MODELLING LAND USE CHANGES IN BRAZIL

2000–2050

A Report by the REDD-PAC project

Brazil wants to reduce emissions from deforestation and land use as a contribution to climate change mitigation and to conserve the country's rich biodiversity. The country has pledged to cut its greenhouse gas emissions to 37 % below 2005 levels by 2025, and intends to reach a 43 % cut by 2030. It is the first time a major developing country has committed to an absolute decrease in emissions.

Public policies for a sustainable future need sound scientific guidance. A consortium of leading research institutes (IIASA, INPE, IPEA, UNEP-WCMC) joined forces in the REDD+ Policy Assessment Center (REDD-PAC), to develop and apply land use models to support policies that balance production and protection. The project is supported by Germany's International Climate Initiative (IKI) with added contribution from the São Paulo Research Foundation (FAPESP).

The resulting evidence-based models assess land use change in Brazil and its impacts on biodiversity in Brazil. Our projections show that Brazil can balance its goals of protecting the environment and becoming a major global producer of food and biofuels. Our tools have helped Brazil set up its intended nationally determined contribution (INDC), based on a REDD+ vision that considers both environmental restrictions and economic gains.

FOTOS: EDUARDO CESAR

THE GLOBIOM LAND USE MODEL

The REDD-PAC project team adapted the Global Biosphere Management Model (GLOBIOM; www.globiom.org) to represent land use policies in Brazil. GLOBIOM is a global economic model used to assess the competition for land use between agriculture, forestry, and bioenergy.

GLOBIOM-Brazil projects future land use and agricultural production across the whole country, accounting for both internal policies and external trade. The model results help decision makers assess possible impacts of public policy on emissions, agricultural production, and biodiversity.
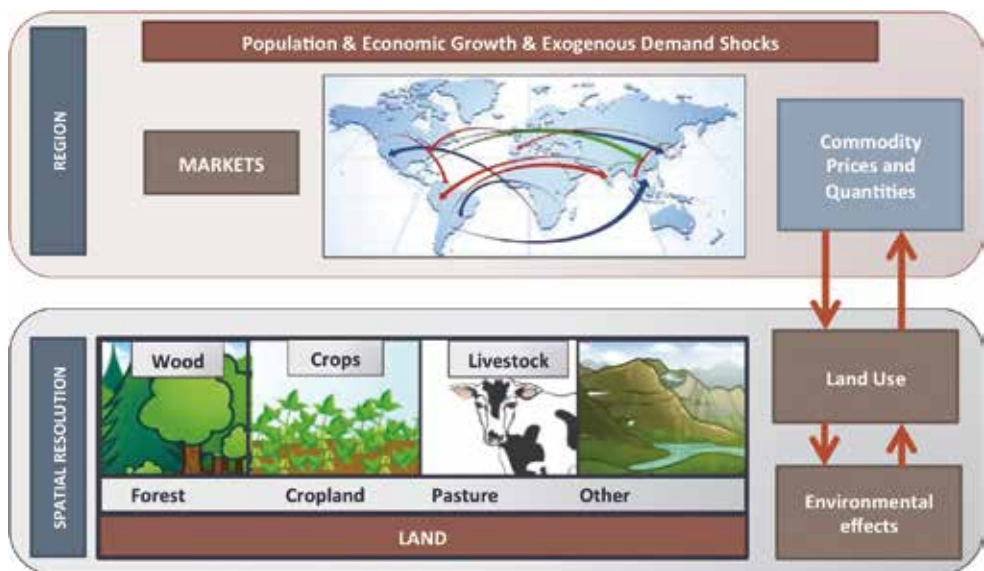
The GLOBIOM model

ADAPTING GLOBIOM FOR BRAZIL

To improve the results, the REDD-PAC team built a new land use map for Brazil for year 2000. The team chose 2000 as the starting year for modeling, so that the 2010 results could be used for validation. The new map combines information from the vegetation map produced by the Brazilian Institute of Geography and Statistics (IBGE), the SOS Mata Atlântica dataset, the MODIS land cover map, and IBGE statistics for crop, livestock and planted forests. The model divides Brazil into 11,003 simulation units whose sizes vary between 100,000 hectares (ha) and 300,000 ha. Our data set has detailed information on crop and livestock production, and captures the role of protected areas in limiting agricultural expansion.
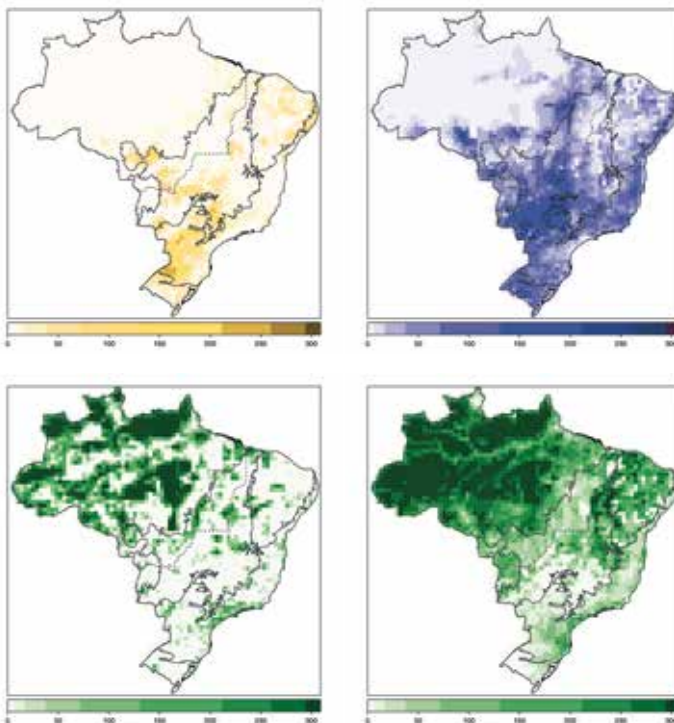

Maps of crops (top-left), pasture (top-right), protected areas (bottom left) and forests (bottom right) for Brazil in 2000. Values are in thousands of ha per 50 x 50 km^2 cell

VALIDATING THE GLOBIOM-BRAZIL MODEL

The GLOBIOM-Brazil model is calibrated for the year 2000 and projects land use up to 2050. For validation, we compared the projections for 2010 with official statistics on agricultural land and production. Differences between IBGE survey data and model projections in 2010 were less than 10 %. We compared PRODES/INPE deforestation areas in the period 2000-2010 with GLOBIOM-Brazil results in 2010. PRODES deforestation in the period 2000-2010 amounts to 16.5 million hectares (Mha), while the model projects 16.9 Mha of deforestation in the Amazonia biome.
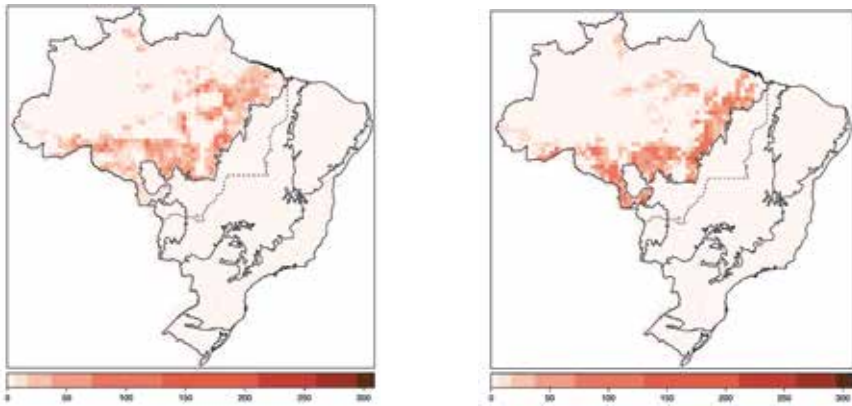
PRODES deforestation map for 2010 (left) and GLOBIOM deforestation projection for 2010 in the Legal Amazon (right). Values are in thousands of ha deforested per 50 x 50 km² cell
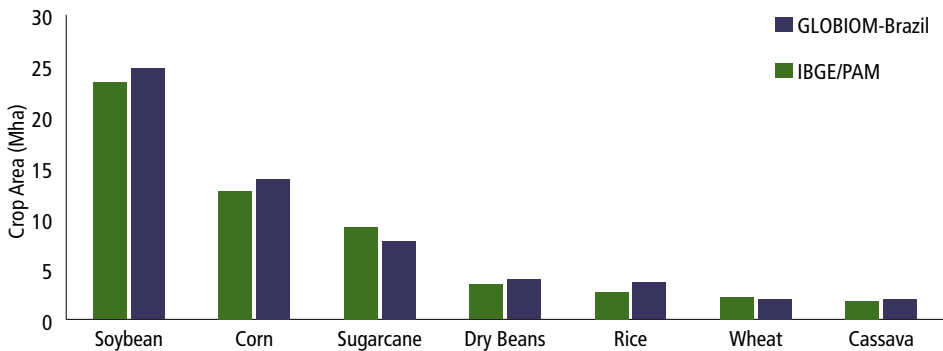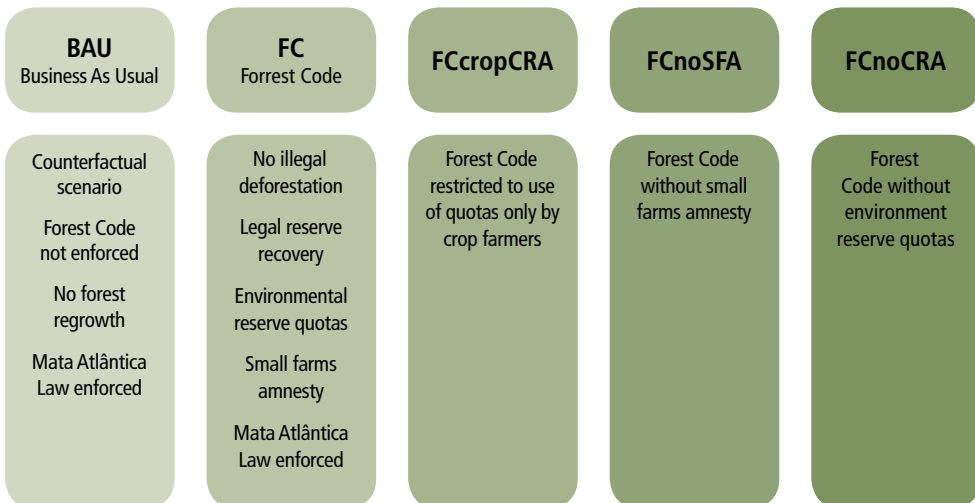

Comparison between estimates of GLOBIOM-Brazil for six crops in 2010 (soybean, corn, sugarcane, dry beans, rice, wheat, cassava) compared to the IBGE PAM (Municipal Agricultural Survey). Values are in millions of ha

MODELLING BRAZIL'S NEW FOREST CODE

     To enable GLOBIOM-Brazil to support the build-up of national commitments on emission reductions, we needed to model how Brazil's new Forest Code will shape future land use. We modelled different approaches to put in practice the main provisions of the Forest Code, such as the small farms amnesty, which would exempt small farms up to 400 ha from forest restoration, and the environmental reserve quotas (CRA), which would allow for trading forest restoration debts and surpluses. Both provisions are not yet fully operational on the ground.

     Our scenarios include: (a) Business as usual (BAU), a counterfactual case that captures what could have happened without the new Forest Code; (b) FC: the full implementation of the Forest Code; (c) FCcropCRA: only crop farmers (as distinct from livestock farmers) are willing to buy environmental reserve quotas; (d) FCnoSFA: the Forest Code without the small farms amnesty; and (e) FCnoCRA: a counterfactual case that captures what could happen without the environmental quotas;

| **BAU** Business As Usual	**FC** Forrest Code	**FCcropCRA**	**FCnoSFA**	**FCnoCRA**
Counterfactual scenario Forest Code not enforced No forest regrowth Mata Atlântica Law enforced	No illegal deforestation Legal reserve recovery Environmental reserve quotas Small farms amnesty Mata Atlântica Law enforced	Forest Code restricted to use of quotas only by crop farmers	Forest Code without small farms amnesty	Forest Code without environment reserve quotas

Scenarios for GLOBIOM-Brazil

DEFORESTATION AND FOREST REGROWTH: 2020–2050

In the Forest Code scenario, we project total forest cover in Brazil to be 430 Mha in 2030. Forest area in Amazonia will stabilize at 328 Mha from 2030 onwards, considering both regrowth and legal cuts of primary forest. In the Cerrado, total forest will level off at 45 Mha. Forest regrowth in Brazil will reach 10 Mha by 2050, an area equaling the size of Iceland.

This work shows that environmental reserve quotas have a major effect on the balance between forest regrowth and cuts in mature forest. In the scenario where only crop farmers would buy quotas to offset their environmental debt, forest regrowth in 2030 increases to 20 Mha, because livestock farmers will have to restore more forest. However, under this scenario, more mature forest (a further 7 Mha) would be lost from Amazonia than in other scenarios – it is more attractive for farmers to clear natural forest and restore secondary forest.
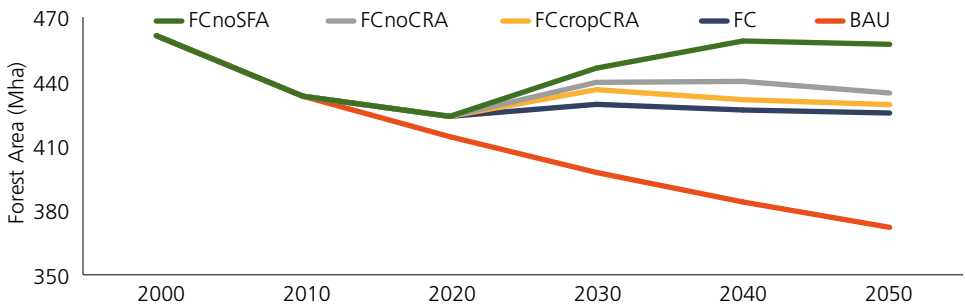
Total forest projections for Brazil: 2020–2050
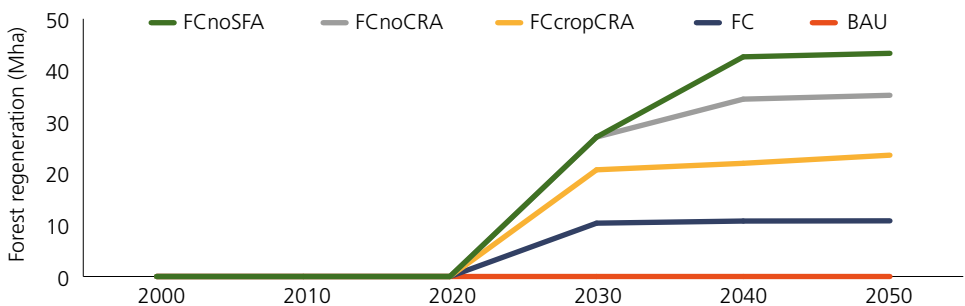
Forest regrowth projections for the different GLOBIOM-Brazil scenarios. Values are in millions of ha

CROP PRODUCTION AND PASTURE: 2020-2050

In all scenarios, cropland area in Brazil grows in the coming decades. Crop production is poised to increase from 56 Mha in 2010 to 92 Mha in 2030 and to reach 114 Mha in 2050. Land area for crop production more than doubles compared to 2010. These results suggest that there are no rigid limits to cropland expansion in Brazil. Current environmental regulations allow sufficient room for expansion to produce more food and biofuels.

In contrast, the study shows that pasture land in Brazil will see a significant decrease in the next decades, as cattle ranchers improve their practices to increase livestock productivity. We project a reduction of pasture area by 10 Mha in 2030 compared to 2010, and further reduction by 20 Mha by 2050. In 2030, there will be 230 M heads of cattle in Brazil, occupying 30 % less area per head than in 2000.
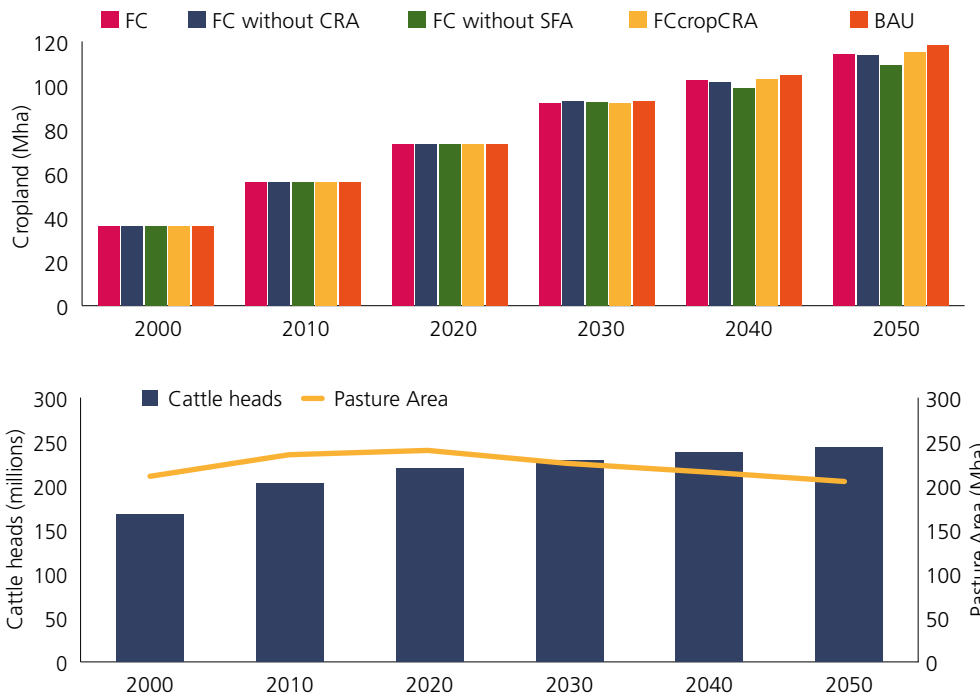

Projections for crop areas outside Caatinga (top) and for cattle heads and pasture area in the Forest Code scenario (bottom). Since crop yields in Caatinga are highly variable, production in this biome is not included in the results.

EMISSIONS FROM LAND USE, FORESTS, AND AGRICULTURE: 2020–2050

The Forest Code can bring about a major reduction in greenhouse gas emissions. Considering forest regrowth and legal deforestation, emissions from deforestation reach 110 MtCO in 2030. This is a 92 % reduction from the emissions in 2000. Brazil will bring forest-related emissions to zero after 2030, due to the combination of forest regrowth and reduced deforestation. Reduction of pasture area will limit the loss of natural land, curbing emissions.

Emissions from agriculture could reach 480 Mt CO_2 eq by 2030, mostly from enteric fermentation and manure from cattle that produce CH_4. Since CH_4 has a shorter lifetime than CO_2, the effective global temperature change potential from agriculture is limited to 160 Mt CO_2 eq.
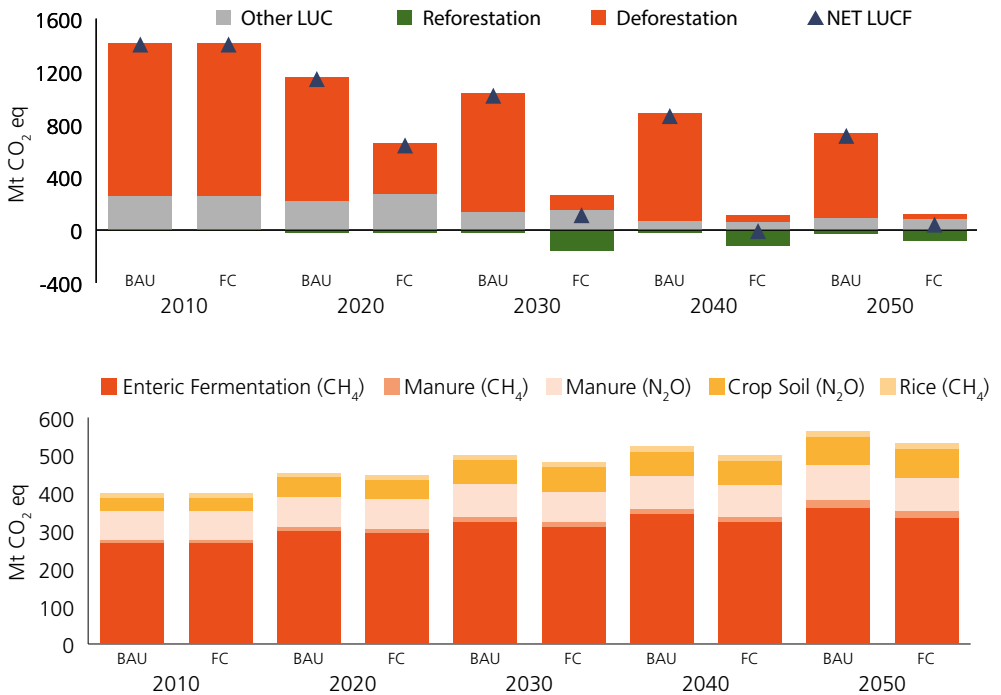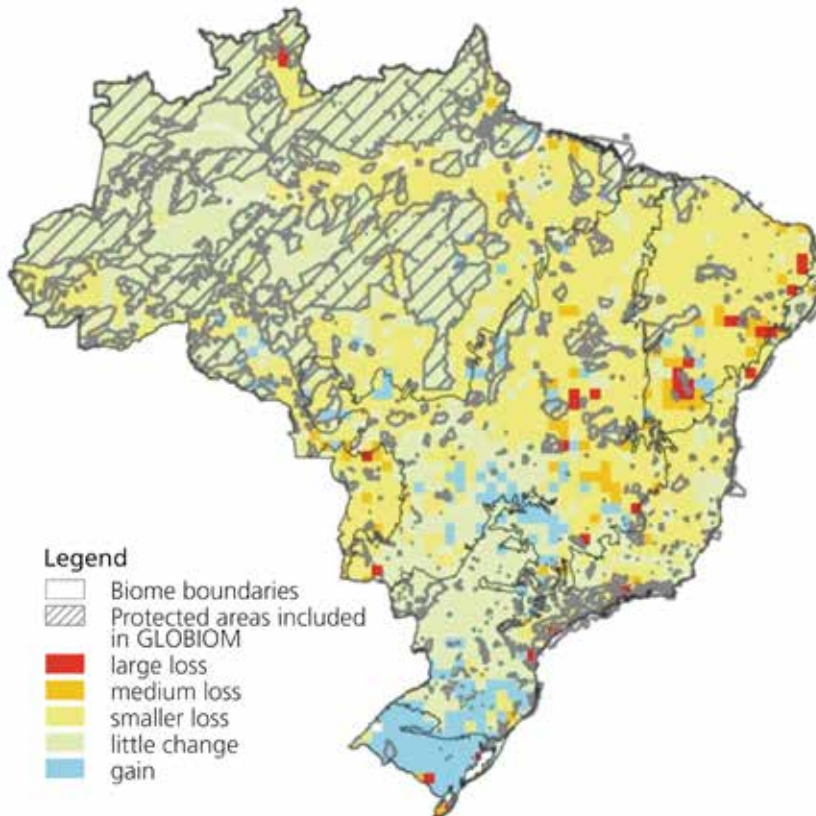

Emissions from land use change and forestry (top) and from crops and cattle (bottom). These are median values from an ensemble that includes different biomass maps for Brazil.

IMPACTS ON BIODIVERSITY

Conversion of natural ecosystems for human use leads to loss and fragmentation of species habitats. Many of the areas identified as national priorities for biodiversity are under protection, but there are still many important species in unprotected areas. Out of 311 threatened species assessed, 20 species lose over 25 % of their potential habitat in the BAU scenario. Enforcing the Forest Code reduces this number to 6 species.

The main areas under threat are the dry forests of the Caatinga, projected to lose 11 Mha from 2010 to 2050, and some areas of the Cerrado. By 2050, over 51 % of the mature Caatinga forests identified as important for biodiversity but not currently protected could be lost. When the loss of both mature forest and natural lands are considered, the Cerrado could lose over 20 % of its unprotected areas of biodiversity importance.

Legend
- Biome boundaries
- Protected areas included in GLOBIOM
- large loss
- medium loss
- smaller loss
- little change
- gain

Combined species habitat change in the Forest Code scenario

CONCLUSION

The overall message of this report is the crucial importance for Brazil of implementing the Forest Code. To do so, the country faces major challenges:

- Building a high quality rural environmental cadaster is key to monitoring forest restoration.
- Brazil needs to set up a monitoring system for the whole country as powerful as the one in place for Amazônia.
- Legal reserve amnesty should be limited to small farmers, avoiding illicit break-up of large farms.
- The market for environmental quotas needs to be regulated to avoid leakages and enhance forest conservation.
- Strong action to avoid illegal deforestation in Amazonia must continue to be enforced.
- The right incentives for efficient production must be in place, including the Low Carbon Agriculture plan.

If Brazil overcomes these challenges, there will be multiple benefits for its citizens, including biodiversity protection, emissions mitigation, and positive institution building.

REDD pac   www.redd-pac.org

CREDITS

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