

# Online Appendix

## Accounting for Biodiversity Costs from Climate Change in Integrated Assessment Models

### Appendix A

#### A1: Inflation adjustment

Table A1: Weighted average inflation adjustment for each geographical region (see Table 2 for the abbreviations) from 2012 US \$ to 2010 US \$, and from 2012 US \$ to 1995US \$, Source: IMF

Region	2012 US \$	2010 US \$	1995 US \$
USA	1.00	0.95	0.67
CAN	1.00	0.95	0.72
WEU	1.00	0.96	0.71
JPK	1.00	0.98	0.73
ANZ	1.00	0.95	0.65
EEU	1.00	0.94	0.20
FSU	1.00	0.92	0.06
MDE	1.00	0.82	0.28
CAM	1.00	0.91	0.34
SAM	1.00	0.91	0.32
SAS	1.00	0.83	0.31
SEA	1.00	0.92	0.33
CHI	1.00	0.94	0.69
NAF	1.00	0.87	0.43
SSA	1.00	0.84	0.16
SIS	1.00	0.88	0.22
World	1.00	0.92	0.46

#### A2: Total damage in FUND 3.9

Table A2: In FUND 3.9, the total global damage cost is divided into economic damage cost and non-economic damage cost.

Total damage cost in FUND 3.9
<ul style="list-style-type: none"> <li>• Economic damage cost           <ul style="list-style-type: none"> <li>▪ Water</li> <li>▪ Forests</li> <li>▪ Heating</li> <li>▪ Cooling</li> <li>▪ Agricultural</li> <li>▪ Costs and costal protection</li> <li>▪ Tropical and extra tropical storms</li> <li>▪ Income (GDP)</li> <li>▪ Other economic damage cost</li> </ul> </li> <li>• Non-economic damage cost:           <ul style="list-style-type: none"> <li>▪ Species</li> <li>▪ Human health: Diarrhea, Vector-borne diseases, Cardiovascular and respiratory mortality</li> <li>▪ Wetland</li> <li>▪ Other non-economic damage cost</li> </ul> </li> </ul>

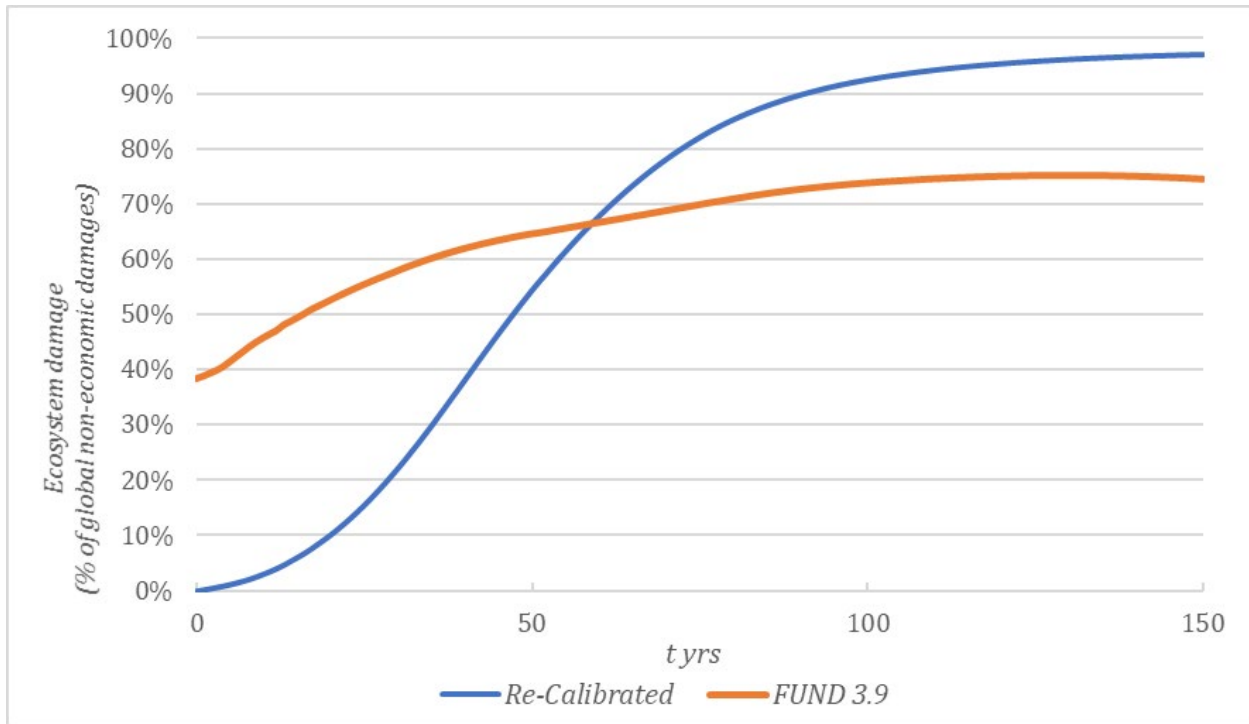


Figure A1: Projection of biodiversity damage cost as a percentage of global non-economic damages cost over time, comparing FUND 3.9 and re-calibrated model. In 1995 US \$.

Figure A1 shows the biodiversity damage cost as a percentage of non-economic damage cost, for FUND 3.9 and the re-calibrated model. In FUND 3.9, this percentage starts at a higher share than in our re-calibrated model. Moreover, the share of biodiversity damage costs decreases after approximately 100 years run in FUND 3.9. The re-calibrated biodiversity damage on the other hand starts well below FUND 3.9, but rapidly increases over time. This increment continues beyond the time horizon in Figure A1.

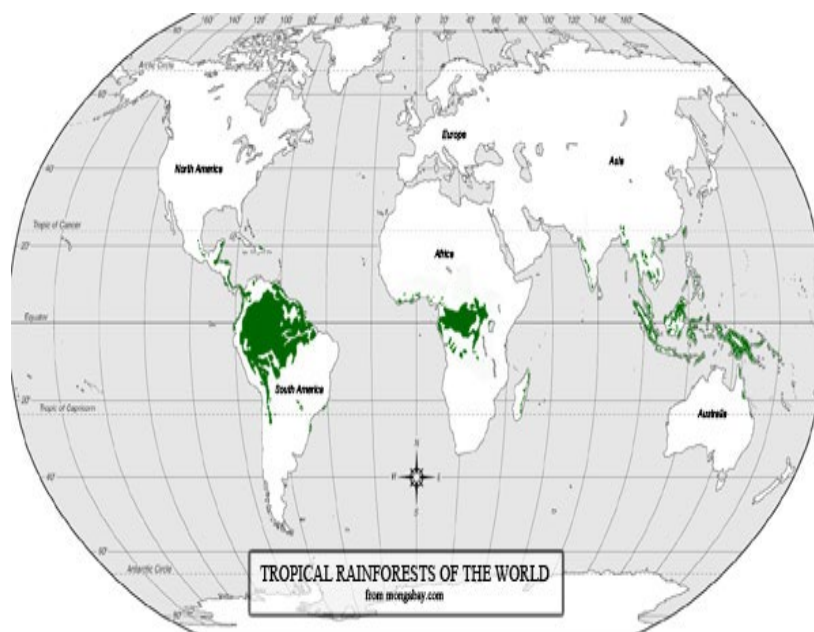
A3: Valuation scenario used in the global Delphi Contingent Valuation survey (Strand et al 2017). (US version, Round 1. The versions for the other regions were similar)

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## I. BRIEF DESCRIPTION AND VISUAL PRESENTATION OF GOOD TO BE VALUED

The map below (FIGURE 1) shows the location of the world's tropical rainforests. Rainforests cover only a small part of the earth's land surface; about 6%. Yet they are home to over half the species of plants and animals in the world. The **Amazon rainforest** is the world's largest rainforest, representing 40 percent of the global total. The Amazon is also home to the greatest variety of plants and animals on Earth. About 1/5 of all the world's plants and birds and about 1/10 of all mammal species are found there. The rainforest also serves as carbon storage, but **the carbon sequestration value is computed separately and should not be considered as part of your valuation assessments in this exercise.**

**FIGURE 1** THE WORLD'S RAINFORESTS (IN GREEN)



For you to get an impression of the size of the Amazon rainforest, FIGURE 2 shows its size relative to the continental United States. The current total area of the Amazon rainforest is 2.2 million square miles, or about 70% of the size of the continental United States.



FIGURE 2. LOCATION AND RELATIVE SIZE OF THE AMAZON RAINFOREST



FIGURE 3. A SMALL PART OF THE AMAZON RAINFOREST AS SEEN FROM THE AIR

A recent World Bank study (Vergara, W. & S.M. Scholz (2011): *Assessment of the Risk of Amazon Dieback*) describes a development where a substantial fraction of the biomass in the standing Amazon rainforest could disappear over time if the current development continues. There are several, man-made, drivers of such a development. One central such driver is man-made deforestation in the region due to cattle ranching/grazing, other agricultural activities, and timber extraction.

The disappearing rainforest would then be transformed into less dense forest, or savannah. A significant fraction of the trees in the Amazon rainforest would dry out and die. Less oxygen would be produced, the standing biomass would shrink dramatically, the ecosystem of the rainforests would change markedly, and numerous species would disappear.

## II. BASIC SCENARIO ELEMENTS

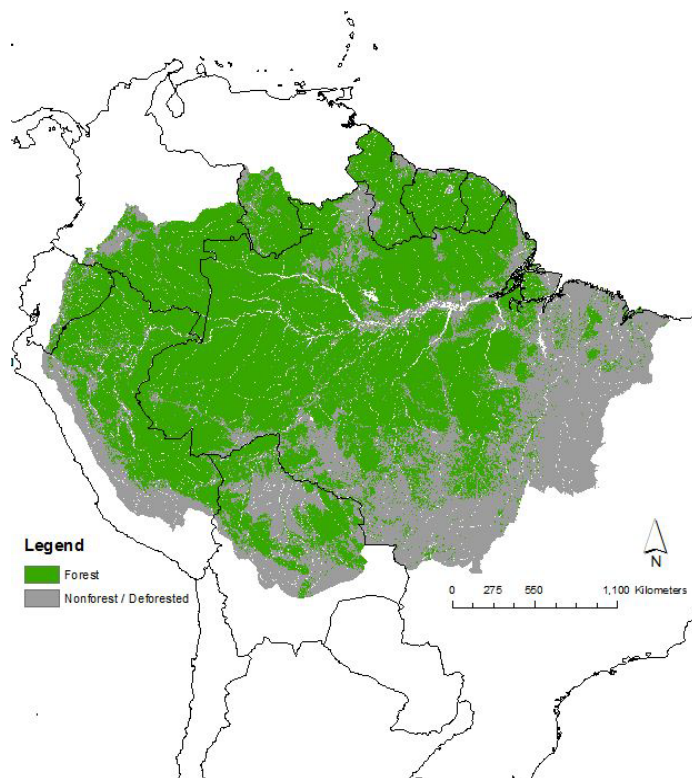
There is concern that only about 70 % of the current Amazon rainforest area will remain in 2050 **with no new preservation measures**. This means at the same time that 30% of the current forest would be lost by then.

The Brazilian Government, in collaboration with experts from international agencies, has developed two different rainforest preservation plans. These preservation plans will be expensive to carry out, since a large number of farmers and other property holders must be compensated for preserving their parts of the forest. It cannot be implemented by the Brazilian government without additional sources of support. If the funds raised by the Brazilian government and internationally exceed the costs of preservation, the preservation plans will be implemented.

Under **Plan A**, **no** further forest losses would occur by 2050, and the required payments will be collected from households in all contributing countries. This is the most expensive plan. It compares to the Business as Usual alternative, with no plan implemented (and thus with no implementation cost), under which only 70% of the present forest cover would remain by 2050.

Under **Plan B**, **some** forest losses would occur up to 2050, but about 88% of the current forest cover would still remain by then. This plan is less expensive to carry out than Plan A. Also in this case, with no plan, only 70% of the present forest cover would remain by 2050.

FIGURE 4. This represents the way the Amazon rainforest appears today



## Species Loss

Along with this forest loss there are likely to be losses of species, some of which are found only in the Amazon. If nothing is done to slow the rate of deforestation in the Amazon, scientists estimate that 105 mammal species, out of 442 currently known to be found there, will (under the Business as Usual alternative) face a high risk of extinction by 2050. Eighty three (83) of these endangered species are found **only** in the Amazon. FIGURE 5, below, shows a random selection of 19 of the 105 mammal species that will be at a high risk of extinction by 2050 if no new forest protection measures are passed. A similar fraction (about 20%) of other animal species, such as birds and amphibians, will also in the same way be threatened.

Under **Plan A** (which preserves all (100 %) of the current Amazon rainforest by 2050), none of these species would be lost by 2050.

Under **Plan B** (which preserves 88% of the current Amazon rainforest by 2050), 41 of these species would face a high likelihood of extinction by 2050.

**FIGURE 5. Some of the mammals threatened with extinction by 2050 with no new forest protection plan**

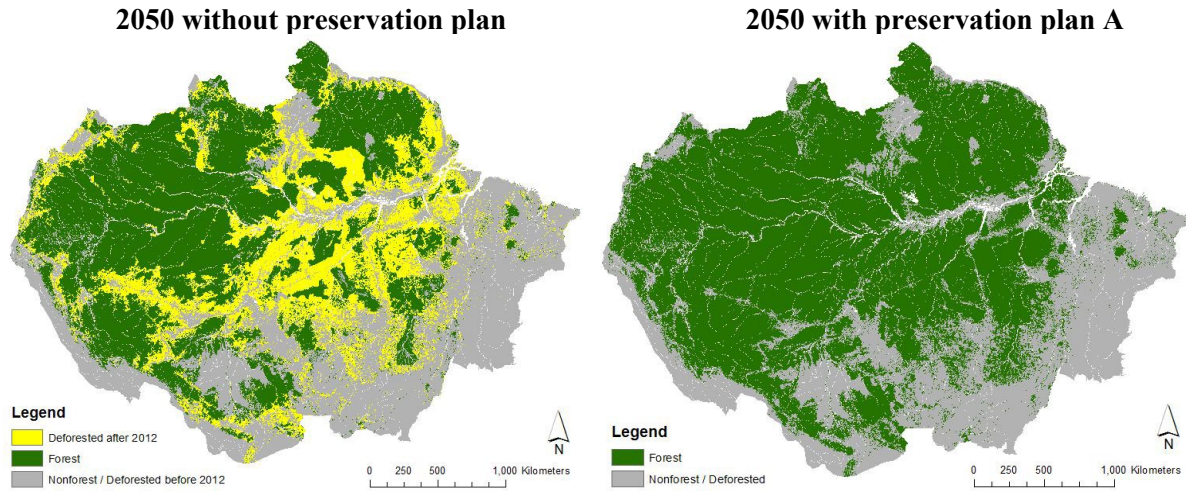


## Plan A

With **PLAN A** no further deforestation would occur. The current area of the Amazon Rainforest will be maintained through 2050 and all (100%) currently existing species will be preserved.

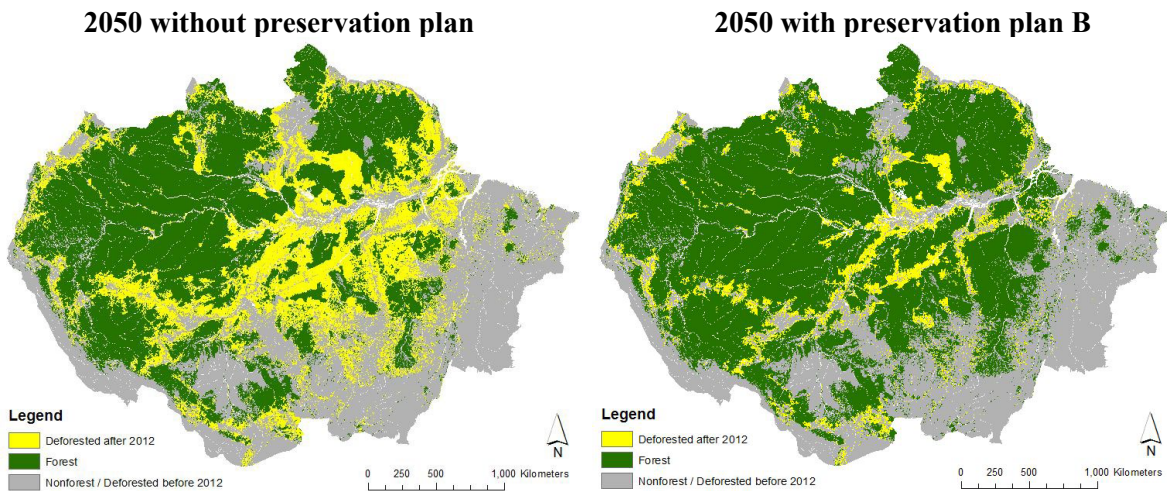
FIGURE 6 compares the Business as Usual Scenario (to the left) to Plan A (to the right). Note that Plan A protects all forest. This is the *most ambitious and expensive plan*.

**FIGURE 6. State of the Amazon Rainforest in 2050 with no new preservation plan, and with Plan A**



With **Plan B** there will be some further losses of rainforest area, but more forest will remain by 2050 than if no measures are taken. 88% of the current rainforest area will remain in 2050, and 41 of the currently existing mammal species (10%) will face a high risk of extinction. [FIGURE 7](#) compares the Business as Usual Scenario (to the left) to Plan B (to the right).

**FIGURE 7. State of the Amazon Rainforest in 2050 with no new preservation plan, and with Plan B**



### III. PAYMENT MECHANISM

Households in the United States will be asked for an *annual payment per household* in terms of a national tax that would be collected by the federal government and submitted to an international Amazon Rainforest Fund. The Fund will be controlled by an international governing body, and the money will be used exclusively and fully for this Amazon Rainforest Preservation Plan (PLAN A or B). Key factors are: (1) *payment per household* rather than

individual, (2) *annual* for all future years rather than a one-time payment (since the Amazon will provide these ecosystem service every year for infinity if the preservation plan is implemented), and (3) payment is *coercive* (e.g., tax) rather than a voluntary contribution; (4) the plan will go through if and only if *a majority of households in high-income countries approve it*.

**IV. TWO WTP ESTIMATES NEEDED FOR EACH PLAN (PLAN A and PLAN B)**

All of your estimates should be provided in US\$ per year. In the actual CV survey we will show a payment card indicating both monthly and annual payment amounts to the respondents. Payments are assumed to be required indefinitely or as long as the forest is to be protected. Assume that the survey design and the statistical analysis of the data would be done according to what you perceive as the current state-of-the-art. The payment card for annual payments is shown in the box below. You are free to report an amount that is not shown on the payment card if you feel it provides a better estimate of average WTP per household per year.

<b>0 1 3 5 10 15 20 25 30 40 50 60 70 80 90 100 125 150 200 300 500 750 1000 1500</b> <i>US dollars /household/year</i>
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We will first ask you to state WTP numbers for PLAN A (FIGURE 6), which preserves all (100%) of the current Amazon rainforest area from now and until 2050. Next, we ask you to state WTP numbers for the less ambitious PLAN B (FIGURE 7) which preserves 88 % of the currently forested area in 2050. Both plans should be compared to the 70% of the current forest area that is being preserved if there is no new preservation plan (the left figures in FIGURES 6 and 7)

**PLAN A (FIGURE 6; the most ambitious and expensive plan, to fully protect today’s rainforest)**

V1. Mean per household WTP (annual payment)

\_\_\_\_\_ ( ) US\$/household/ year

V2. Median per household WTP (annual payment)

\_\_\_\_\_ ( ) US\$/household/ year

**PLAN B (FIGURE 7; a less ambitious, and less expensive, plan than plan A, to protect only 88% of today’s rainforest)**

W1. Mean per household WTP (annual payment)

\_\_\_\_\_ US\$/household/ year

W2. Median per household WTP (annual payment)

\_\_\_\_\_ US\$/household/ year