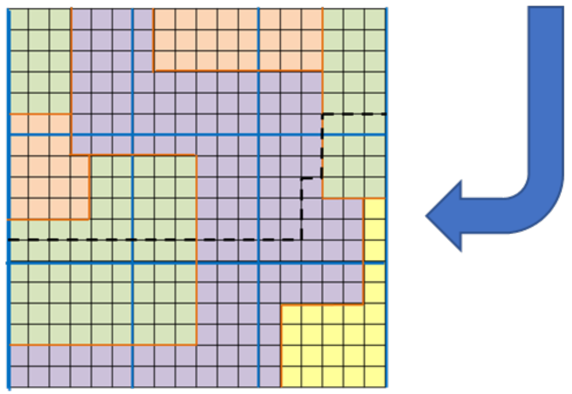
Regional:
- Prices (US$)
- Demand quantities (Tons)
- Production quantities (Tons)
- Trade quantities (Tons)

Spatial:
- Land use area (Hectares)
- Land use change area (Hectares)
- Emissions (CO_2 eq)

Land cover data

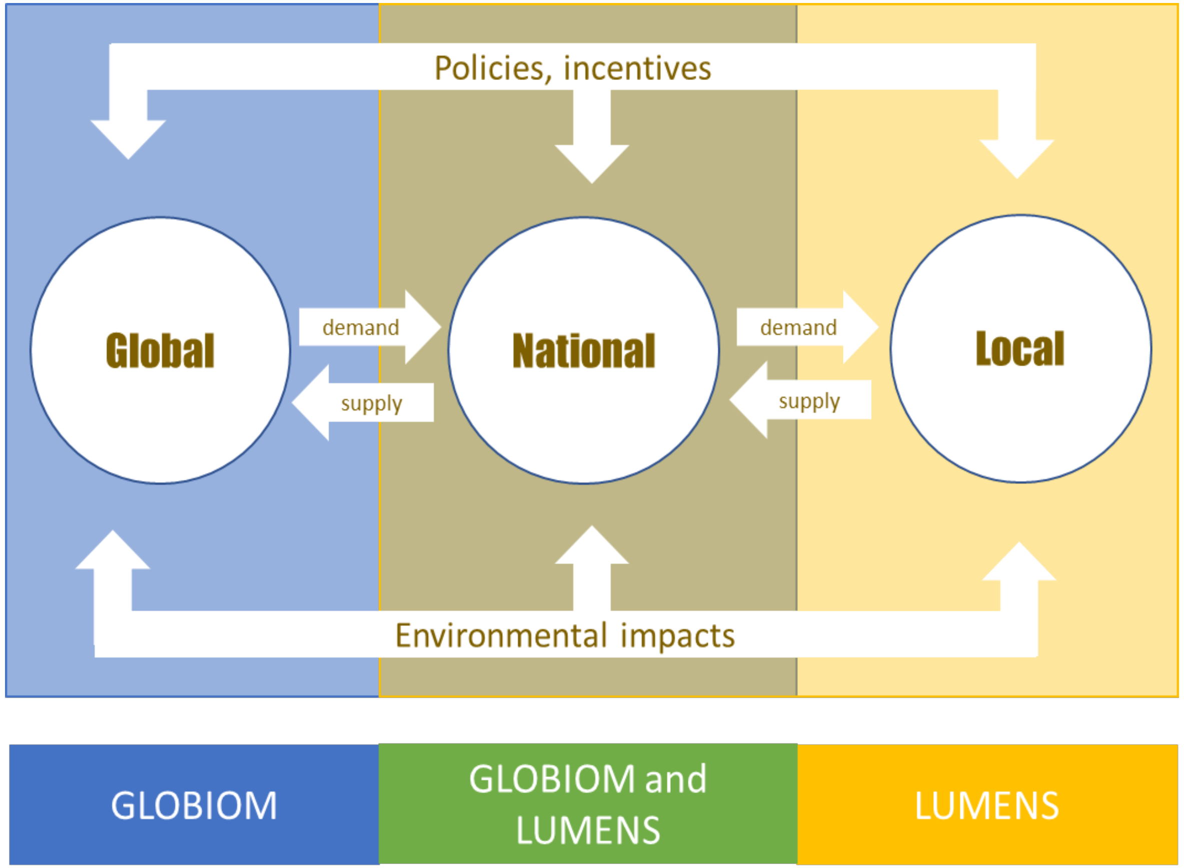
Agricultural statistics

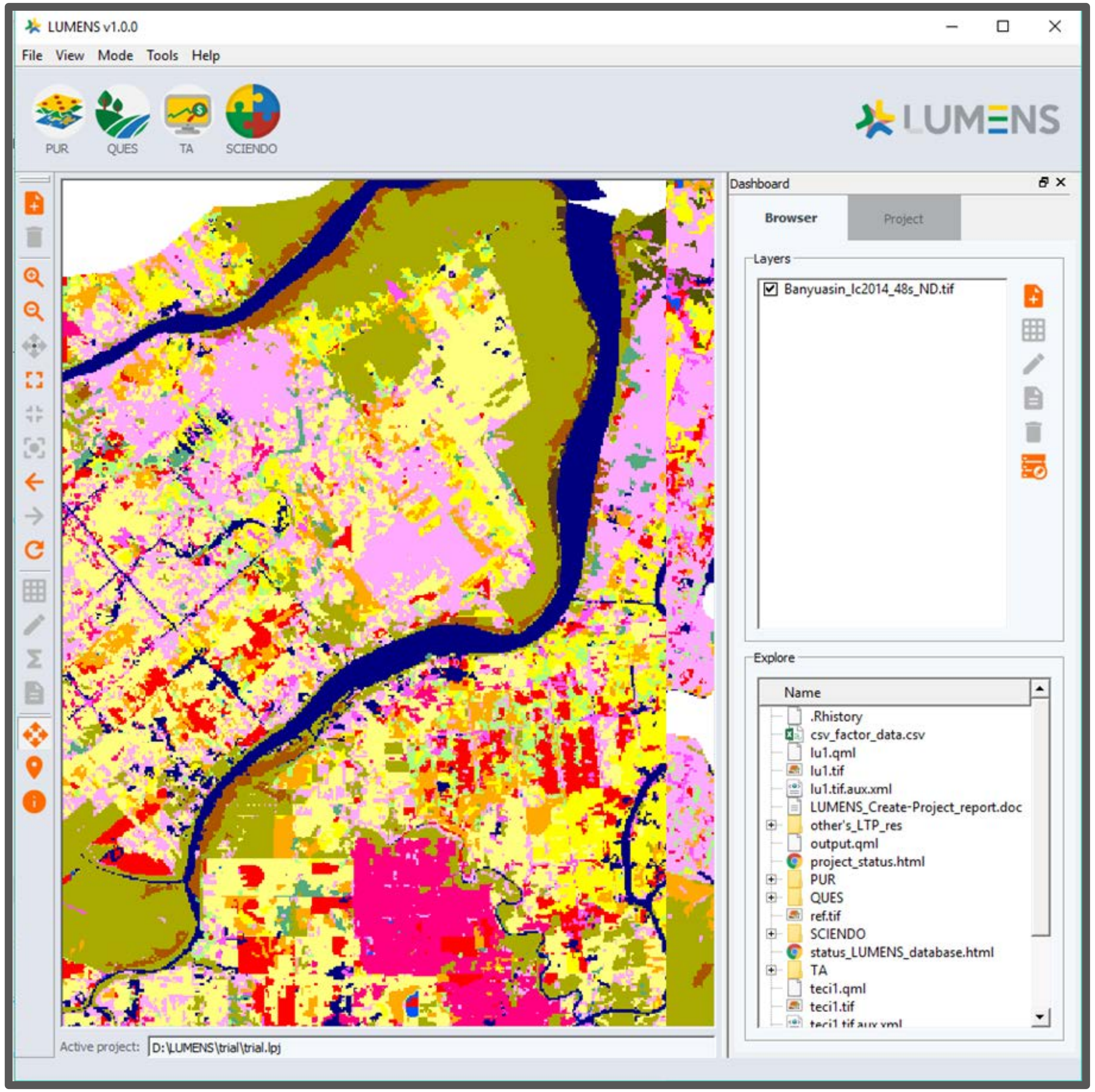
Biophysical data (EPIC, G4M, WaNulLCAS)



Model integration for Indonesia

Land use planning tool for sustainable landscapes (LUMENS)

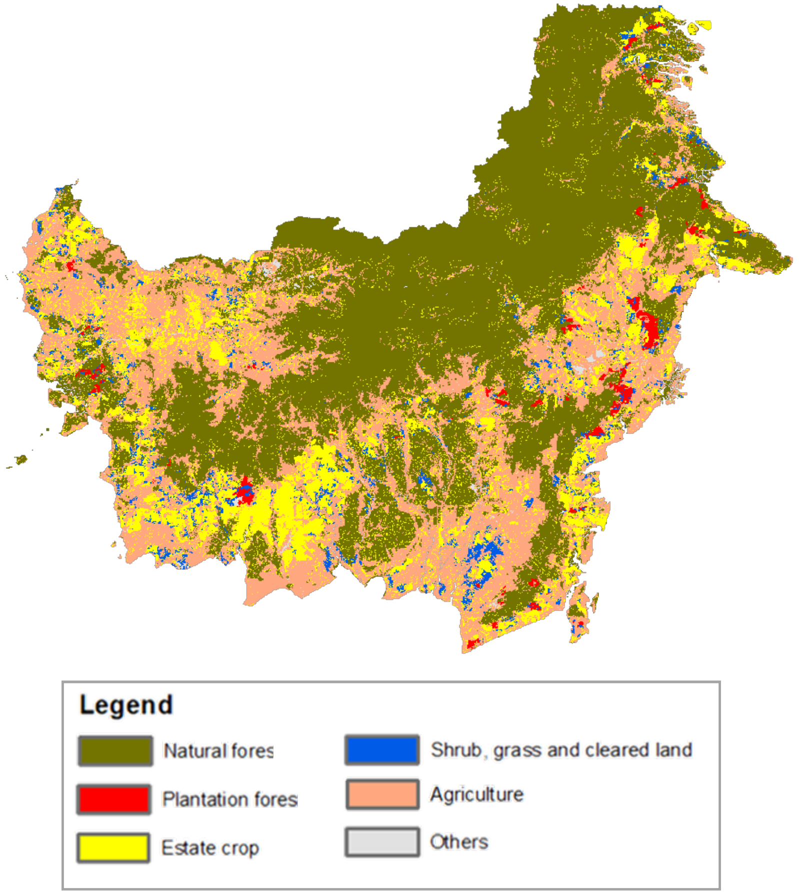




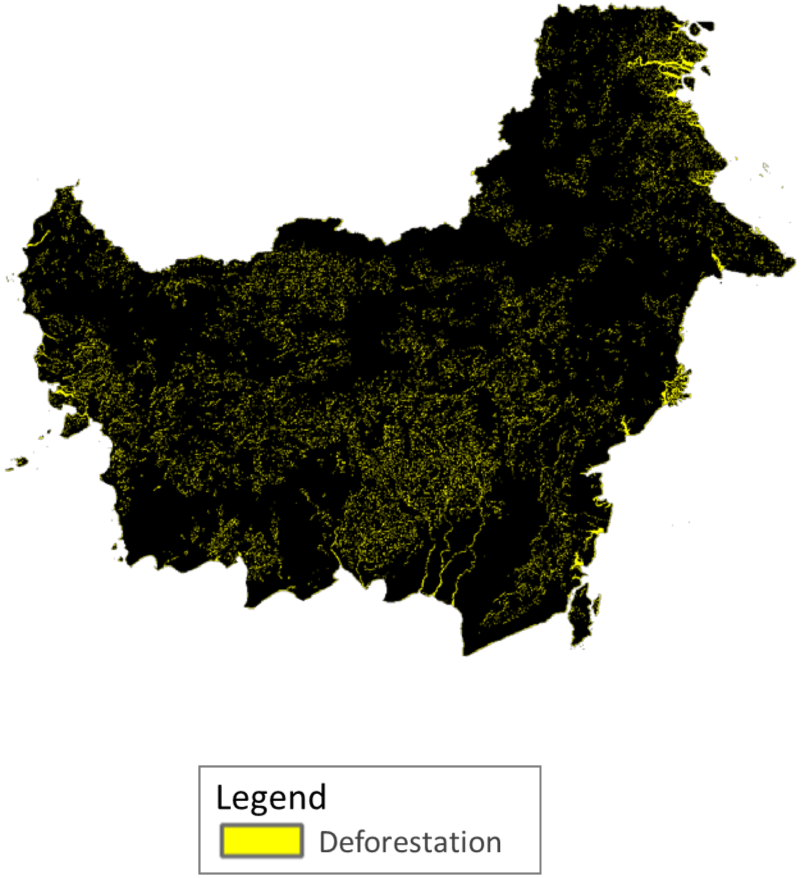
Model integration for Indonesia

Allowing high resolution results for further analysis

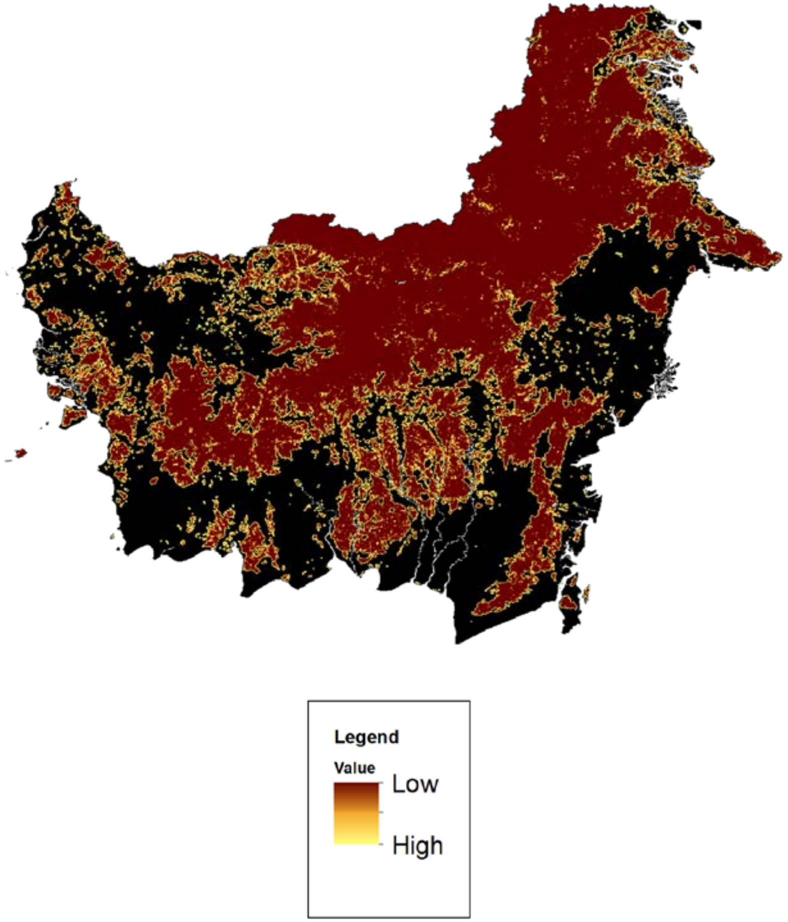
Land Cover



Deforestation



Fragmentation

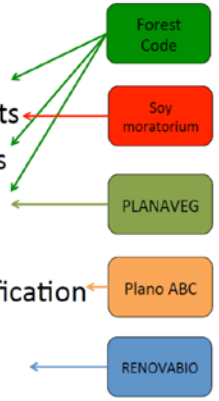


Policy scenarios assessment

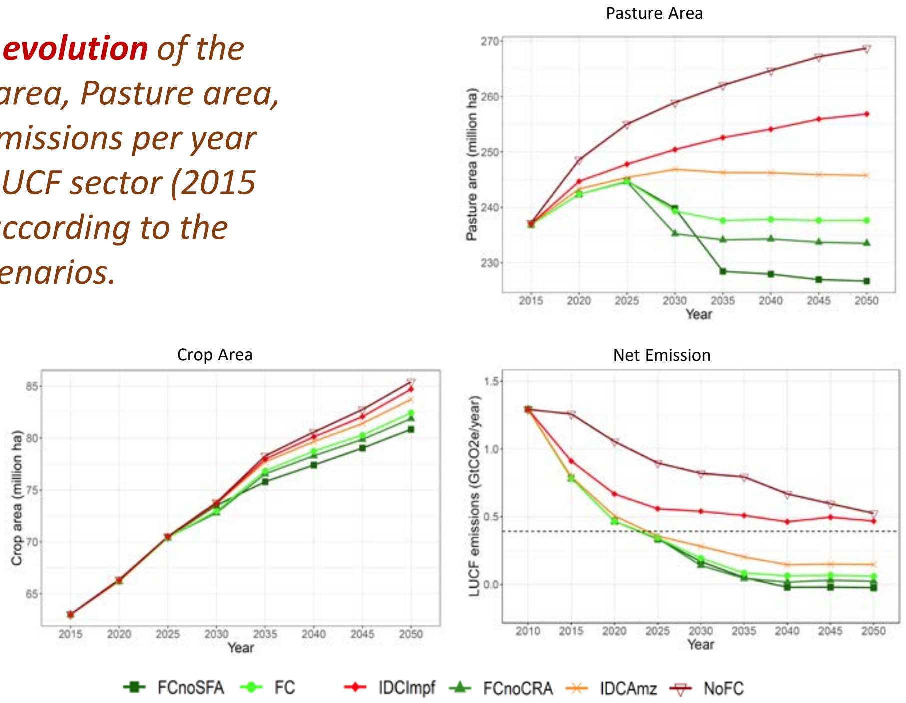
Forest code enforcement – Results example for Brazil

***Scenarios** definition*

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

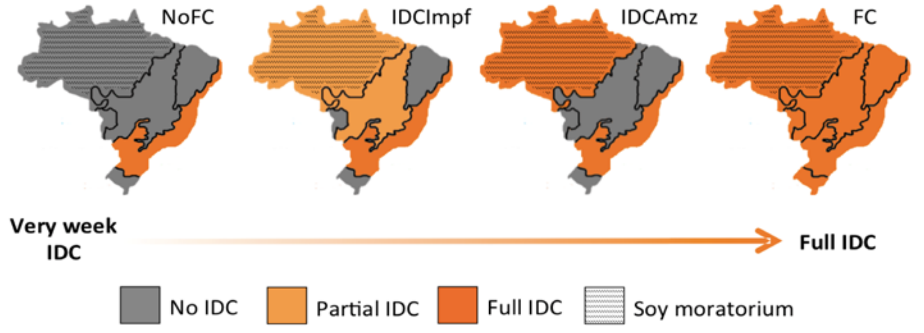


***Projected evolution** of the Cropland area, Pasture area, and Net Emissions per year from the LUCF sector (2015 to 2050) according to the various scenarios.*

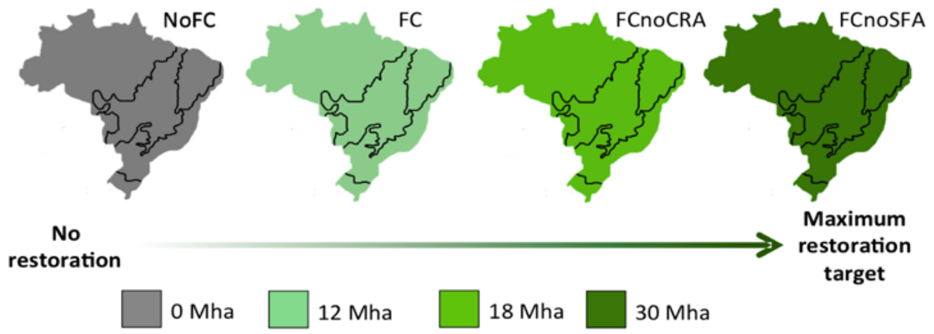


*Different level of **compliance with the Forest Code**.*

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



(a) Governance gradient

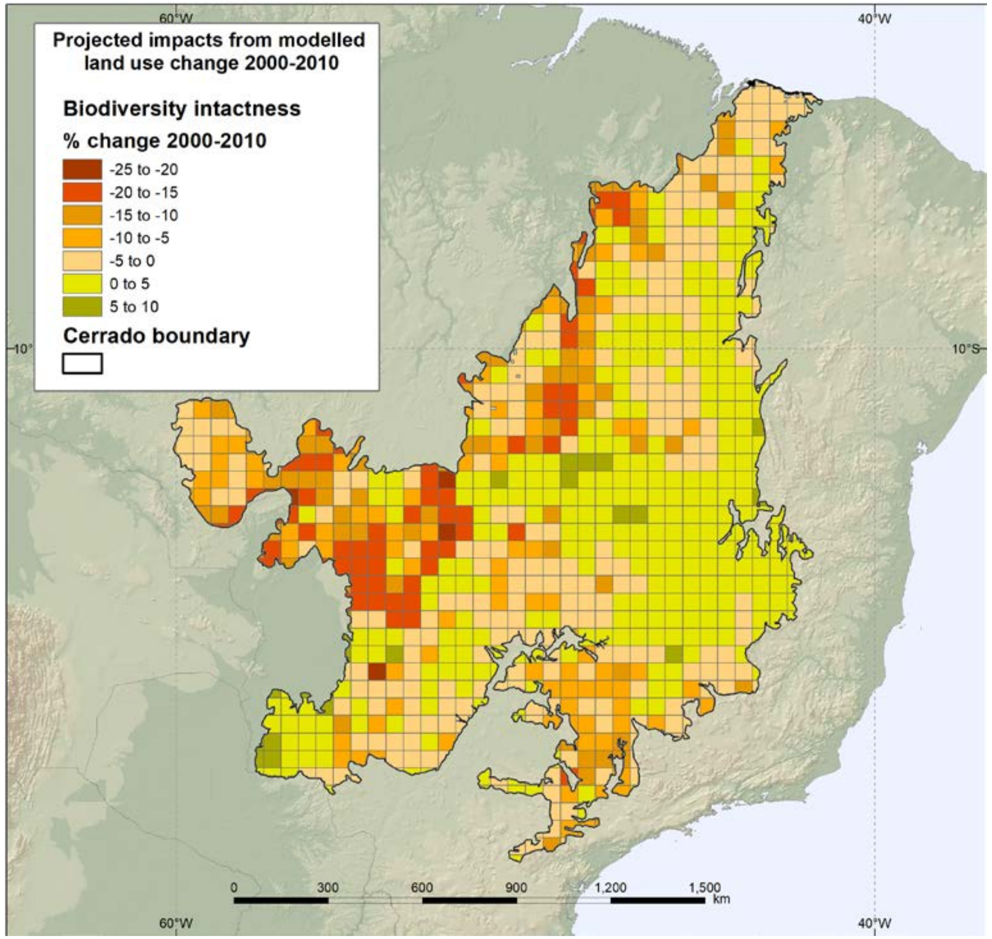


(b) Restoration targets

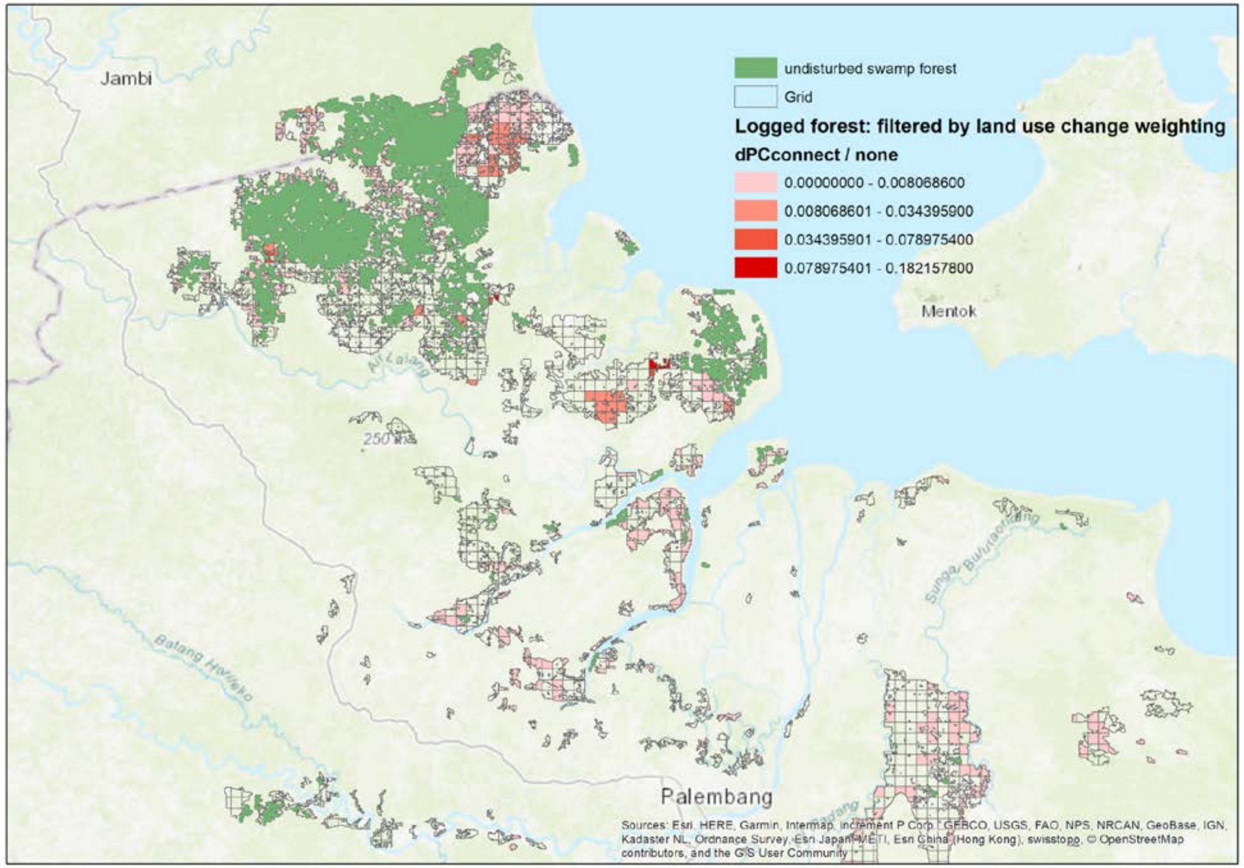
Restoration and Biodiversity

Assessment of restoration impacts on biodiversity

Biodiversity Intactness Analysis for Cerrado



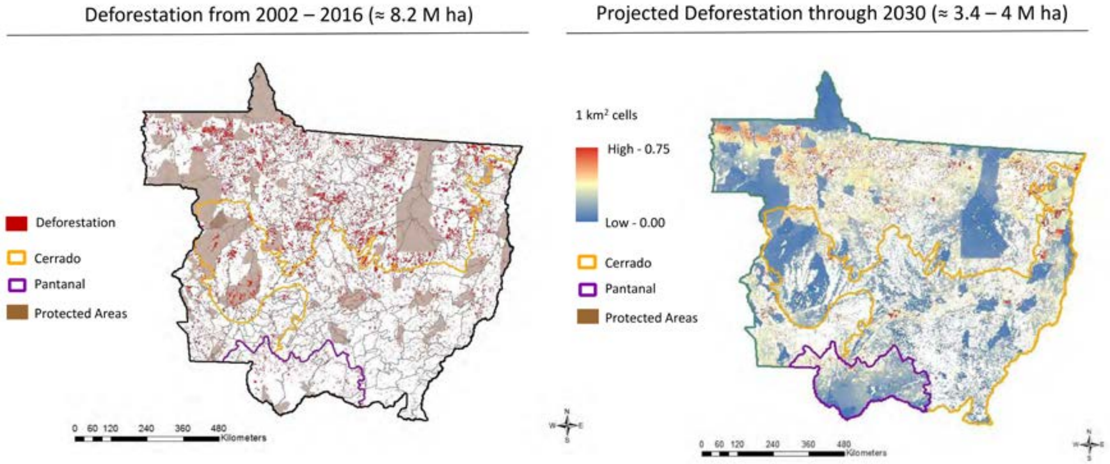
Connectivity modelling for South Sumatra



Scalable financing mechanisms for restoration

Opportunity cost assessment

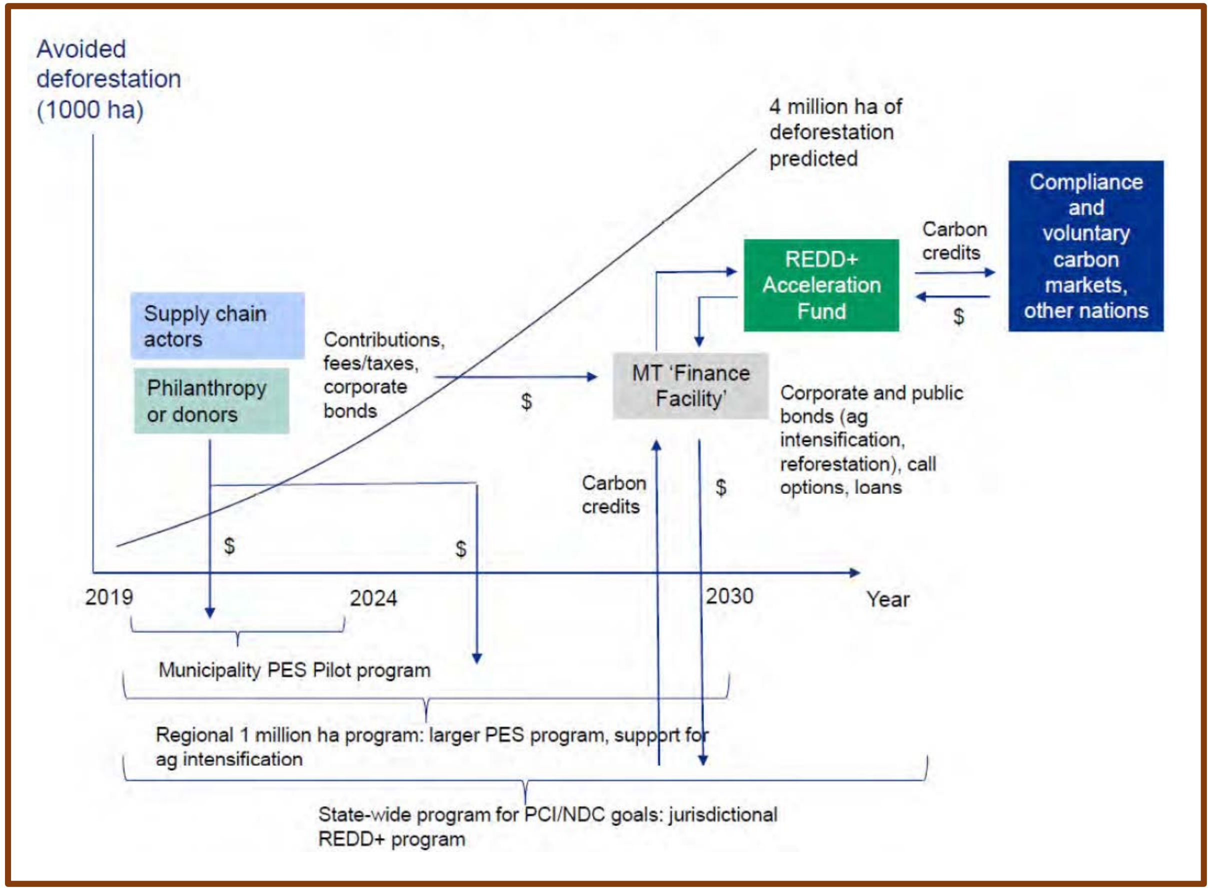
(projected deforestation in Mato Grosso)



Restoration cost analysis

	Restoration method										
	Total Planting Seedlings		*Assisted Natural Regeneration*		*Natural Regeneration*	*Total Planting Seeds*		*Dens and Enrich with Seedlings*		*Dens and Enrich with Seeds*	
Favorable Environmental Condition	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No
Total cost ($ per hectare)	2,116	4,981	468	679	51	643	2,596	909	1,975	319	1,066

Financial strategies for restoration



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