Supplementary Information for

Future land carbon removals in China consistent with national inventory

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Supplementary Tables 1-6, and Supplementary Figures 1-12

Supplementary Table 1. Forestation targets set by the Chinese government based on publicly accessible data and information. The targets of forest coverage have been converted into actual forest area, assuming the total area of China is 960 million hectares (Mha).

	Name of Plan	Forest related targets	Year	Forest area (Mha)
A	The 14th Five-Year Plan for the development of forestry and grassland conservation	"China's forest coverage will reach 24.1% by 2035…"	2025	231.36
B	Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy	"By 2030, the forest coverage rate will have reached about 25%, and the forest stock volume will have reached 19 billion cubic meters."	2030	240
C	The Master Plan of National Major Ecological System Protection and Restoration (2021–2035)	"To expand the forest coverage to 26% of China's terrestrial area, its stocking volume to 21 billion cubic meters, and to maintain the area of natural forest at 200 million hectares..."	2035	249.60
D	The document of the 2018 National Forestry Department Directors' Conference	"the national forest cover may reach the world average of 30.7% in 2050..."	2050	294.72

* The first three documents (A, B, C) articulate official policy target with a broad scope at the national or global level. In contrast, the last item (D) represents a non-official goal rather than a formalized policy target

Supplementary Table 2. Main differences among the approaches used to estimate Land Use, Land-Use Change, and Forestry (LULUCF) carbon fluxes in this study.

Name	NGHGI	FAOSTAT	OSCAR-China	IAMs	Bookkeeping models in GCB2023		
					BLUE	H&C	OSCAR
Spatial representation	Country level	Country level	0.5° for China	Regions and/or countries	0.25°	Country level	Country level
Time period	Post-1990	Post-1990	1800-2018, 2019-2100	2005-2100	1850-2022	1850-2022	1850-2022
Land use change forcing	Implicit	FRA2020	See Methods	Endogenously calculated	LUH2-GCB2023	FRA2020	LUH2-GCB2023, FRA2020
Carbon densities of vegetation and soil	Inventories	Inventories	Calibrated on DGVMs	Calibrated on various data sources	Inventory-based	Inventory-based	Calibrated on DGVMs
IPCC guidelines	Tier 2, Tier 3	Tier 1	None	None	None	None	None
Direct anthropogenic effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indirect anthropogenic effects/Natural effects	Yes	Yes	Yes	No	No	No	Yes
Net LULUCF fluxes	$F_{NET(man)}$	$F_{NET(man)}$	$F_{NET(man)}$, E_{LUC}	E_{LUC}	E_{LUC}	E_{LUC}	E_{LUC}
Reference	UNFCCC[1]	FAO[2]	This study	Byers et al.[3]	Hansis et al.[4]	Houghton & Castanho[5]	Gasser et al.[6]

Supplementary Table 3. The list of CMIP6 models utilized in our research.

ID	Models	ID	Models
1	ACCESS-CM2	17	FIO-ESM-2-0
2	ACCESS-ESM1-5	18	GFDL-ESM4
3	AWI-CM-1-1-MR	19	IITM-ESM
4	BCC-CSM2-MR	20	INM-CM4-8
5	CAMS-CSM1-0	21	INM-CM5-0
6	CAS-ESM2-0	22	IPSL-CM6A-LR
7	CESM2-WACCM	23	KACE-1-0-G
8	CIESM	24	MIROC6
9	CMCC-CM2-SR5	25	MPI-ESM1-2-HR
10	CMCC-ESM2	26	MPI-ESM1-2-LR
11	CanESM5	27	MRI-ESM2-0
12	EC-Earth3	28	NESM3
13	EC-Earth3-Veg	29	NorESM2-LM
14	EC-Earth3-Veg-LR	30	NorESM2-MM
15	FGOALS-f3-L	31	TaiESM1
16	FGOALS-g3		

Supplementary Table 4. Overview of future forest expansion trajectories.

Short name	Description
Pledged	Commits to the Chinese government's official targets for 2025, 2030, and 2035, with an expansion goal of 1.8 Mha each year until 2035. Beyond this year, it holds the forest area steady at the 2035 level, serving as a baseline that reflects the impact of current targets without further expansion efforts.
Continued	This strategy extends the existing forestation rate (1.8 Mha yr^{-1}) beyond the year 2035, aiming for consistent growth until China's total forest potential is fully utilized. The expansion is projected to reach its peak by the year 2071, capturing a progressive commitment to forest growth.
Accelerated	As the most ambitious pathway, this strategy assumes a faster forestation rate after 2035, accelerating to 3 Mha per year. This rapid increase is in line with a more ambitious, non-official target for 2050, seeking to max out all forestation potential by 2058, demonstrating an aggressive approach towards forestation.

Supplementary Table 5. Land Use, Land-Use Change, and Forestry (LULUCF) carbon fluxes for China as reported in official documents. The values represent net carbon fluxes in gigatonnes of carbon per year (Gt C yr^{-1}), which are converted from units originally reported in Gt CO_2 by dividing them by 3.664. Negative values indicate a net carbon removal. Data sources include National Communications (NC) and Biennial Update Reports (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC).

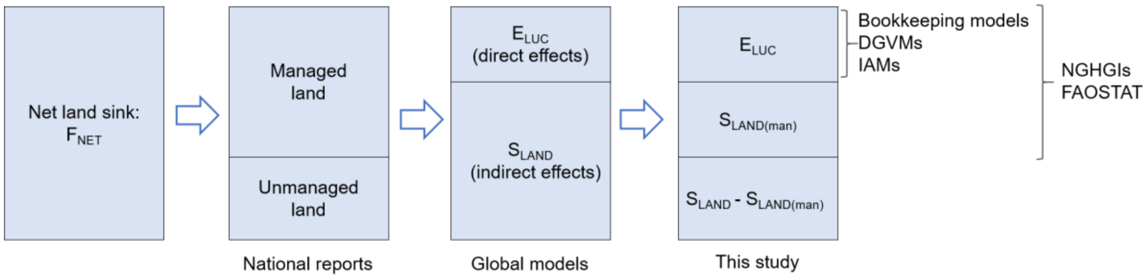
	1994	2005	2010	2012	2014	2017	2018
LULUCF	-0.1112	-0.2353*	-0.2810	-0.1572	-0.3141	-0.3663	-0.3657
Source	1st NC	2nd NC	3rd NC	1st BUR	2nd BUR	4th NC	3rd BUR

* The carbon flux data for the year 2005 was recalculated in the 3rd BUR and differs from the original estimate provided in the 2nd NC due to updated methodologies.

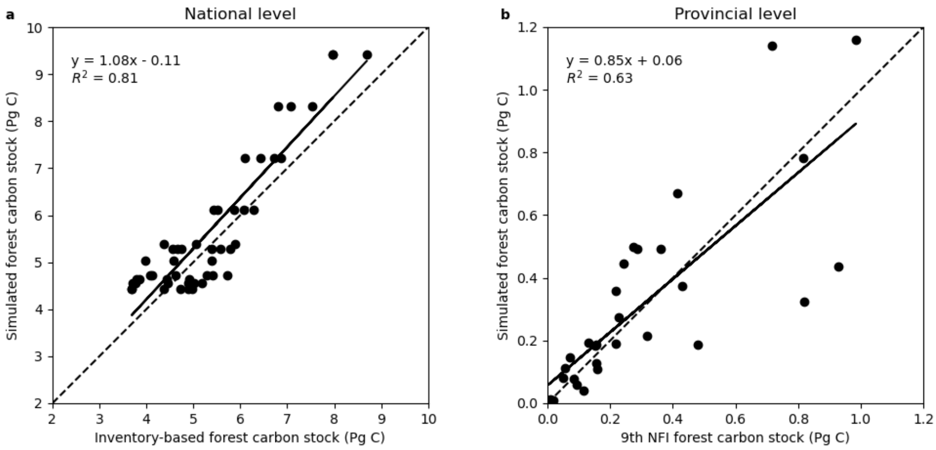
Supplementary Table 6. Comparison of forest carbon stocks in China. The values represent carbon stocks in gigatonnes of carbon (Gt C).

Period	Fang et al.[7]	Guo et al.[8]	Xu et al.[9]	Yang et al.[10]	Zeng et al.[11]	Zhang et al.[12]	This study
1949	5.06				5.89	4.38	5.38
1950-1962	4.58				5.38	3.98	5.04
1973-1976	4.44		3.85		4.91	3.79	4.65
1977-1981	4.38	4.97	3.70	4.72	4.9	3.69	4.44
1984-1988	4.45	5.18	3.76	4.89	5.01	3.71	4.55
1989-1993	4.63	5.73	4.11	5.40	5.28	4.08	4.72
1994-1998	4.75	5.78	4.66	5.39	5.57	4.56	5.29
1999-2003		6.29	5.51	5.86	6.08	5.43	6.12
2004-2008		6.87		6.43	6.73	6.1	7.21
2009-2013				7.07	7.52	6.81	8.31
2014-2018				7.98	8.69	7.97	9.41

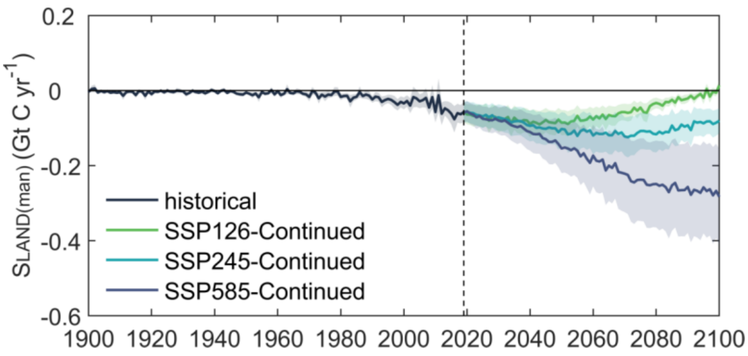
Supplementary Figure 1. Conceptual illustration of the difference, for the carbon removals, between national reports and global models. The net land carbon sink (F_{NET}) can be broken down by processes (i.e., direct versus indirect effects) and land types (i.e., managed versus unmanaged lands). Global models, such as bookkeeping models, Dynamic Global Vegetation Models (DGVMs), and Integrated Assessment Models (IAMs), account only for direct anthropogenic effects (E_{LUC}) as LULUCF. In contrast, national reports (e.g., National Greenhouse Gas Inventories (NGHGIs), FAOSTAT) also consider the indirect effects (S_{LAND}) on managed lands, denoted as $S_{LAND(man)}$, as LULUCF.



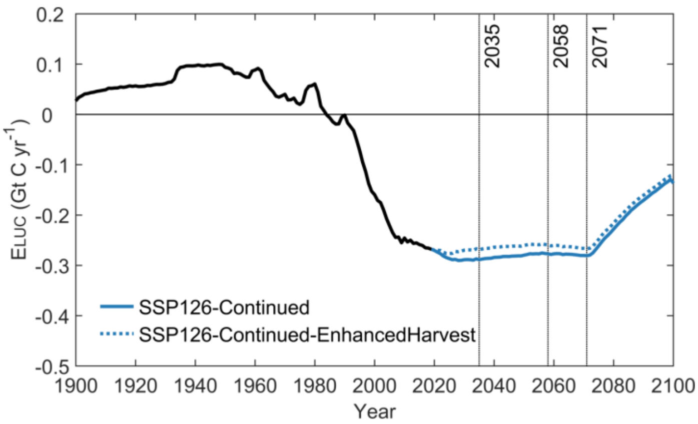
Supplementary Figure 2. Comparison of simulated and inventory-based forest carbon stocks in China. a. National-level analysis comparing model simulations to inventory-based estimations from different periods over 1949-2018 (see Supplementary Table 6). **b.** Provincial-level analysis based on officially released 9th NFI data (SFGA, 2019), assessing spatial variability.



Supplementary Figure 3. Historical and future trajectories of the indirect effects on managed land ($S_{LAND(man)}$). Results are shown for the combination of three climate change scenarios (that is, SSP1-2.6, SSP2-4.5 and SSP5-8.5) with a continued forestation land-use change scenario (see details in Methods). The shaded areas represent the weighted standard deviation from a constrained Monte Carlo ensemble of 1000 elements.

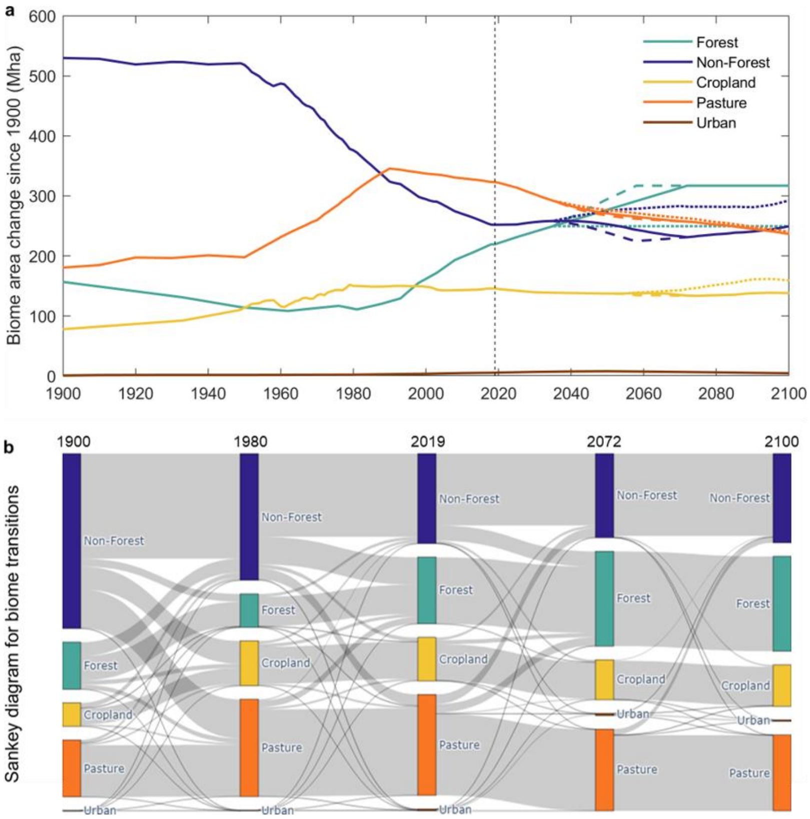


Supplementary Figure 4. Direct carbon removals (ELUC) considering different wood harvest strategies. Uncertainty ranges are not shown for legibility.

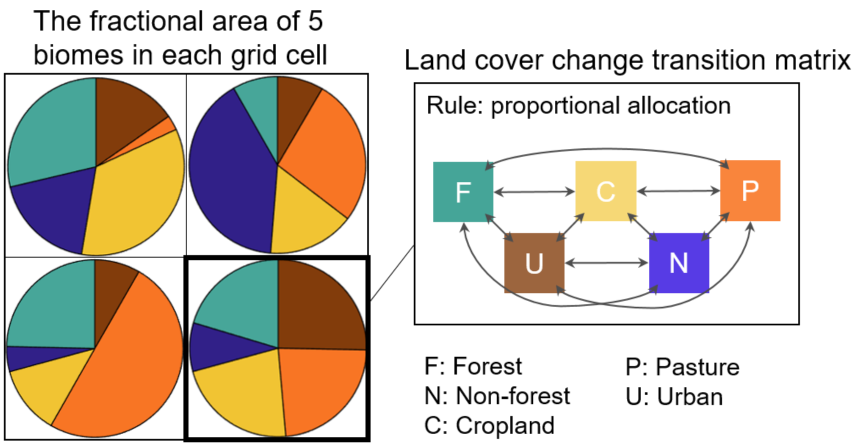


Supplementary Figure 5. Spatial distribution of the seven primary geographical regions in China.

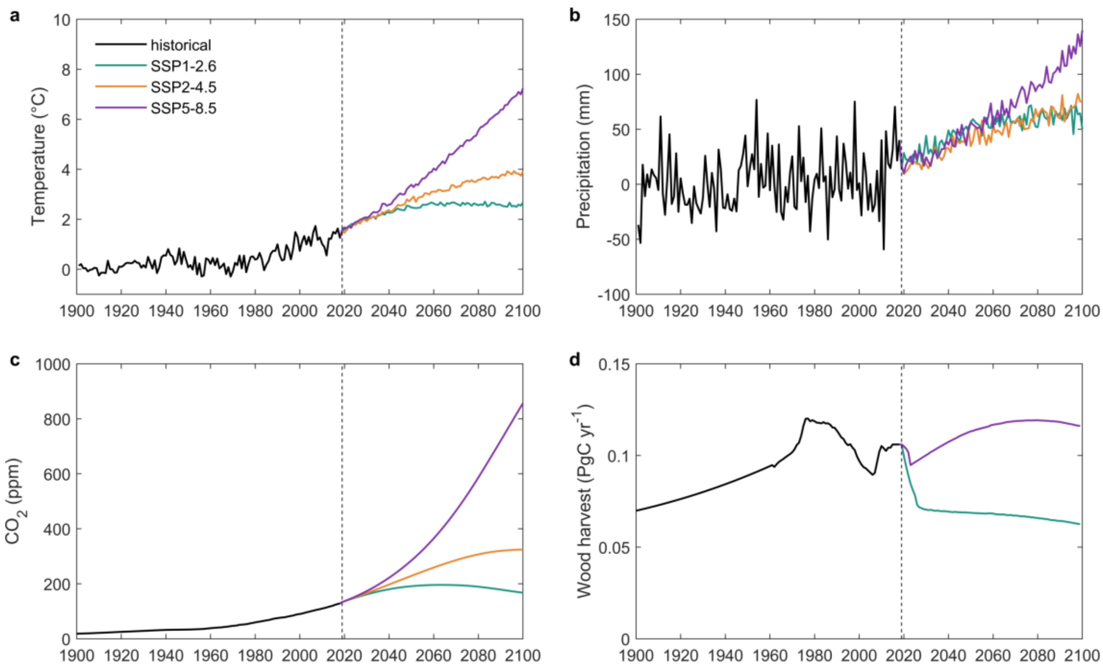
Supplementary Figure 6. Temporal changes in biome area and their transitions in China. a. biome are changes in China from 1900 to 2100. From 2019 onward, changes in area under the continued forestation scenario are represented by solid lines, while the area variations under the accelerated and pledged forestation scenarios are shown through dashed lines and dotted lines, respectively. **b.** Sankey diagram of the transitions among the five biomes since 1900. Transitions from 2019 to 2100 are projected based on the continued forestation scenario as an example. The widths of the arrows in the Sankey diagram correspond to the magnitude of the transitions.



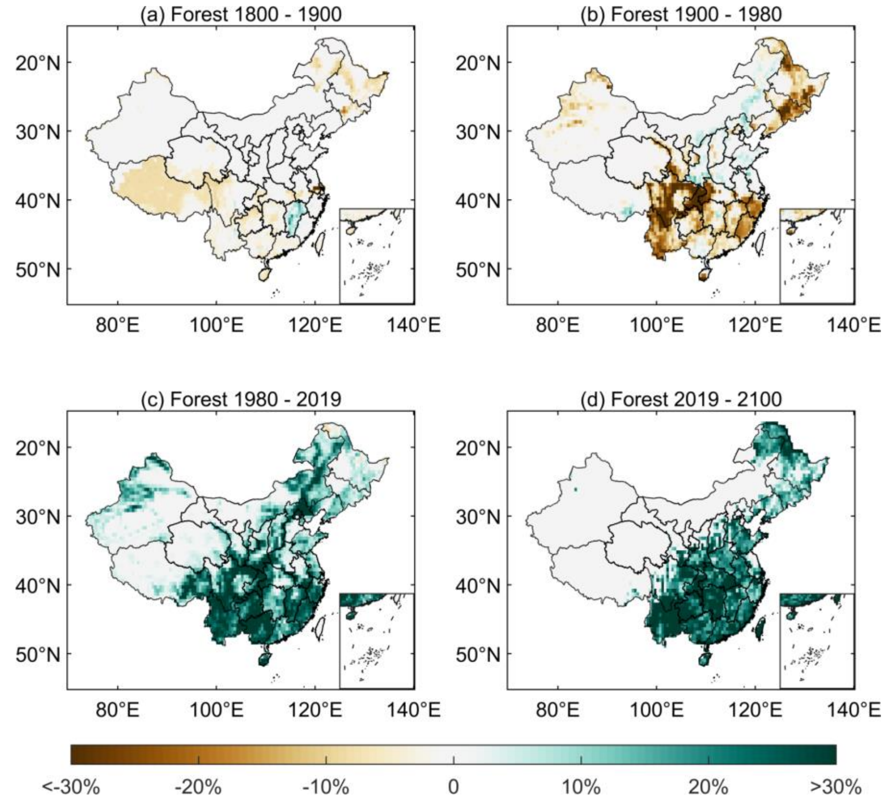
Supplementary Figure 7. Land cover representation in OSCAR-China and the assumption of land cover change transition matrix used in this study. Each grid cell contains varying biome fractions, and changes in biome areas are allocated proportionally within the same grid cell based on the total area changes of other biomes.



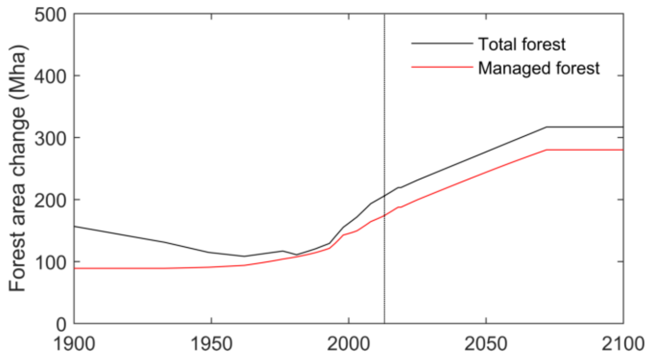
Supplementary Figure 8. Bias corrections for future climate forcing and wood harvest data used in OSCAR-China. Panels (a), (b), and (c) present temperature, precipitation, and CO_2 projections, respectively, under both historical data and SSP1-2.6, SSP2-4.5, and SSP5-8.5 scenarios. Panel (d) shows wood harvest projections under two contrasting scenarios, representing low (SSP1-2.6) and high (SSP5-8.5) harvest intensities.



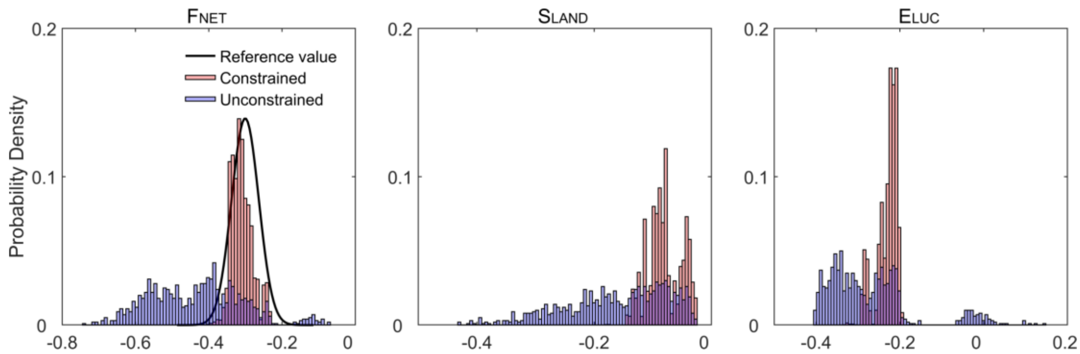
Supplementary Figure 9. Spatial distribution of the fractional coverage changes of forest in China (unit: %). Panels (a), (b), and (c) show the changes in forest coverage from 1800 to 1900, 1900 to 1980, and 1980 to 2019, respectively. Panel (d) represents potential forestation opportunity from 2019 to 2100. Negative values indicate a reduction in forest coverage, while positive values indicate an increment.



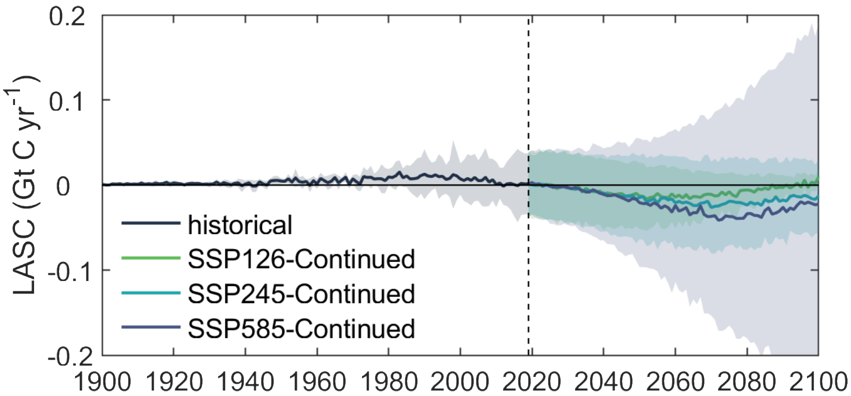
Supplementary Figure 10. Changes in total forest area and managed forest area over the period of 1900-2100. Since 2019, results based on the continued forestation scenario are shown for illustration.



Supplementary Figure 11. Probability distributions of key carbon fluxes in the OSCAR-China model, informed by observation-based constraints. The distributions are based on 1000 Monte Carlo simulation elements. Histograms demonstrate distributions before (unconstrained) and after the application of constraints (constrained). The reference value shown here is the RECCAP2 $F_{NET.}$



Supplementary Figure 12. Historical and future trajectories of the loss of additional sink capacity (LASC). Results are shown for the combination of three climate change scenarios (that is, SSP1-2.6, SSP2-4.5 and SSP5-8.5) with a continued forestation land-use change scenario (see details in Methods). The shaded areas represent the weighted standard deviation from a constrained Monte Carlo ensemble of 1000 elements.



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