Supplementary information to:
Regenerate natural forests to store carbon

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by Simon L. Lewis, Charlotte E. Wheeler, Edward T. A. Mitchard and Alexander Koch

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Supplementary Information

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Supplementary Methods: We estimate the long-term (to 2100) carbon sequestration of achieving the Bonn Challenge target of restoring 350 million hectares (Mha) of forest by 2030 (www.bonnchallenge.org). We focus on tropical and sub-tropical forest restoration as to date the majority of restoration commitments (83%) are located in the tropics and sub-tropics (i.e. including Argentina and China as they both span the sub-tropical and temperate zones)[5[main article]]. Furthermore, the area available for restoration is larger (go.nature.com/2ogmbmz), carbon sequestration rates are higher[9], and the impact of cooling larger for a given level of carbon uptake due to evaporative cooling in the tropics[10,11], compared to temperate and boreal regions. Additionally, there are no major negative climate impacts due to changes in surface albedo, as seen in northern temperate and boreal forests[12]. Hence we analyse data from 43 countries, which are wholly or partly in the tropics (-23.5 to +23.5 latitude). An additional 16 countries in the temperate and boreal regions that have made restoration commitments are not analysed here.

Current national restoration commitments made under the Bonn Challenge, UN REDD+ program, UNFCCC Nationally Determined Contribution under the Paris Agreement, and other national schemes were extracted from http://www.bonnchallenge.org/ [accessed October 2017] and the Forest Landscape Restoration tracking inventory at https://infoflr.org/ [accessed October 2017]. A total of 43 countries, which are wholly or partly in the tropics, have committed 292 Mha (Table S1. Tropical restoration commitments, restoration method (where available) and commonest timber and non-timber plantation crops, by country.

) as of October 2017, with 135 Mha of commitments being made specifically under the Bonn Challenge (Table S1. Tropical restoration commitments, restoration method (where available) and commonest timber and non-timber plantation crops, by country.

). In 18 countries commitments have been made under both the Bonn Challenge and national schemes, in these cases we selected the largest commitment for analysis, as it was unclear if there was an overlap between Bonn Challenge and national commitments (e.g. Colombia; Bonn Challenge commitment = 1 Mha; national commitment = 2 Mha, therefore 2 Mha was used for analysis). National commitments were larger than Bonn Challenge commitments in seven countries: Brazil, Chile, Colombia, Democratic Republic of Congo, Indonesia, Mexico and Uganda. Twenty-four countries (accounting for 196 Mha, 67% of commitments to date) have determined the type(s) of restoration that will be carried out (Table S1). In 13 countries, the type of restoration has been determined for 100% of the committed area, in the remaining 11 countries the type of restoration has been determined for 60% (± 13.1%, 95% CI) of the committed area (average of all 24 countries = 81%; Table S1). To calculate the proportion of each type of restoration, we took the mean proportion of land committed to each type(s) of restoration across all 24 countries. Restoration commitments fall into three main categories: natural regeneration (or assisted natural regeneration) to natural forest (34.2% of commitments are to this category, and an among country 95% CI of 14.8%; i.e. total of 64 Mha of commitments), plantations (44.8 ± 13.3%; 102 Mha) and agroforestry (21.0 ± 12.4%; 31 Mha).

We estimate long-term carbon sequestration potential between 2015 and 2100 (85 years) under four different pathways. Pathway 1: 'Natural Forest Only', assuming 350 Mha of land naturally regenerates until the end of the century, with no harvesting of timber. Pathway 2; 'Mixed Restoration With Protection' assuming the same proportion of natural regeneration, plantations and agroforestry that has been published by countries to date applies across all 350 Mha, with naturally regenerating forest protected until 2100. Pathway 3; 'Mixed Restoration Without Protection' also assuming that the same proportion of natural regeneration, plantations and agroforestry applies to all 350 Mha, but with naturally regenerating forest converted to plantations for bioenergy in 2050. Finally, pathway 4: 'Plantation only', assuming 350 Mha of land are converted to plantations. In Table S 6 we also include an additional pathway of 'Agroforestry only' assuming 350 Mha of land are converted to agroforestry, for completeness.

Initial carbon stocks. To estimate the initial carbon stocks in restoration areas, we first used the Restoration Opportunity map commissioned as part of the Bonn Challenge[5,13] to assess where restoration is likely to occur. We then extracted the aboveground biomass in areas with restoration potential from a recently published 1 km resolution tropical biomass map, itself made from a weighted average of other biomass maps and an extensive field dataset[9]. For each of the 43 countries with a restoration commitment we created a layer where each pixel is flagged as suitable for either 'Mosaic' or 'Wide-scale restoration' in the Restoration Opportunity map was given the overlying value from the biomass map. Within countries, we then ranked these restoration pixels from lowest to highest biomass, and calculated percentile values to estimate the median initial carbon stock. We converted the above ground biomass estimates to total live biomass carbon stocks using a root:shoot ratio of 0.23 to account for biomass in roots (Table S2) and assumed a carbon density of 47.1%[14]. Under all pathways, we estimate the initial carbon stock per country in 2015 using the 50th percentile (median) total live biomass carbon value.

Natural regeneration. In naturally regenerating forests, we first assume that carbon stocks increased from the 50th percentile (median) in 2015 to a value in 2100, estimated via a two stage process. First, we estimate the maximum potential carbon stocks of vegetation within each national restoration potential area as the 99th percentile within each country in 2015, i.e. the carbon stocks in naturally regenerating forest increase to the maximum carbon stocks in the region. Second, we then account for the impacts on forests of changes in climate and carbon dioxide concentration by the end of the century. We use three model simulations that had time-varying climate and CO_2 concentrations but fixed land use at 2006 values, to calculate the pixel-by-pixel differences in decadal average total biomass between 2010-2019 and 2090-2099 (models HadGEM2-ES, MIROC-ESM and MPI-ESM[15]). We selected the RCP2.6 scenario as it assumes climate policies are enacted leading to large reductions in greenhouse gas emissions, and so mostly likely coincides with policies for large-scale forest restoration for climate mitigation rather than a more business-as-usual scenario. For each country, the proportional increase or reduction in carbon stocks related to changes in climate and atmospheric CO_2 concentrations was calculated, using the median of the three models, given in Table S3, and multiplied by the 2100 carbon density estimates. On average, forest carbons stocks are higher in 2100 than today under a scenario that limits warming to below 2°C above pre-industrial levels leads. Thus the total carbon sequestration under natural regeneration is the 2100 carbon stocks, i.e. the 2015 99th percentile of regional carbons stocks scaled by the climate and CO_2 impacts, minus the 2015 median carbon stocks already on the land. We apply this method to the Natural Forest Only pathway and to the natural regeneration commitments within the 'Mixed Restoration with Protection' and 'Mixed Restoration Without Protection' pathways. Overall, our methodology is likely to be a conservative, as carbon stocks in 2100 may be greater than the highest values found within today's restoration opportunity areas multiplied by the modelled net impacts of CO_2 and climate by 2100 under a RCP2.6 scenario.

Plantations data. We assume that today's commercially important tree species are the most likely to be planted in the future because knowledge, skills and markets are all well developed for these widely planted species. For the 43 countries with restoration commitments, we extracted the area under timber plantations (i.e. wood crops, including *Eucalyptus* spp. and *Acacia* spp.) in 2015 from the FAO Forest Resource Assessment[7]. We then extracted the area under non-timber tree plantations in 2014 from FAOStat[16], which included perennial fruit tree crops (e.g. cocoa, cashew) or commodity tree crops (e.g. rubber), and palms that fit an FAO tree height definition (e.g. Oil Palm). We selected the timber or non-timber tree crop that covered the largest area in each country and assumed that this species was used for plantations in that country (Table S1). In 75% of countries timber (i.e. wood crops) covers the largest area. In nine countries, Oil Palm was the commonest crop. However, for our analysis we exclude Oil Palm as some countries consider it an agricultural crop rather than a plantation species, and the classification and utilization of Oil Palm for 'forest restoration' is highly controversial given its negative environmental impacts (overall, in climate mitigation terms it performs poorly compared to other tree crops due to the very high levels of fertilizer application). For these nine countries where Oil Palm is the most widely planted species in our list, the second commonest tree crop within each country was used for analysis (Table S1).

Agroforestry data. For each country we assume that the commonest non-timber tree species is the most likely to be planted as the overstorey species in an agroforestry system. That is, we included fruit tree and other commodity tree crops but excluded commercial timber crops from our list of potential species (Table S1). Again, in the nine countries which have Oil Palm as their commonest non-timber tree, the second commonest non-timber tree crop was used for analysis (Table S1).

Time-averaged carbon stocks for plantations and agroforests. For both timber species and tree crops, stands of trees grow and sequester carbon, but after a given period of time the trees are harvested, the land cleared, and the process is begun again. We therefore estimate the time-average carbon stocks on the land to assess the mean carbon stocks on the land through an entire growth and harvest cycle for plantations of each species. Just nine species comprised the commonest trees under either the plantation or agroforestry classes across all 43 countries. To estimate the time-averaged carbons stocks for each species, we first calculate the annual carbon sequestration rate, in Mg C ha^{-1} yr^{-1}, by (i) utilizing the mean aboveground carbon uptake rate (Mg C ha^{-1} yr^{-1}) from published values (Table S4), and (ii) multiplying by the root: shoot ratio, again from published values (Table S4). Second, for each species we use published nitrogen fertilizer application rates (kg N ha^{-1} yr^{-1}) and express this as an offset factor of the addition C sequestration necessary to offset the radiative forcing from the N_2O emission from the fertilizer use (i.e in units Mg C ha^{-1} yr^{-1}; Table S4). Hence the C sequestration rate is the total live biomass carbon production minus the N_2O emission offset.

The N_2O emissions offset (expressed as Mg C ha^{-1} yr^{-1}) was calculated using the annual N_2O emissions from nitrogen fertilizer application using an emission factor of 1% (Ref. 19[)], and N_2O-N was converted to N_2O using a conversion factor of 1.57 (1g N = 1.57g N_2O; Ref [17]). We used a 100-year global warming potential (including climate-carbon feedbacks) of 298 years[18] to convert N_2O to CO_2 equivalent (CO_2e). We then converted all CO_2e values to a C offset value, i.e. the amount of additional carbon uptake required to offset the radiative forcing of the fertilizer use emissions, using a conversion factor of 3.66 (1g C = 3.66g CO_2), and finally express the offset in Mg C ha^{-1} yr^{-1}. For example, if 100 Kg N ha^{-1} yr^{-1} were applied to a crop, this equates to 0.13 Mg C ha^{-1} yr^{-1}:

100 Kg N ha^{-1} yr^{-1} = 1 Kg N_2O-N ha^{-1} yr^{-1} emitted = 1.57 kg N_2O ha^{-1} yr^{-1} = 468.3 kg CO_2e ha^{-1} yr^{-1} = 128.0 kg C ha^{-1} yr^{-1} = 0.13 Mg C ha^{-1} yr^{-1}.

Third, for each species, we used the annual carbon sequestration rate and mean tree rotation length, in years (Table S4), to calculate the time average carbon stock ($T_{av}C$, in Mg C ha^{-1}) over a single rotation:

$$T_{av}C = \frac{\sum_{i=1}^{n} x}{n}$$

Where x = C sequestration rate (Mg C ha^{-1} yr^{-1}), and n = rotation length (yrs). Carbon sequestration was assumed to be linear within the rotation period. Thus, $T_{av}C$, is the average carbon stocks on the land surface for species-specific plantations or agroforests.

Finally to scale these species-specific time-averaged C stocks to the pathways Plantation Only, Agroforestry Only, and the plantation and agroforestry areas within the 'Mixed Restoration With Protection' and 'Mixed Restoration With No Protection' pathways, we assume that the initial carbon stock in 2015, is the 50th percentile carbon stock value within the Restoration Opportunity area (i.e. median C stocks; estimated identically to the natural forest calculation), but this carbon in vegetation is replaced with a plantation or agroforest. Carbon stocks then increase up to the $T_{av}C$ of the commonest timber/tree crop. Therefore, the net carbon sequestration by 2100 is the $T_{av}C$, minus the median C stocks originally on the land per hectare multiplied up by the total area of plantation/agroforestry per country.

To then estimate the carbon sequestration for the full Bonn Challenge area of 350 Mha under each of the four pathways, the 43 country-level carbon sequestration estimates (Table S5) are summed to give the carbon sequestration over 292 Mha which is then scaled to estimate the carbon stocks for the full 350 Mha area (Table S6). The 95% confidence interval associated with each pathway was calculated by propagating the errors ($\sqrt{\sum} e_1, e_2, e_3, e_4,$ where e_1 = C sequestration rate, e_2 = root:shoot ratio, e_3 = N fertilizer application and e_4 = rotation length uncertainty) for each data source (carbon sequestration rate, root: shoot ratio, nitrogen fertilizer application, and tree rotation length), and appears as the uncertainty bars in Figure S1.

Table S1. Tropical restoration commitments, restoration method (where available) and commonest timber and non-timber plantation crops, by country.

	Country commitments		Restoration method [b]				Timber/ Non-timber crop			
Country	**Area (Mha)**	**Scheme[a]**	**Area with restoration method data – Mha (%)[c]**	**Plantation area – Mha (%)[c]**	**Natural Forest area - Mha (%)[c]**	**Agroforestry area – Mha (%)[c]**	**Timber plantation area 2015 (1000 ha)**	**Commonest Non-timber plantation area (1000 ha)[d]**	**Commonest plantation crop[ef]**	**Commonest non-timber plantation crop[fg]**
Argentina	1.0	Bonn	-	-	-	-	1,202	34	Timber	Apple
Bangladesh	0.8	Bonn	-	-	-	-	274	59	Timber	Rubber
Benin	0.5	Bonn	-	-	-	-	23	**621**	Cashew	Cashew
Bolivia	6.0	National scheme	-	-	-	-	26	14	Timber	Cocoa
Brazil	23.1	National scheme	23.1 (100)	19.0 (82.3)	0.0 (0.1)	4.1 (17.6)	7,736	704	Timber	Cocoa
Burkina Faso	1.2	National scheme	1.2 (100)	0.1 (4.1)	0.2 (13.0)	1.0 (82.9)	239	96	Timber	Cashew
Burundi	2.0	Bonn	-	-	-	-	120	9	Timber	Timber*
Cameroon	12.1	Bonn	-	-	-	-	26	**670**	Cocoa	Cocoa
Central African Republic	3.5	Bonn	-	-	-	-	2	**3**	Cocoa	Cocoa
Chad	5.0	Bonn	-	-	-	-	18	8	Timber	Mango
Chile	0.6	National scheme	0.6 (100)	0.1 (16.7)	0.4 (66.7)	0.1 (16.7)	3,044	37	Timber	Apple
China	40.0	National scheme	15.8 (39.4)	15.6 (98.8)	0.2 (1.2)	0.0 (0.0)	78,982	2,272	Timber	Apple
Colombia	2.0	National scheme	2.0 (100)	1.0 (50.4)	1.0 (49.6)	0.0 (0.0)	71	**267**	Cocoa*	Cocoa*
Congo	2.0	Bonn	1.0 (50.1)	1.0 (99.9)	0.0 (0.1)	0.0 (0.0)	71	26	Timber	Cocoa
Congo, Democratic Republic of	17.0	National scheme	17.0 (100)	13.0 (76.7)	1.3 (7.9)	2.6 (15.3)	60	**176**	Timber*	Rubber*
Costa Rica	1.0	Bonn	0.2 (23.4)	0.1 (30.8)	0.2 (69.2)	-	18	**78**	Timber*	Mango*
Cote d'Ivoire	5.0	Bonn	2.1 (42.1)	0.2 (11.7)	1.9 (88.3)	-	427	**2,748**	Cocoa	Cocoa
Ecuador	0.5	Bonn	-	-	-	-	55	**373**	Cocoa	Cocoa
El Salvador	1.0	Bonn	1.0 (100)	-	-	1.0 (100.0)	16	11	Timber	Mango
Ethiopia	15.0	Bonn	14.3 (95.4)	5.9 (41.5)	8.4 (58.5)	-	972	16	Timber	Mango
Ghana	2.0	Bonn	1.7 (83.6)	1.1 (66.0)	0.5 (32.5)	0.03 (1.6)	325	**1,684**	Cocoa	Cocoa
Guatemala	1.4	Bonn	0.8 (58.9)	0.2 (29.6)	0.3 (38.6)	0.3 (31.8)	185	111	Timber	Rubber
Guinea	2.0	Bonn	-	-	-	-	104	**311**	Timber*	Mango*

Honduras	1.0	Bonn	-	-	-	-	-	**130**	Mango*	Mango*
India	21.0	Bonn	10.4 (49.5)	0.3 (2.9)	6.5 (62.5)	3.6 (34.6)	12,031	2,516	Timber	Mango
Indonesia	29.3	National scheme	29.3 (100)	16.8 (57.2)	12.3 (41.9)	0.02 (0.1)	4,946	**7,429**	Timber*	Rubber*
Kenya	5.1	Bonn	4.2 (82.6)	4.1 (97.4)	0.01 (0.2)	0.1 (2.4)	220	59	Timber	Mango
Lao	7.6	National scheme	7.6 (100)	0.05 (0.6)	7.5 (99.4)	-	113	1	Timber	Mango
Liberia	1.0	Bonn	-	-	-	-	8	**96**	Rubber	Rubber
Madagascar	4.0	Bonn	-	-	-	-	312	48	Timber	Mango
Malawi	4.5	Bonn	-	-	-	-	419	7	Timber	Mango
Mexico	10.5	National scheme	10.5 (100)	3.6 (34.6)	6.8 (65.4)	-	87	**196**	Mango	Mango
Mozambique	1.0	Bonn	-	-	-	-	75	**83**	Coconut	Coconut
Nicaragua	2.7	Bonn	-	-	-	-	48	7	Timber	Cocoa
Niger	3.2	Bonn	-	-	-	-	150	40	Timber	Mango
Nigeria	30.0	National scheme	30.0 (100)	13.8 (45.8)	0.6 (1.9)	15.7 (52.3)	420	**3,032**	Timber*	Cocoa*
Panama	1.0	Bonn	-	-	-	-	80	6	Timber	Cocoa*
Peru	3.2	Bonn	1.8 (55.9)	1.2 (67.8)	0.01 (0.5)	0.6 (31.7)	1,157	107	Timber	Cocoa
Rwanda	2.0	Bonn	1.6 (79.3)	-	0.003 (0.2)	1.6 (99.8)	418	19	Timber	Avocado
Sri Lanka	0.2	Bonn	-	-	-	-	215	**395**	Coconut	Coconut
Uganda	2.9	National scheme	2.9 (100)	2.1 (74.2)	0.7 (25.7)	0.01 (0.2)	60	52	Timber	Cocoa
Vietnam	17.3	National scheme	17.3 (100)	2.7 (15.4)	14.6 (84.6)	-	3,663	567	Timber	Rubber
Zambia	0.1	National scheme	0.1 (100)	0.1 (69.4)	0.02 (12.9)	0.02 (17.7)	64	-	Timber	Timber
Total	**292.2**		**196.5 (81.7)**	**102.1 (44.8)**	**63.5 (34.2)**	**30.7 (21.0)**				

[a] restoration commitments either fall under the Bonn Challenge or a national scheme (including; NDCs, REDD+ projects, Forest investment programme-FIP- or Global Environment Facility-GEF- projects). [b] restoration falls into three broad categories; plantations, natural regeneration, or agroforestry, a subset of 24 countries has details of the type of restoration to be carried out. [c] table shows area in Mha for each restoration method with percentage of commitments by country in parenthesis. [d] **bold** values show countries which have a non-timber plantation crop covering a larger area than timber plantation, for these countries the commonest non-timber crop was used for analysis as we assumed this crop is the most likely species to be used for plantations. [e] timber refers to wood crops, which is predominantly *Eucalyptus* spp. and *Acacia* spp. [f] nine countries have oil palm as the commonest crop (marked with *), for these countries the 2nd commonest timber and non-timber plantation crop was used for analysis, as we don't advocate the use of oil palm for restoration. [g] the commonest non-timber plantation crop was used as a proxy for agroforestry in analysis

Table S2. Root mass to shoot mass ratio for naturally regenerating forests.

Source	Region	Root: Shoot
Yuen *et al*., 2013 [19]	Southeast Asia	0.17
Phillips *et al*., 2008 [20]	Amazon	0.37
Deans *et al*., 1996 [21]	Africa	0.25
Hertel *et al*., 2009 [22]	Southeast Asia	0.17
Mokany *et al*., 2006 [23]	Pan-tropical	0.24
Niiyama *et al*., 2010 [24]	Southeast Asia	0.18
Mean (Standard Deviation)		0.23 (0.08)

Table S3. Climate impacts on carbon stocks within potential restoration areas in 2090-2099 compared to 2010-2019 under a RCP 2.6 emissions scenario using three Earth System Models (MPI, MIROC, HadGEM2). Values greater than 1 indicate that the net effect of climate change and CO_2 fertilization will result in increased forest biomass carbon stocks by the end of the century, those less than 1 a reduction in forest biomass carbon stocks.

	Earth System Model			
Country	MPI	HadGEM2	MIROC	Median
Argentina	1.13	1.07	0.85	1.07
Bangladesh	1.32	1.03	1.22	1.22
Benin	1.51	1.13	1.07	1.13
Bolivia	1.32	0.97	0.85	0.97
Brazil	1.16	0.91	0.88	0.91
Burkina Faso	1.24	ND	1.34	1.29
Burundi	1.40	0.86	1.33	1.33
Cameroon	1.30	1.04	0.94	1.04
Central African Republic	1.12	1.22	1.46	1.22
Chad	1.06	0.94	2.57	1.06
Chile	1.13	1.01	1.86	1.13
China	1.14	1.07	0.91	1.07
Colombia	1.61	1.02	1.36	1.36
Congo	1.62	1.02	0.95	1.02
Congo, Democratic Republic of	1.23	1.04	1.03	1.04
Costa Rica	1.22	1.03	0.77	1.03
Cote d'Ivoire	1.88	0.95	1.43	1.43
Ecuador	1.46	1.06	0.60	1.06
El Salvador	ND	0.84	ND	0.84
Ethiopia	1.21	0.99	0.57	0.99
Ghana	1.66	ND	1.62	1.64
Guatemala	1.02	0.86	ND	0.94
Guinea	1.52	1.00	0.42	1.00
Honduras	1.21	1.02	ND	1.12
India	1.37	0.99	1.07	1.07
Indonesia	1.18	1.09	0.83	1.09
Kenya	1.94	0.24	0.67	0.67
Lao	1.17	1.05	1.06	1.06
Liberia	1.63	0.96	2.11	1.63
Madagascar	1.30	0.64	ND	0.97
Malawi	1.92	0.79	1.26	1.26
Mexico	1.22	1.00	1.23	1.22
Mozambique	1.95	0.68	0.02	0.68
Nicaragua	1.18	0.99	ND	1.09
Niger *	1.43	1.01	1.56	1.43
Nigeria	1.91	0.96	1.27	1.27
Panama	1.38	1.03	0.80	1.03
Peru	1.16	1.05	1.03	1.05
Rwanda	1.54	0.82	1.34	1.34
Sri Lanka	1.41	ND	1.06	1.24
Uganda	1.89	0.50	1.02	1.02
Vietnam	1.23	1.04	1.33	1.23
Zambia	1.29	0.93	0.99	0.99
Median				1.07

Values show proportional change in carbon stocks in 2100 due to carbon dioxide fertilization and other climate impacts for RCP 2.6 scenario using three Earth System Models; MPI = Max-Planck Institut Earth System model, HadGEM2 = Hadley Centre Global Environmental Model-Version 2, MIROC = Model for Interdisciplinary Research On Climate – University of Tokyo. MPI and MIROC data from Earth System Grid Federation (https://esgf-index1.ceda.ac.uk/search/cmip5-ceda/; registration required), HadGEM2 data provided by E. Robertson, UK Met Office. The median values of the three models were used for analysis. ND = no pixels were available to calculate estimates. In this case we used the mean of the other two scenarios to calculate the 'median'. * = for Niger there were no pixels available for any model, the values were calculated using the mean of neighbouring countries (Benin, Burkina Faso, Chad and Nigeria).

Table S4. Time-averaged carbon stocks for timber and non-timber plantation crops, and inputs used to calculate time averaged carbon stocks.

Species	**C Sequestration Rate (Mg C ha^{-1} yr^{-1})**	**Rotation length (yrs)**	**R:S**	**N fertilizer application (Kg N ha^{-1} yr^{-1})**	**N fertilizer offset (Mg C ha^{-1} yr^{-1})**	**Time averaged C stocks (Mg C ha^{-1} ± 95% CI)**
Timber (Inc. *Acacia* and *Eucalyptus* spp.)	5.0 [25-30]	10 [31-35]	0.226 [36-40]	39.8 [41,42]	0.05	27.3 ± 8.0
Apple (*Malus* spp.)	2.6 *	35 [43]	0.210 [19]	201.3 [43,44]	0.26	53.2 ± 33.9
Avocado (*Persea americana*)	2.6 *	35 *	0.210 *(23)*	195.0 [45-47]	0.25	53.2 ± 33.9
Cashew (*Anacardium occidentale)*	3.6 [48]	30 [43]	0.210 *(23)*	70.8 [43]	0.09	63.9 ± 0.1
Cocoa (*Theobroma cacao*)	1.5 [49-54]	20 [55]	0.360 *(23)*	0.0 [49,52,55-57]	0.00	19.8 ± 2.3
Coconut (*Cocos nucifera)*	0.9 [58,59]	60 [43]	0.210 *(23)*	89.0 [43]	0.11	33.1 ± 1.8
Mango (*Mangifera indica)*	1.6 [60]	40 [61]	0.210 *(23)*	60.3 [43,44,62]	0.08	37.8 ± 0.1
Rubber (*Hevea brasiliensis)*	3.7 [27,51,63-65]	35[51,64,65]	0.205 *(23)*	92.3 [66,67]	0.12	76.5 ±12.2

References shown in parenthesis. * Values for apple and avocado taken as the mean of cashew and mango, as these species are most similar in structure to avocado and apple.

Table S5. Country-level area available for restoration, area committed to restoration, and the carbon sequestration for each of our four modelled restoration pathways.

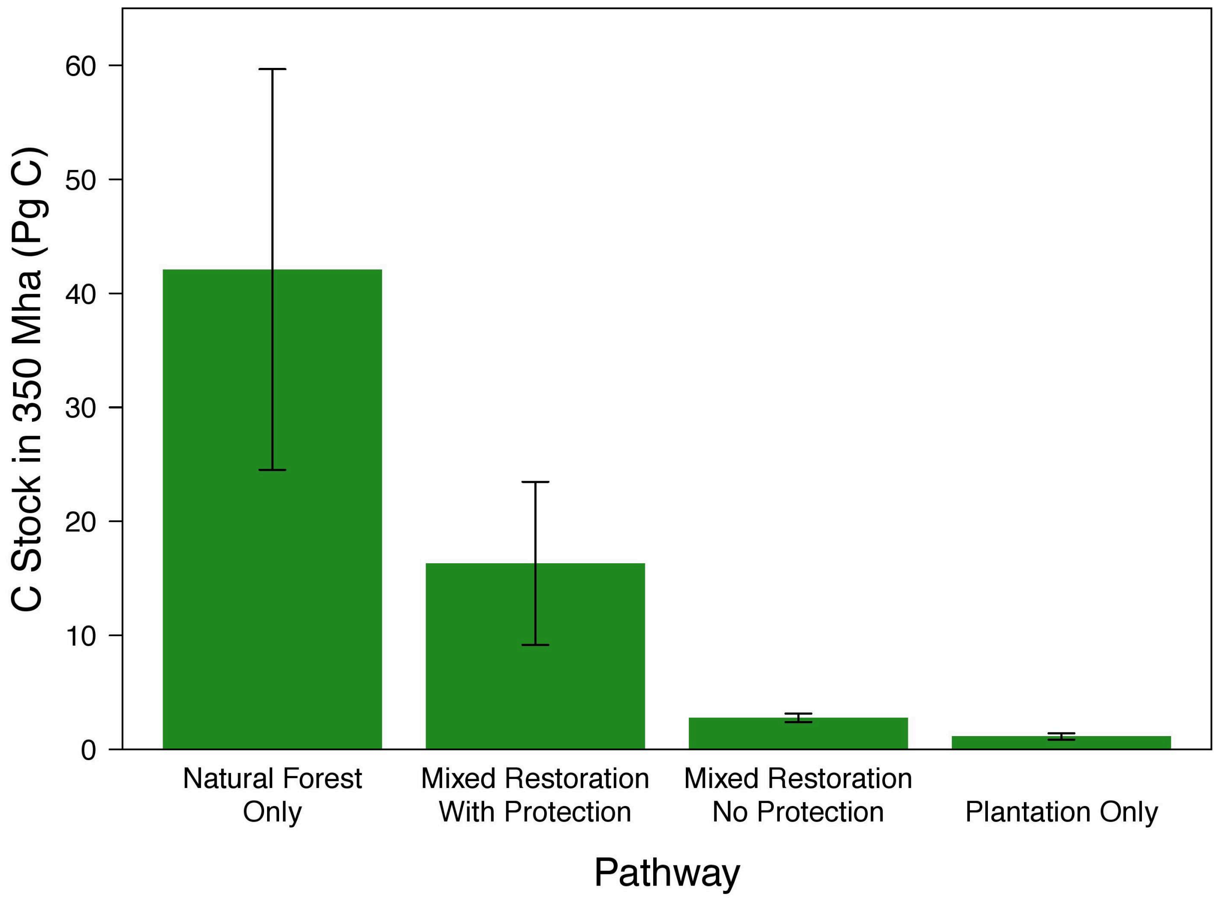
Country	**Area Available for Restoration (Mha)**	**Area Committed (Mha)**	**'Natural Forest Only' pathway (Pg C)**	**'Mixed Restoration With Protection' pathway (Pg C)**	**'Mixed Restoration Without Protection' pathway (Pg C)**	**'Plantation Only' pathway (Pg C)**
Argentina	43.3	1.0	0.07	0.05	0.03	0.02
Bangladesh	0.2	0.8	0.07	0.04	0.02	0.02
Benin	6.6	0.5	0.01	0.02	0.03	0.03
Bolivia	9.7	6.0	0.65	0.22	0.01	0.01
Brazil	313.6	23.1	2.19	1.00	0.39	0.44
Burkina Faso	14.4	1.2	0.02	0.04	0.04	0.03
Burundi	0.8	2.0	0.21	0.10	0.04	0.04
Cameroon	15.5	12.1	3.25	1.13	0.11	0.03
Central African Republic	18.2	3.5	0.81	0.31	0.06	0.05
Chad	22.8	5.0	0.07	0.12	0.13	0.13
Chile	6.7	0.6	0.10	0.05	0.01	0.01
China	141.4	40.0	4.73	1.33	-0.44	-0.77
Colombia	28.2	2.0	0.43	0.12	-0.02	-0.04
Congo	11.6	2.0	0.45	0.18	0.04	0.04
Congo, Democratic Republic of	84.8	17.0	3.15	1.44	0.48	0.28
Costa Rica	2.4	1.0	0.07	0.03	0.01	0.00
Cote d'Ivoire	20.6	5.0	0.45	0.18	0.05	0.05
Ecuador	6.4	0.5	0.08	0.03	0.00	0.00
El Salvador	0.9	1.0	0.02	0.02	0.01	0.01
Ethiopia	31.1	15.0	0.62	0.46	0.33	0.33
Ghana	14.4	2.0	0.20	0.09	0.03	0.03
Guatemala	4.7	1.4	0.06	0.05	0.03	0.01
Guinea	9.7	2.0	0.12	0.07	0.04	0.04
Honduras	4.8	1.0	0.06	0.03	0.01	0.02

India	71.2	21.0	2.62	1.14	0.36	0.30
Indonesia	40.0	29.3	6.13	1.71	-0.59	-1.06
Kenya	8.6	5.1	0.19	0.15	0.12	0.12
Lao	6.0	7.6	1.04	0.25	-0.14	-0.18
Liberia	1.3	1.0	0.31	0.13	0.04	0.04
Madagascar	35.8	4.0	0.51	0.25	0.10	0.09
Malawi	4.8	4.5	0.39	0.20	0.10	0.09
Mexico	47.3	10.5	0.55	0.36	0.23	0.26
Mozambique	53.2	1.0	0.05	0.03	0.02	0.03
Nicaragua	6.4	2.7	0.15	0.06	0.01	0.02
Niger	0.5	3.2	0.05	0.08	0.08	0.08
Nigeria	36.5	30.0	2.52	1.17	0.48	0.46
Panama	3.4	1.0	0.09	0.04	0.01	0.01
Peru	4.1	3.2	0.58	0.16	-0.04	-0.05
Rwanda	0.7	2.0	0.30	0.14	0.05	0.04
Sri Lanka	2.6	0.2	0.03	0.01	0.00	0.00
Uganda	9.5	2.9	0.14	0.09	0.05	0.06
Vietnam	11.3	17.3	2.56	0.93	0.05	-0.18
Zambia	34.3	0.1	0.01	0.00	0.00	0.00
Total C -Commitments to date (292 Mha)		292.2	36.1	14.0	2.4	1.0
Bonn Challenge (350 Mha)		350	42.1	16.3	2.8	1.1

Table S 6. Total carbon stocks (Pg C) in 2100 and carbon sequestration rate (Pg C yr^{-1}) between 2015 and 2100 assuming a linear increase, in the 292 Mha area committed to date and the full 350 Mha Bonn Challenge area, under our restoration pathways.

	Currently Committed Area (292 Mha)		Full Bonn Challenge Area (350 Mha)		Full Bonn Challenge Area by Restoration Category (Total C Stocks, Pg C)		
Pathway	Total C Stocks (Pg C)	Sequestration Rate (Pg C yr^{-1})	Total C Stocks (Pg C)	Sequestration Rate (Pg C yr^{-1})	Natural Regeneration	Plantations	Agroforestry
Natural Forest Only	36.1	0.42	42.1	0.50	42.1	0.0	0.0
Mixed Restoration With Protection	14.0	0.16	16.3	0.19	14.4	0.5	1.4
Mixed Restoration Without Protection	2.4	0.03	2.8	0.03	0.9	0.5	1.4
Plantation Only	1.0	0.01	1.1	0.01	0.0	1.1	0.0
Agroforestry Only	5.8	0.07	6.8	0.08	0.0	0.0	6.8

Figure S1.Total Carbon stocks (Pg C) in 350 Mha by 2100 under four restoration scenarios. Natural Forest Only (using natural regeneration to restore the whole area); Mixed Restoration With Protection (using current published pledged proportions of natural regeneration, plantations and agroforestry over 350 Mha, plus long-term protection for naturally regenerated forest); Mixed Restoration, No Protection (the same pledged proportions pathway but naturally regenerated forest is converted to bioenergy after 2050); and Plantation Only (the whole area is converted to plantations). Error bars show 95% confidence intervals.



Supplementary Notes:

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