



Valuing the Brazilian Amazon Rainforest

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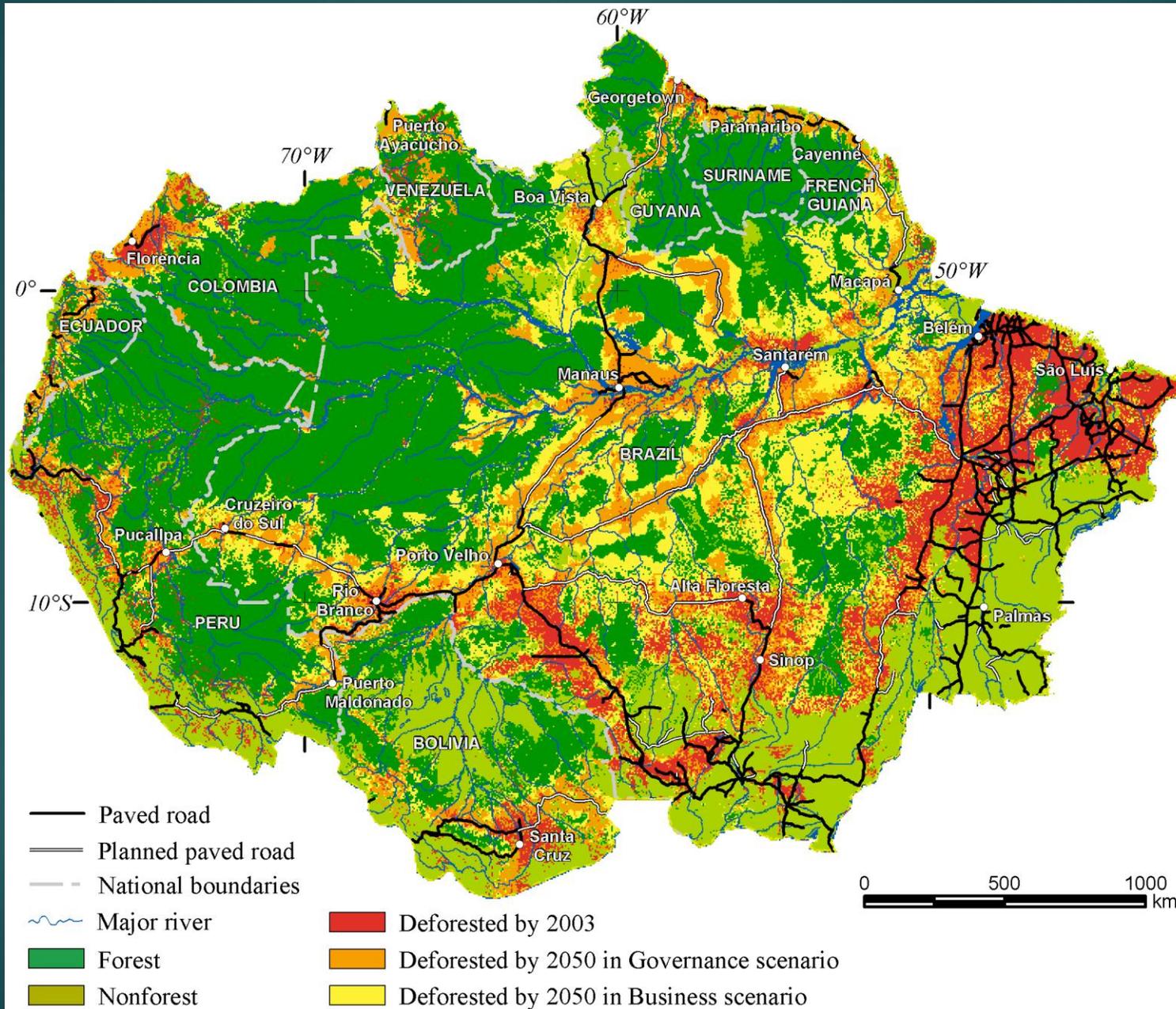
This project:

- ▶ Carried out in the Development Research Group, Environment and Energy Team (DECÉE), at the World Bank.
- ▶ Funded by the Norwegian government through its Ministry of Climate and Environment; and strongly supported by the Brazilian government.
- ▶ Initiated and headed by me, and involves two major (mainly natural science) Brazilian research groups, and a number of additional researchers (economists).

Elements of the presentation

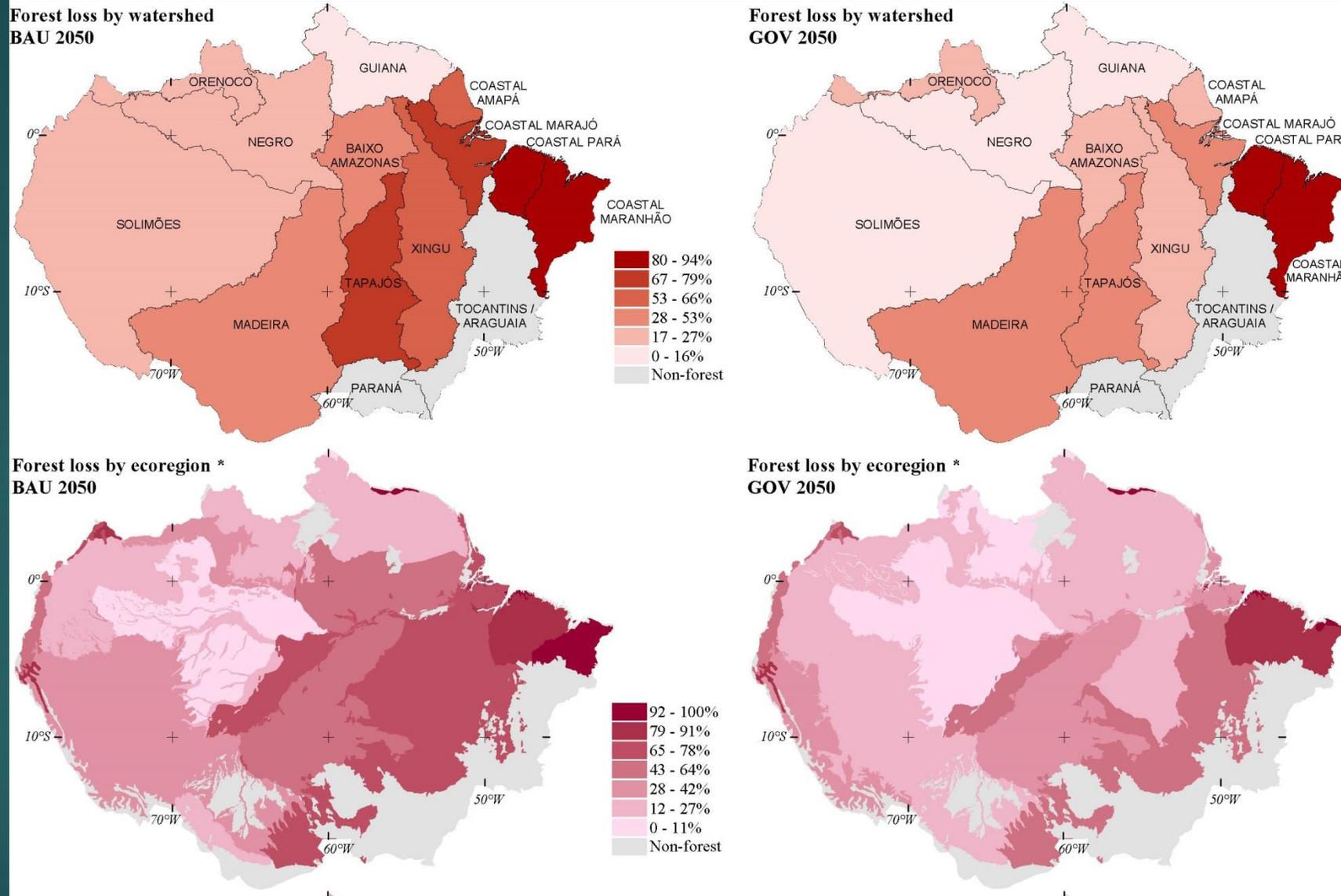
1. Predictions for the Amazon rainforest up to 2050
2. What is the «value» of the Amazon and its parts?
3. What does the valuation platform do?
4. The elements of forest value entering the platform
5. Aggregate forest value
6. Future work
7. What have we learned, and gained, from this work?

Possible forest losses in the Amazon to 2050



Analyzing the consequences

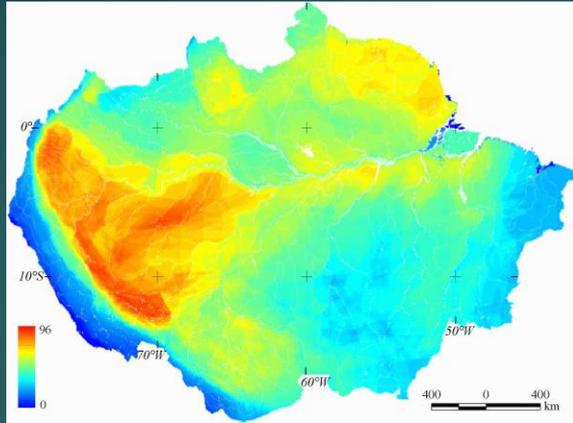
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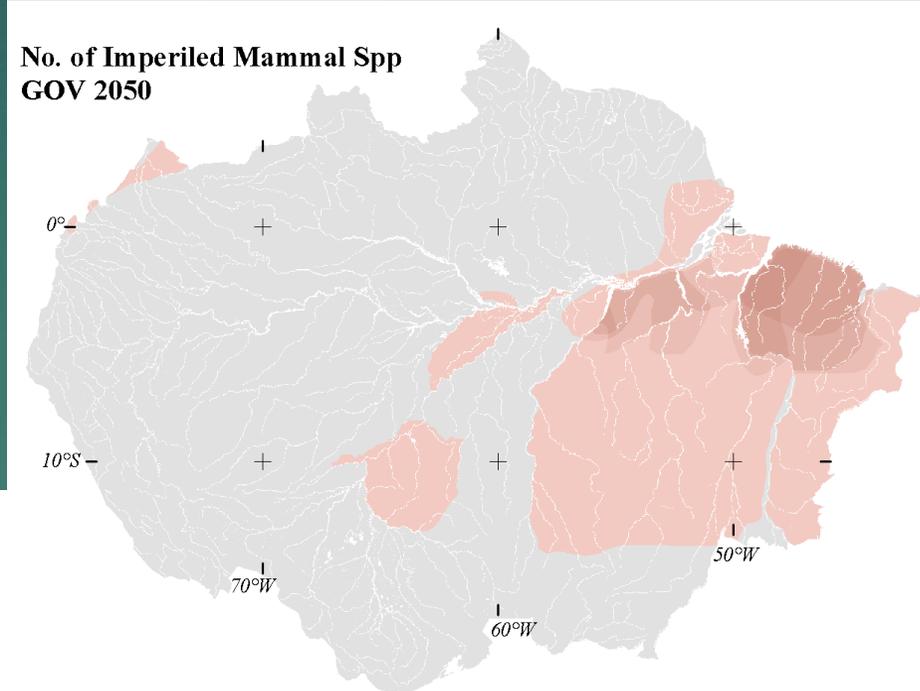
2/3 of vegetation cover of 15 ecoregions among 32 would be eliminated

Predicted biodiversity loss by 2050

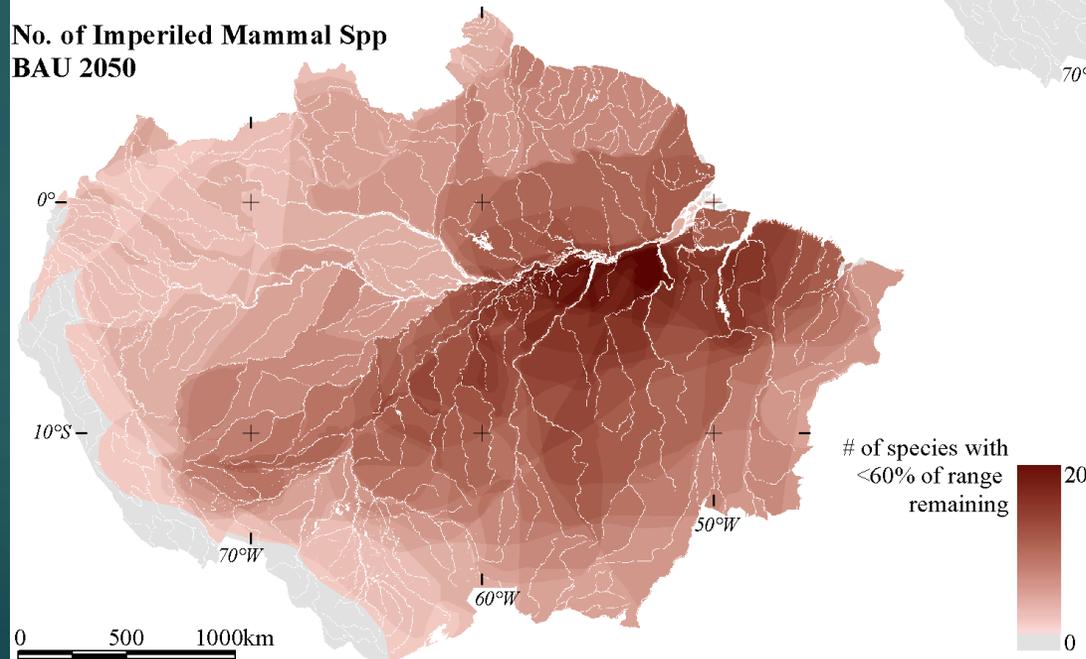
Mammal diversity



BAU



No. of Imperiled Mammal Spp
GOV 2050



No. of Imperiled Mammal Spp
BAU 2050

of species with
<60% of range
remaining

Governance

1/4 of 382 mammals
lose 40% of their Amazon
geographical range

IPAM/YALE

Lessons from these figures:

- ▶ There is a risk of losing far more of the Amazon rainforest by 2050.
- ▶ This project derives geographically differentiated economic values of losing the Amazon rainforest in Brazil.
- ▶ These values are assembled in a “valuation platform”, available on the web (see slides 13 and 16).

What is the value of the Amazon rainforest?

Three value elements:

- ▶ 1) Local and regional values to the population in South America
- ▶ 2) Carbon values: The global benefit from carbon sequestration by keeping the forest
- ▶ 3) “Other global values”: Willingness to pay to preserve the Amazon rainforest in other countries.

This project considers elements 1 and 2 only. 3 is subject to separate research in the World Bank.

Spatially differentiated economic valuation of the Amazon is important in several contexts:

- ▶ Where to most discourage conversion of rainforest to agriculture, by comparing preservation values to local opportunity values
- ▶ Where to most work to prevent illegal logging
- ▶ How and where to prevent forest fires
- ▶ Where to establish new national parks.

We create a “platform” for geographically differentiated ecosystem values of the Brazilian Amazon

- ▶ Focus on value of forest losses in Brazil
- ▶ Focus on local and regional values, and carbon values
- ▶ Train government officials (mainly in Brazil) in using our tools.

The project's approach to economic valuation 11

- ▶ Convert all values to a common money metric.
- ▶ We assemble data from already existing economic valuation studies, from the Amazon and elsewhere.
- ▶ Rely on calculations from several biophysical/economic models.
- ▶ A (smaller, pilot) stated-preference study included.

The valuation platform

- ▶ The valuation platform is the centerpiece of the project
- ▶ Set up by the Belo Horizonte team, led by Britaldo Soares-Filho
- ▶ The platform is constructed with two layers for each included elements, with pixel size 1 km²:
 - ▶ **1)** Biophysical mapping of resource base or impact
 - ▶ **2)** Economic valuation of biophysical impacts.

The valuation platform (cont.)

- ▶ The valuation platform is available interactively at: <http://csr.ufmg.br/amazones/>
- ▶ Certain parameters (including the price of carbon) are flexible, to be set by individual users
- ▶ The platform displays all key results from the project on biophysical and economic value mapping
- ▶ The platform also adds up individual values to a total

Key elements of the valuation platform:

- ▶ 1. Hydrological impacts of forest losses on main economic activities (agriculture and hydropower)
- ▶ 2. Economic value of sustainable timber and non-timber forest products
- ▶ 3. Biodiversity values
- ▶ 4. Carbon emissions when rainforest is lost.
- ▶ 5. Forest fire activity in the Amazon

Element 1: Mapping hydrological impacts of forest losses

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- ▶ This element is carried out by a team at the Federal University of Viçosa, Brazil, led by Marcos Costa.
- ▶ This research consists in three steps:
 - ▶ Analyze impacts of Amazon rainforest losses on rainfall patterns in all of South America, using global circulation models
 - ▶ Calculate impacts of rainfall changes on agricultural outputs, and net economic returns from soy, beef and hydropower, in Brazil and Argentina
 - ▶ “Reverse calculations” to ascribe losses for soy, beef and hydropower back to each forest pixel in the Amazon, in terms of US\$/ha/year.

Element 1 (cont): Mapping hydrological impacts of forest losses

- ▶ Impact maps for rainfall, soy output, cattle ranching, and hydroelectric production (4 facilities) have been established, for various deforestation rates, and other features (planting dates).
- ▶ “Return economic value impact” maps created, with reverse calculations back to (large) pixels.
- ▶ Impact values of deforestation on soy and cattle each up to about \$10/ha/year.
- ▶ <http://www.biosfera.dea.ufv.br/en-US/deforestation-and-rainfall>

Element 2: Mapping economic values of sustainable timber extraction:

- ▶ Net economic returns from reduced impact logging (RIL) modeled and mapped by the Belo Horizonte team, based on their SimMadeira model.
- ▶ Sustainable NTFP extraction, including economic valuation of these, is mapped for two products, found throughout the Brazilian Amazon:
 - ▶ a) Brazil nut
 - ▶ b) Rubber

Element 3: Local/regional biodiversity valuation

- ▶ Two main steps:
 - ▶ 1) Geographical mapping of biological resources, by the Belo Horizonte team.
 - ▶ 2) Local/regional economic valuation of biodiversity impacts.
 - ▶ No economic values yet ascribed to biodiversity. (A pilot stated-preference survey in Brazil however indicates that these values could be small.)

Element 4: Carbon emissions from deforestation

- ▶ Avoiding carbon emissions are an important part of the value of protecting the Amazon.
- ▶ This is not an important research item of the project, as carbon impacts of Amazon deforestation are already extensively mapped.
- ▶ The spatial carbon emissions map is built into the valuation platform.
- ▶ Average carbon emissions resulting when Amazon rainforest is lost: about 130 ton C/ha (460 ton CO₂/ha).

Element 5: Forest fires and forest value

- ▶ This element is carried out by the Belo Horizonte team, based on two models developed by the team: FISC, and EcoFire.
- ▶ This is not in itself a value element. Forest fires however have (potentially large) impacts on forest value.
- ▶ Aim of this work:
 - ▶ a) Model forest fire occurrence and spread using the FISC model
 - ▶ b) Calculating economic costs due to forest fires using the EcoFire model.
 - ▶ c) Create a map of externality impacts whereby forest losses lead to further future losses due to localized forest fragmentation and dryness.

Forest fires and forest value (cont.)

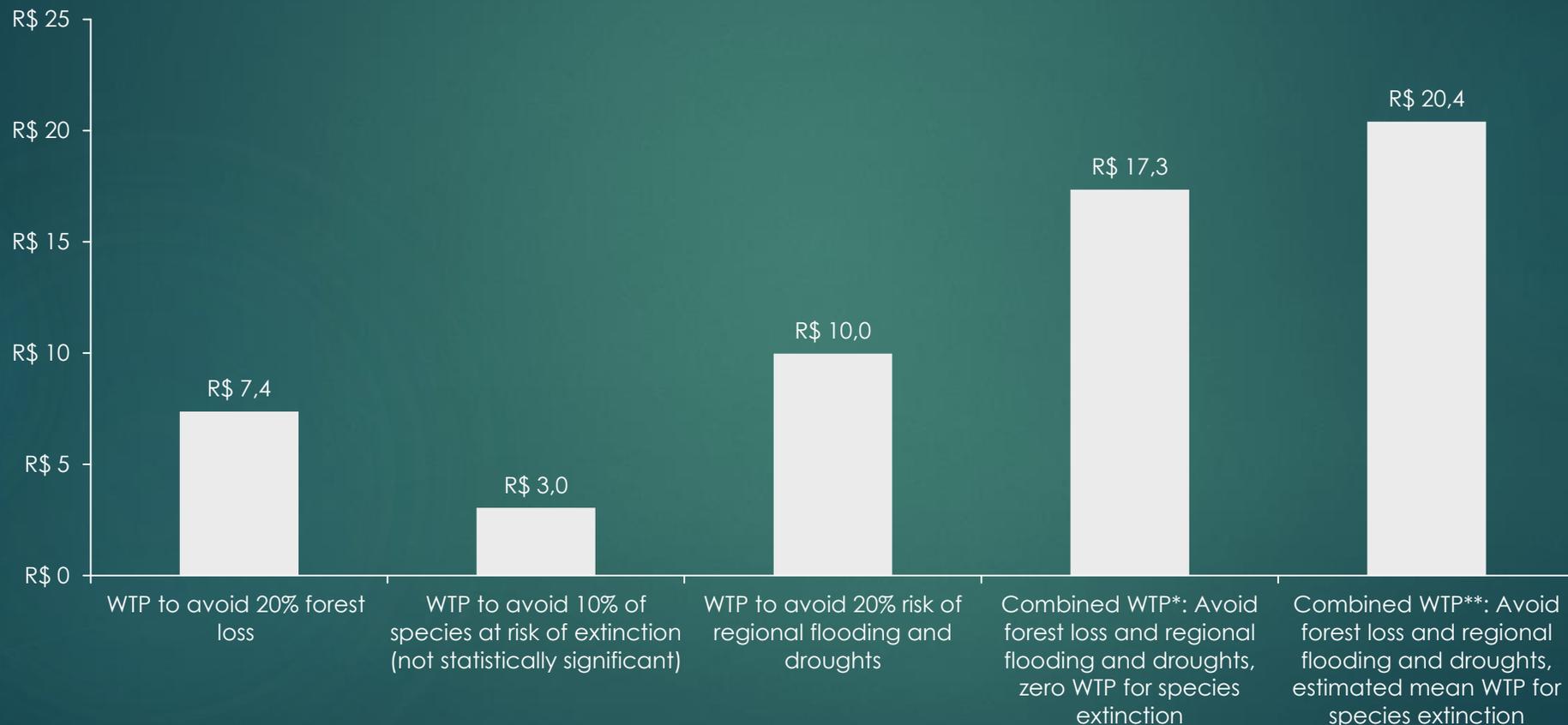
- ▶ Several maps in the valuation platform show impacts of forest fires:
- ▶ Simulated fire recurrence, 2002-2041
- ▶ Simulated fire scars, 2002-2041
- ▶ Observed fire scars, 2001-2010
- ▶ Effective economic losses due to fire, 2002-2041 (losses in US\$/ha/year)
- ▶ Potential economic losses due to fire (assuming that all potential RIL timber extraction is made effective), 2002-2041

Average and marginal forest values

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- ▶ Average and marginal forest values often not the same.
- ▶ Two externality factors, both related to forest fires, may increase marginal forest values:
 - ▶ Losing additional rainforest could increase local fire risk
 - ▶ Losing more rainforest makes the remaining forest drier, increasing fire risks, and reducing the value of standing forest.
- ▶ These factors *increase the value of saving a (small) piece of forest*. This is despite the fact that forest fires reduce average forest values.
- ▶ We aim to parameterize these externalities via our modeling of forest fire risk. Not yet part of the platform.

Stated-preference work to date: 3 pilot surveys focusing on forest loss, biodiversity loss, and local climate effects (three issues found as important in initial focus group work). Results below are stated in WTP/hh/month, found from the pilots. (Social groups A-C)



The central valuation platform's aggregate value feature:

- ▶ The «query» facility on the central valuation platform adds up the following value impacts:
- ▶ RIL, rubber, Brazil nut, soy production, beef production, hydropower outputs, and carbon
- ▶ To calculate the protection value per hectare per year, for the entire Brazilian Amazon.
- ▶ The user can insert desirable parameter values for the prices of carbon, soy, beef, and electricity.
- ▶ Note that biodiversity values are not (yet) included in the aggregate protection value on the platform.

Future work

Work still remaining to be done in extension of the project in Brazil:

- ▶ Additional work to develop biodiversity measures for economic valuation purposes, and select such measures as suitable for economic valuation.
- ▶ All economic component values assembled to reflect a measure of “total marginal forest value”.
- ▶ More complete/extended stated-preference survey of Brazilian population for valuing Amazon forest losses (with more focus on biodiversity aspects).

Value elements not (yet) in the platform, that might be part of our Amazon valuation project:

1. Tourism and recreation related to the Amazon
2. Bioprospecting (could be integrated part of biodiversity values)
3. Health impacts
4. Watershed protection impacts, including for droughts and flooding
5. Other local benefits and products, including fishing, hunting and gathering.

Mapping opportunity costs

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1. Opportunity costs are the economic values of converting Amazon rainforest land to other uses, such as agriculture.
2. Only when opportunity costs are higher than the value of the rainforest (including all value components) should deforestation be allowed.

Work to assess opportunity values for the Amazon will be addressed in follow-up work.



Extension of the valuation platform to
other Amazon countries (Peru,
Colombia, Ecuador, Guyana..)

**To recapitulate:
The total value of protecting the Amazon rainforest
has three major components:**

- ▶ **1. Local and regional values**
- ▶ **2. Carbon values**
- ▶ Finding, and geographically mapping, values 1-2 are the objectives this project.
- ▶ **For carbon values**, 100-160 tons of carbon (360-550 tons of CO₂) are assumed to be released on average per ha of rainforest deforested. With a carbon price of \$30 per ton, this is equivalent to a deforestation cost of about \$10,000-16,000 per hectare, as the “carbon value of preventing deforestation”.

Value components in Amazon rainforest valuation (cont.)

- ▶ **3. Value of protecting the Amazon in the rest of the world:** People in other countries are also willing to pay to preserve the Amazon forest. The total magnitude of such values is currently unclear.
- ▶ Parallel research in the World Bank has assessed such values in the U.S. and Canada. Indicates a protection value of around \$5,000 per hectare of saved rainforest in the Amazon, for the population in these two countries. Most of this value is related to biodiversity and forest area protection, and not carbon.

Value components in Amazon rainforest valuation (cont.)

- ▶ Consider adding all value components 1-3 to an integrated (spatially explicit) value of the Brazilian Amazon rainforest.
- ▶ This would at the same time, arguably, constitute an evaluation of the economic results from the Norwegian Forest Initiative, in terms of its impacts on saving rainforests in Brazil.

Thank you!