

Supplementary information for

Forest vegetation increased across China's carbon offset projects and positively impacted neighboring areas

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Supplementary Note 1

Background

Chinese Certified Emission Reduction (CCER) market is a carbon credits program governed by China's government. It is open to project owners who are legally registered persons or organizations in China, and is linked to China's national carbon market through the offset mechanism. The CCER market was initiated in 2012 when the National Development and Reform Commission issued the Interim Measures and key guidelines, followed by the launch of the National Trading Platform in October 2013. It is suspended in 2017, when the authorities had announced a total of 100 forestry projects on the official website. In 2023, it is re-launched with the Ministry of Ecology and Environment issuing new measures, guidelines, and methodologies.

Project implementation follows a process similar to many carbon credit systems, including project development and registration, validation and verification, and carbon credit issuance. Project developers must submit detailed Project Design Documents (PDDs) specifying project boundaries, planned activities, methodological compliance, baseline scenarios, and project additionality.

Site selection and boundary determination are governed by specific criteria outlined in the 2013 afforestation methodology (revised in 2023). Key conditions include: land must have been non-forested since February 16, 2005, with specific vegetation thresholds (must not simultaneously meet continuous area ≥ 0.0667 hectares, canopy cover $\geq 20\%$, tree height ≥ 2 meters after forest formation); clear land ownership rights, certified by county-level or higher government, are required; land must not be classified as wetland or organic soil; project activities must comply with soil and water conservation requirements; and the pre-existing agricultural activities should not shift from the intended project sites to other sites. It's important to note that forest property rights remain complex in China, impacting project implementation. Despite the Forest Tenure Reform initiated in the early 2000s, the confirmation and registration of forestland ownership continue to present significant challenges (Ho, 2001; Qin et al., 2011). These criteria contribute to the scattered nature of project sites, reflecting China's land and forest rights systems.

The 2023 revision of the interim measures for the CCER program introduced significant changes in project eligibility criteria. Notably, it stipulates that project activities cannot predate 2012. This revision also shifts the eligible project start date in the afforestation methodology from 2005 (as specified in the previous version) to 2012, ensuring consistency with the CCER program's

launch. It's important to note that while project activities could predate the generation of the PDDs, the crediting period is defined as the timeframe when the project scenario generates additional greenhouse gas emission reductions compared to the baseline scenario.

During the validation and verification period, when the project officially begins implementation, all activities within the project boundaries must be meticulously recorded and reported. This comprehensive documentation covers a wide range of aspects: afforestation activities, including planting details, tree species used, and land preparation methods; management activities such as patrols, replanting efforts, harvesting operations, pest control measures, and forest fire prevention strategies; and any occurrences of natural disasters or human disturbances.

Supplementary Note 2

Analysis of sample representativeness

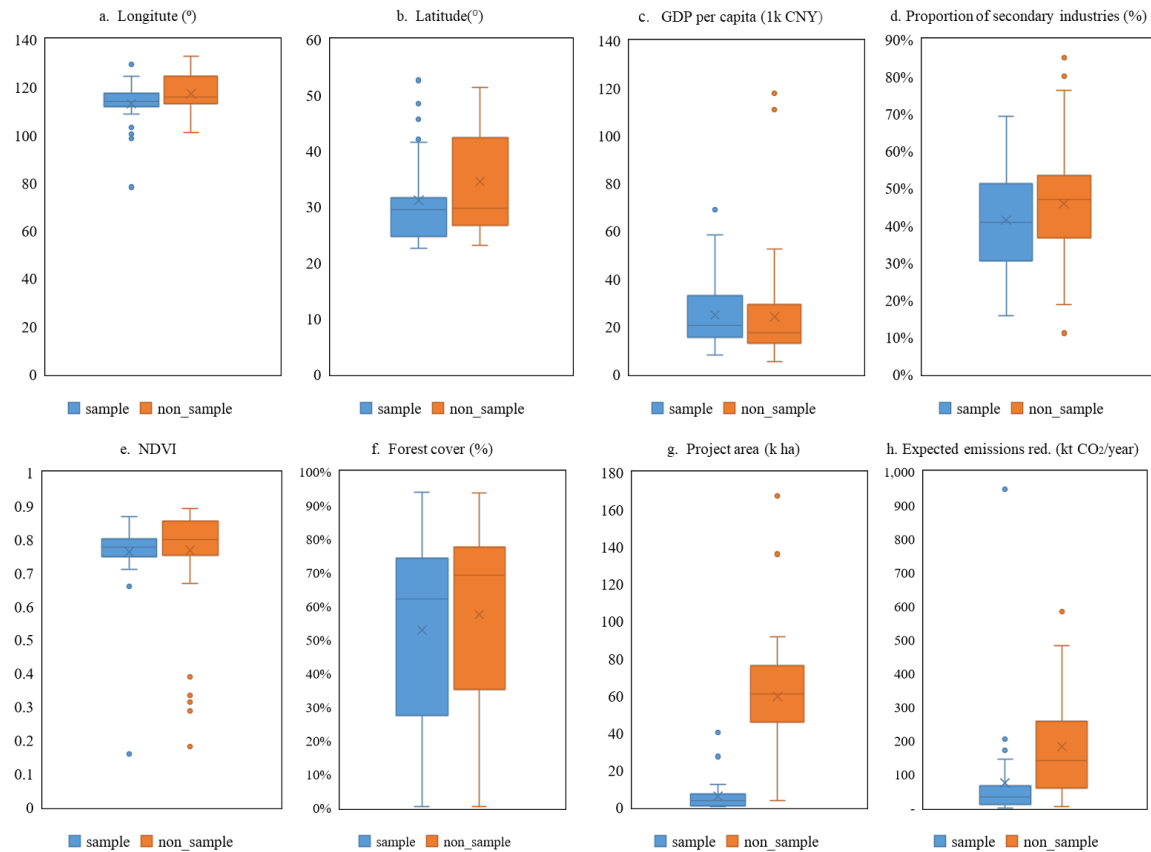
This study analyzes 36 out of 100 projects of CCER programs. Using data from the PDDs, we assess the representativeness of these 36 projects, which are detailed in terms of location (hereinafter, sample projects). This involves a comparative analysis of the geographical distribution, socio-economic contexts, forest conditions, and project characteristics of the sample projects against those lacking detailed location data (hereinafter, non-sample projects), as shown in Fig. S1.

Figs. 1a and 1b compare the geographical distribution of sample projects to non-sample projects, revealing small variance in the longitude and latitude. However, non-sample projects tend to be more concentrated in the northeast. Despite this skew, the sample includes projects from the northeast, ensuring coverage from various national regions, thus affirming the geographical representativeness of the sample projects. Due to the absence of explicit geographical coordinates for project sites, we compare the socio-economic conditions (Figs. 1c and 1d) and forest conditions (Figs. 1e and 1f) of the counties where the projects are located. The findings indicate negligible differences in GDP per capita (24864.1 CNY vs. 24079.3 CNY, $p=0.81$), proportion of secondary industry (41% vs. 45%, $p=0.10$), NDVI (0.76 vs. 0.77, $p=0.84$), and forest land proportion (53% vs. 57%, $p=0.38$) between the two groups, illustrating a balance in these aspects.

Further comparisons of project characteristics demonstrate similar administrative statuses between the two groups (both approximately four-fifths of their projects in the process of approval) and a larger share of forest management in non-sample projects (nearly double that observed in the sample projects). Notably, it indicates significant differences between sample and non-sample projects in terms of area and expected emissions reduction (5934.31 ha vs. 59605.90 ha, $p<0.01$; 75154.1 tCO₂/year vs. 182833 tCO₂/year, $p<0.01$). This primarily arises from the practice of submitting detailed coordinate data for larger projects as separate documents to relevant authorities, instead of including them in the PDD due to length considerations. During the public consultation phase, authorities disclose only the PDDs, not these additional location documents. Therefore, this omission results in the loss of larger-sized samples from our analysis. This also explains the observed geographic tendency and project type difference, where most of these large projects, predominantly forest management projects, are situated in the northeast. Moreover, the observed

discrepancy in project sizes suggests administrative challenges in the project application process, rather than deliberate data manipulation or selective disclosure by projects developers. It addresses concerns related to adverse selection and authenticity of the sample to a considerable extent. Despite their relatively smaller size, sample projects demonstrate substantial areas compared to forest offset projects in other jurisdictions^{23,24}.

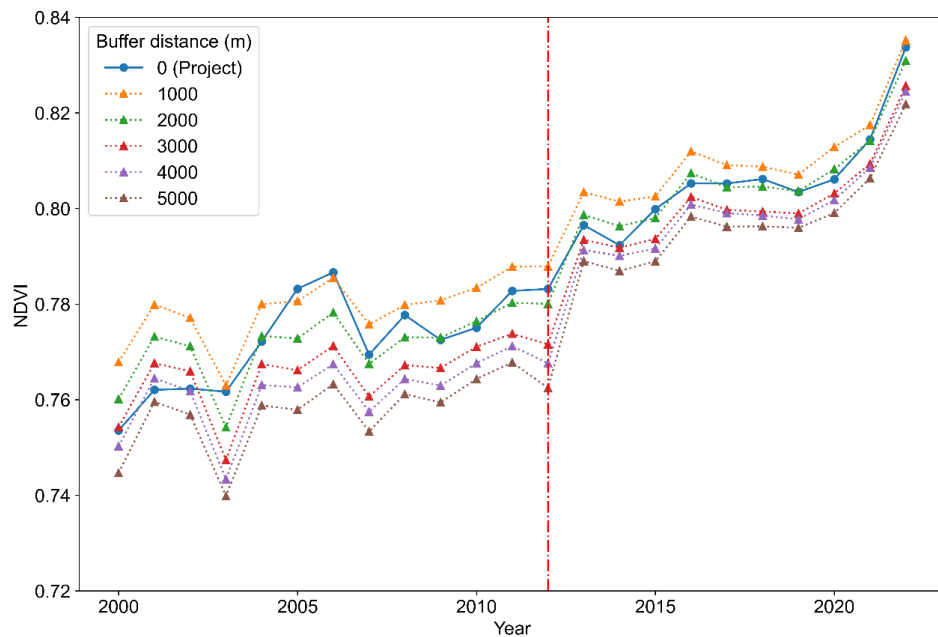
In conclusion, despite some sample omissions, the sample projects provide a broadly representative cross-section across multiple dimensions, thereby supporting the validity of our research findings.



Supplementary Fig.S1. Sample representativeness.

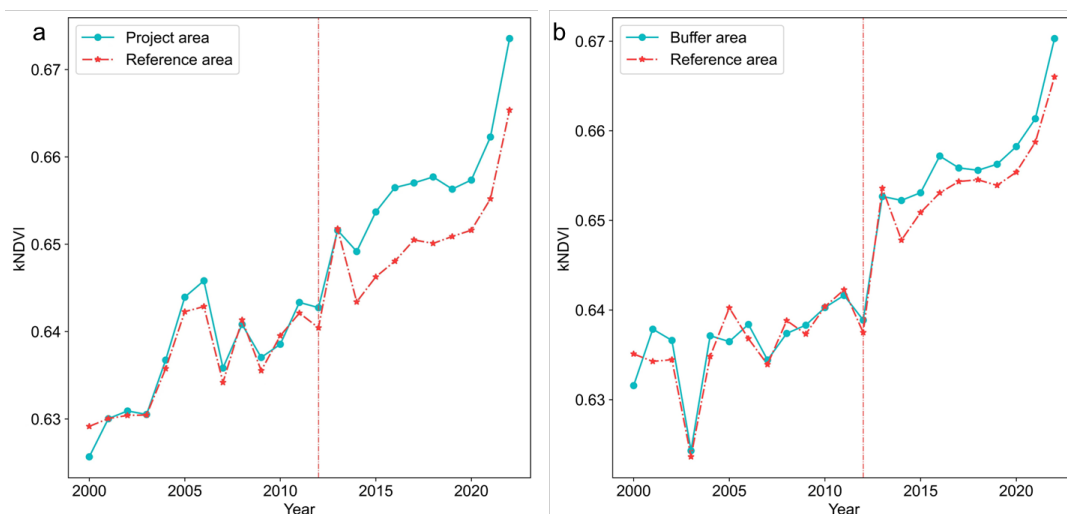
Note: In the box plots, blue represents sample projects, while orange denotes non-sample projects. The top edge, middle edge, and bottom edge of the rectangle are the third quartile (Q_3), median (Q_2), and the first quartile (Q_1) respectively. The “×” symbol indicates the mean. The line extending above the rectangle represents the upper boundary ($X_1 = Q_3 + 1.5 * (Q_3 - Q_1)$), and the line below signifies the lower boundary ($X_2 = Q_1 - 1.5 * (Q_3 - Q_1)$). Points exceeding X_1 or below X_2 are depicted as dots. In the absence of such outliers, X_1 or X_2 is replaced by the maximum or minimum value. All data pertain to 2011, the year preceding the policy implementation.

Supplementary figures



Supplementary Fig.S2. NDVI trend of project sites and buffer zones.

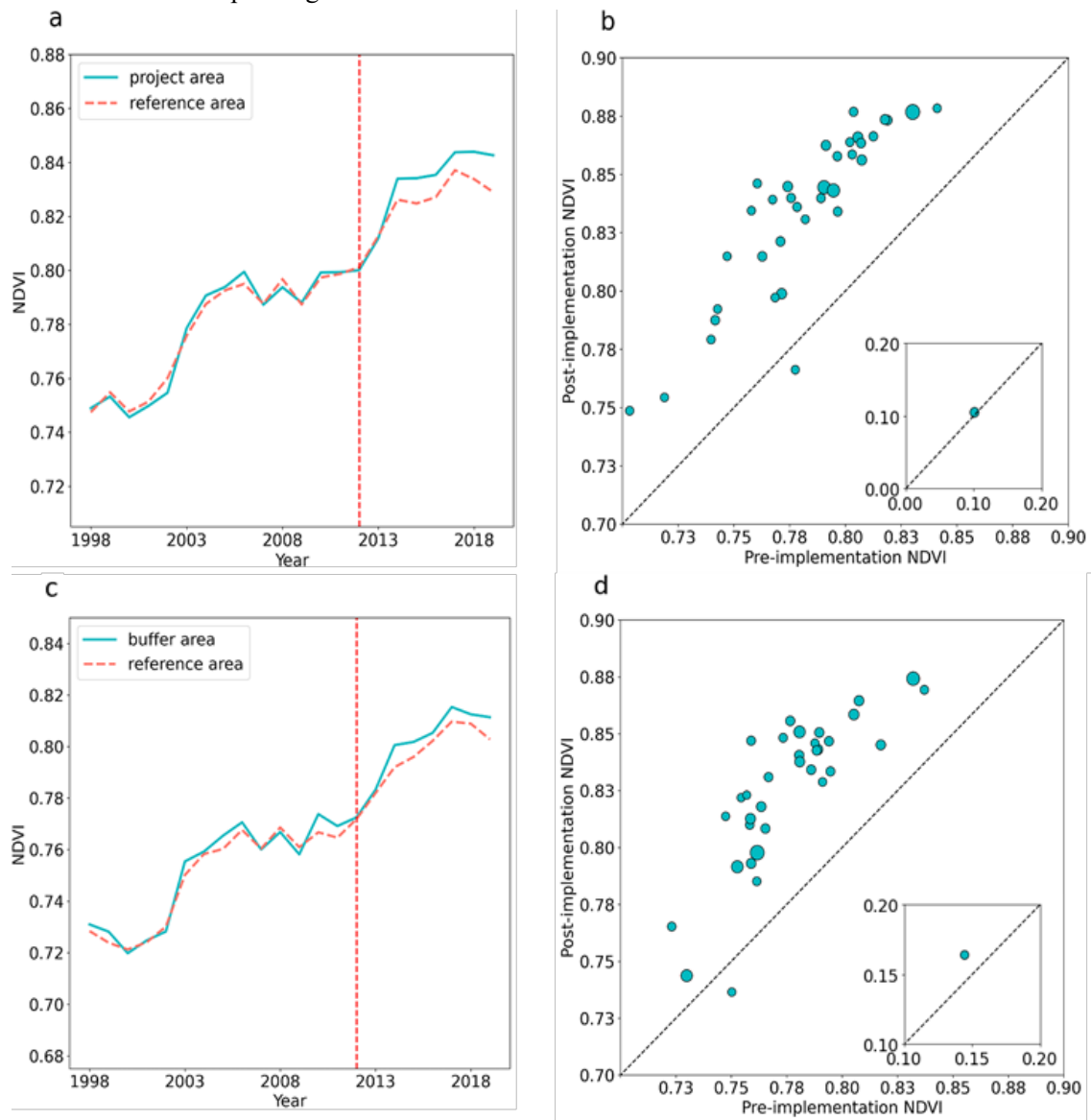
Note: This figure illustrates the 23-year NDVI trend for both the project area and surrounding buffer zones. The solid blue line represents the NDVI trend of the project area (consistent with Fig. 2a), while the dotted lines depict NDVI trends for buffer zones at various distances (0-1000m, 1000-2000m, 2000-3000m, 3000-4000m, and 4000-5000m) from the project boundaries. The vertical red dashed line marks the policy implementation year, 2012. The buffer zone trends demonstrate a spatial gradient effect, with NDVI values generally decreasing as distance from the project area increases.



Supplementary Fig.S3. Trends of kNDVI for project areas and buffer zones with the reference areas.

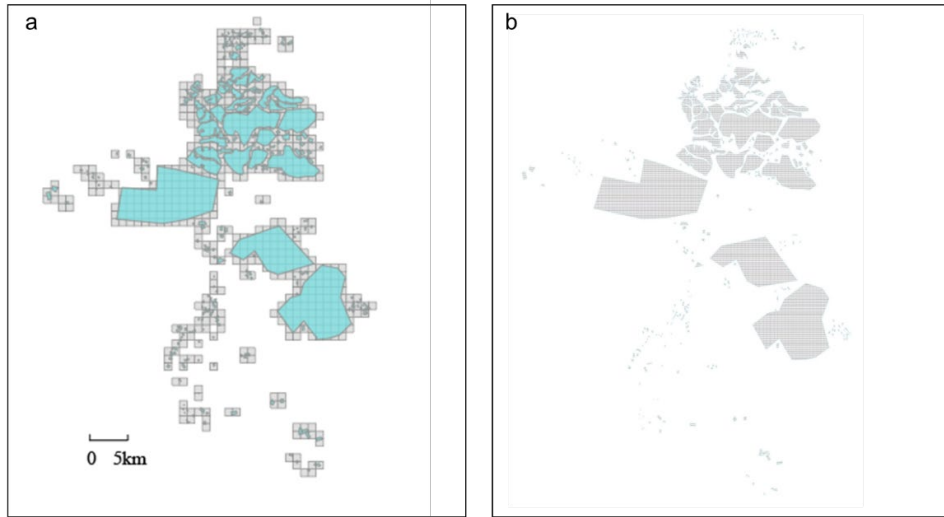
Note: Plot a presents the annual mean trends of kNDVI for project areas and the

corresponding reference area. Plot *b* presents the annual mean trends of kNDVI for 5-km buffer zones and the corresponding reference area.



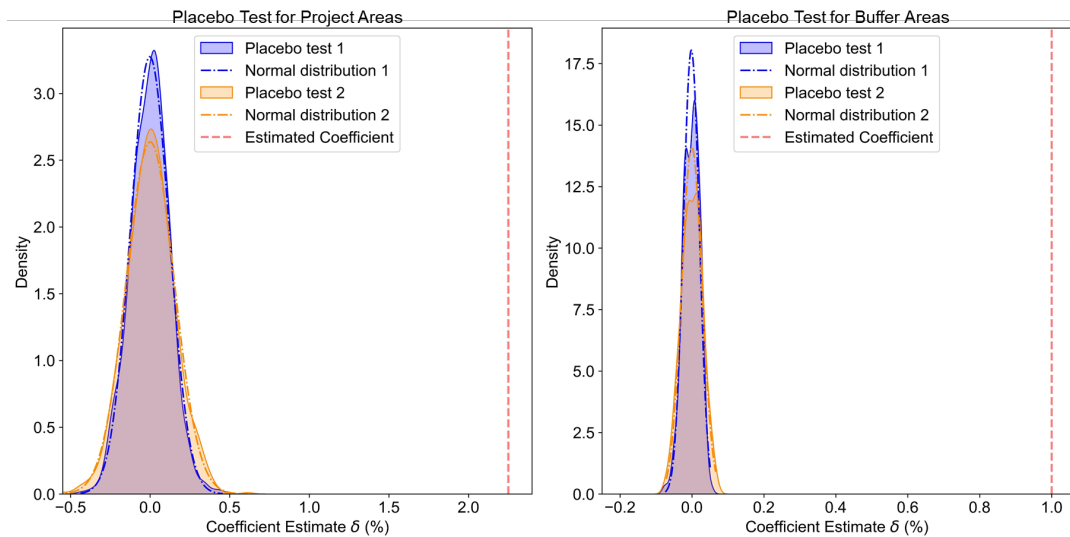
Supplementary Fig.S4. Forestry activities in project sites and buffers using 1km×1km resolution data.

Note: Plot *a* and Plot *c* illustrates the annual mean trends of NDVI for project areas and buffer zones, respectively, alongside their corresponding reference areas, and the red vertical line representing the year 2012. plots *b* and *d* offer comparative analyses of NDVI values between the pre-implementation and post-implementation periods for project areas and buffer zones, respectively.



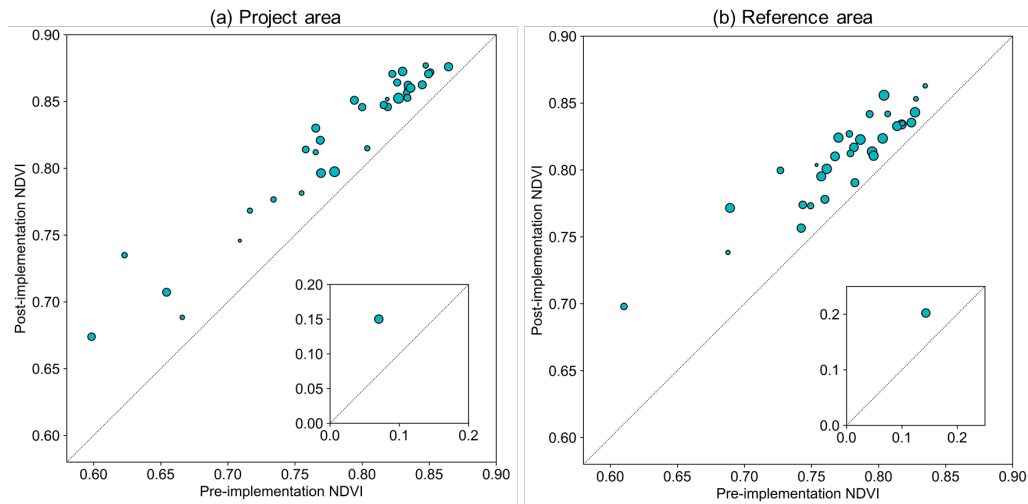
Supplementary Fig.S5. Grid of different spatial resolution overlaid on an example study site.

Note: Plot *a* demonstrates the coverage of a 1km×1km grid over the project area. The blue region delineates the actual project boundary, while the grey grid cells represent areas that intersect with the project site. The relatively coarse granularity of this grid results in the inclusion of substantial non-project areas within grid cells that overlap the project boundary. Plot *b* shows the same project area overlaid with a 30m×30m grid. The finer granularity allows for a nearly seamless integration of the grid with the project area, to the extent that the distinction between the grid and the project boundary becomes visually indiscernible, effectively eliminating the blue demarcation visible in plot *a*.

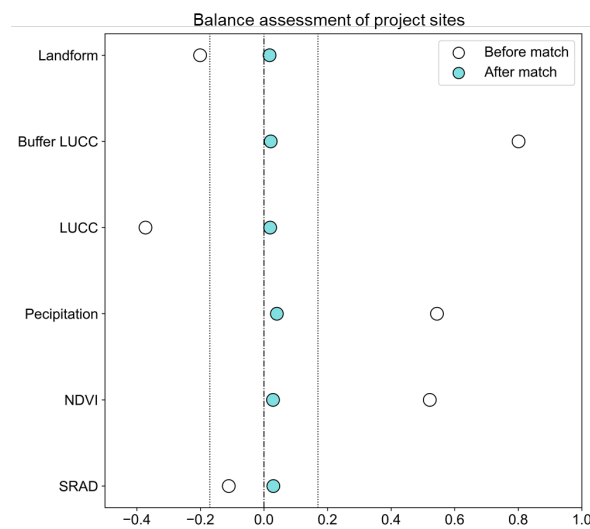


Supplementary Fig.S6. Placebo test. The left plot is the placebo test for project sites and the right plot is for the buffer zones. The solid density curves illustrate the empirical distribution of the placebo estimates of the coefficient δ , the DID estimator. The superimposed dashed lines represent the theoretical normal distribution based on the central limit theorem, serving as a reference to assess how our empirical findings deviate from the expected distribution under the null hypothesis of no effect. Placebo test 1 (purple) displays the distribution of estimators for pseudo-treatment groups,

while Placebo test 2 (orange) shows the distribution of estimators resulting from randomly assigning both treatment groups and policy intervention years. The dotted vertical lines indicate our actual DID estimators obtained from the baseline regression.



Supplementary Fig.S7. Comparison of NDVI between the pre- and post-implementation periods. Plot *a* compares NDVI in the project area, and plot *c* represents the reference area. The sizes of the circles indicate the sizes of the project areas.



Supplementary Fig.S8. Spatial matching and balance assessment of project sites. This figure compares the standardized mean difference of covariates between treated and control pixels in project sites before and after matching. The covariates include land use within and beyond the project sties (LUCC, LUCC Buffer) and landform, where the proportion of each category is considered, as well as NDVI, precipitation, and solar radiation (SRAD).

Supplementary tables

Supplementary Table S1. Baseline results of project sites and buffer zones.

	(1)	(2)	(3)	(4)	(5)	(6)
Area	Project			Buffer		
Dependent	NDVI	NDVI	kNDVI	NDVI	NDVI	kNDVI
DID	0.0225*** (113.87)	0.0225*** (300.54)	0.0425*** (305.25)	0.0091*** (21.33)	0.0091*** (32.99)	0.0160*** (32.69)
post	0.0444*** (317.75)	0.1174*** (888.02)	0.1947*** (792.75)	0.0544*** (180.75)	0.1136*** (233.63)	0.1857*** (214.99)
treat	0.0037*** (26.73)	0.0038*** (73.12)	0.0062*** (64.209)	0.00113*** (3.83)	-0.00238*** (-12.48)	0.0084*** (24.94)
Cons.	8.869 (91771)	8.8472*** (16893)	8.402*** (8643)	18.059*** (86655)	18.094*** (34069)	8.457*** (8962)
FE	No	Yes	Yes	No	Yes	Yes
Obs.	106,566,063	106,566,063	106,566,063	16,918,564	16,918,564	16,918,564
R ²	0.003	0.86	0.87	0.005	0.58	0.60

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; T-statistics in parentheses. Columns 1 and 2 display pooled regression outcomes for project sites taking NDVI as the dependent variable, with and without two-way fixed effects, respectively. Column 3 presents results for project sites using kNDVI as the dependent variable, incorporating two-way fixed effects. Columns 4 and 5 display the pooled regression results of the associated 5-km buffer zones of the project sites, using NDVI as the dependent variable, without and with two-way fixed effects, respectively. Column 6 presents results for project sites using kNDVI as the dependent variable, incorporating two-way fixed effects. The substantial fluctuation in R^2 indicates that, captured by the fixed effect, time trends and individual characteristics have significant explanatory power and should not be omitted.

Supplementary Table S2. Baseline results of individual project sites.

Project ID	Dependent Variable: ln (NDVI)				Dependent Variable: ln (kNDVI)				Obs.
	DID (%)	R ²	T-statistic	Standard error	DID (%)	R ²	T-statistic	Standard error	
1	-1.538	0.129	-51.703	0.000	-2.265	0.120	-44.91	0.001	3,100,584
2	-1.165	0.007	-43.656	0.000	-1.917	0.006	-39.071	0.000	16,733,559
3	-0.652	0.118	-34.644	0.000	-0.961	0.099	-30.892	0.000	2,808,484
4	-0.437	0.091	-53.979	0.000	-0.648	0.081	-48.839	0.000	20,227,764
5	-0.15	0.035	-0.495	0.003	0.436	0.034	0.768	0.006	269,107
6	-0.117	0.102	-7.509	0.000	-0.209	0.088	-8.4	0.000	2,876,334
7	0.051	0.059	4.398	0.000	0.096	0.047	5.017	0.000	6,966,194
8	0.159	0.055	2.24	0.001	0.114	0.052	0.877	0.001	2,703,639
9	0.182	0.161	9.672	0.000	0.289	0.142	9.75	0.000	1,187,766
10	0.365	0.061	19.814	0.000	0.652	0.05	20.585	0.000	3,602,076
11	0.474	0.027	16.374	0.000	0.607	0.018	12.025	0.001	1,969,214
12	0.698	0.098	69.753	0.000	1.278	0.085	80.448	0.000	5,018,876
13	0.76	0.019	21.491	0.000	1.287	0.015	20.075	0.001	5,923,690
14	1.025	0.086	14.632	0.001	1.69	0.071	13.843	0.001	394,496
15	1.168	0.086	47.193	0.000	1.99	0.071	47.591	0.000	1,570,670
16	1.351	0.029	12.057	0.001	2.411	0.021	11.664	0.002	459,084
17	1.547	0.129	66.724	0.000	2.503	0.110	66.129	0.000	1,404,702
18	1.637	0.125	41.08	0.000	2.721	0.112	40.655	0.001	1,110,255
19	1.933	0.053	105.922	0.000	3.452	0.047	112.973	0.000	3,097,548
20	2.121	0.139	188.258	0.000	3.22	0.123	182.622	0.000	4,849,412
21	2.203	0.089	66.626	0.000	3.601	0.073	62.931	0.001	1,758,932
22	2.214	0.087	52.09	0.000	3.549	0.080	51.581	0.001	407,514
23	2.221	0.05	85.413	0.000	3.59	0.041	82.577	0.000	1,395,824
24	2.403	0.078	70.992	0.000	3.966	0.064	71.163	0.001	1,363,575
25	2.64	0.184	113.274	0.000	4.188	0.179	116.332	0.000	802,838
26	3.189	0.173	21.801	0.001	5.126	0.172	20.441	0.003	184,966
27	3.383	0.211	32.335	0.001	5.838	0.209	32.912	0.002	140,346
28	3.421	0.073	25.245	0.001	6.364	0.065	26.082	0.002	390,264
29	4.284	0.137	88.239	0.000	6.618	0.128	83.22	0.001	451,582
30	4.924	0.097	178.549	0.000	8.386	0.080	175.594	0.000	3,134,612
31	5.135	0.182	68.307	0.001	9.696	0.166	69.937	0.001	2,122,163
32	8.438	0.238	43.908	0.002	15.32	0.233	44.307	0.003	77,096
33	8.962	0.111	333.34	0.000	13.906	0.090	297.598	0.000	2,883,302
34	9.153	0.073	73.547	0.001	15.516	0.069	69.456	0.002	301,070
35	9.785	0.224	100.959	0.001	17.903	0.220	102.448	0.002	488,474
36	37.051	0.417	449.436	0.001	72.997	0.414	450.493	0.002	4,390,051

Note: Columns 2 to 5 present the baseline regression results for 36 sample projects, with the NDVI as the dependent variable. Columns 6 to 9 replace the dependent variable with the kNDVI. "Obs." denotes the number of project observations.

Supplementary Table S3. Baseline results of individual buffer zones.

Buffer ID	Dependent Variable: ln (NDVI)				Dependent Variable: ln (kNDVI)				Obs.
	DID (%)	R ²	T-statistic	Standard error	DID (%)	R ²	T-statistic	Standard error	
1	-2.273	0.077	-506.29	0.000	-3.597	0.069	-455.01	0.000	264,311,939
2	-2.497	0.013	-298.49	0.000	-4.035	0.009	-264.34	0.000	97,484,591
3	-2.866	0.193	-123.05	0.000	-4.751	0.171	-122.59	0.000	2,760,828
4	-4.414	0.218	-94.832	0.000	-8.171	0.204	-99.069	0.001	1,919,074
5	1.827	0.06	23.433	0.001	3.946	0.059	26.827	0.001	8,093,233
6	0.17	0.075	10.117	0.000	0.034	0.06	1.197	0.000	4,782,252
7	0.706	0.028	30.67	0.000	1.069	0.021	27.49	0.000	3,068,840
8	-4.053	0.128	-79.445	0.001	-7.712	0.125	-83.894	0.001	2,628,256
9	-1.475	0.023	-183.72	0.000	-2.352	0.017	-166.45	0.000	52,050,327
10	0.3	0.013	35.422	0.000	0.615	0.01	41.869	0.000	39,988,487
11	0.085	0.011	12.966	0.000	-0.137	0.008	-11.98	0.000	87,891,951
12	-1.096	0.031	-150.10	0.000	-1.637	0.024	-129.10	0.000	48,986,638
13	22.335	0.027	210.522	0.001	40.946	0.029	213.325	0.002	7,477,097
14	-0.004	0.052	-0.584	0.000	-0.009	0.043	-0.713	0.000	35,544,924
15	-0.963	0.008	-116.82	0.000	-1.484	0.006	-101.82	0.000	62,967,859
16	0.606	0.024	58.289	0.000	1.041	0.019	55.702	0.000	53,476,844
17	0.878	0.025	99.967	0.000	1.654	0.019	103.094	0.000	103,770,936
18	0.566	0.09	85.104	0.000	0.738	0.078	64.343	0.000	64,086,835
19	-1.118	0.026	-199.48	0.000	-1.784	0.02	-181.78	0.000	82,321,044
20	2.172	0.028	180.971	0.000	3.671	0.022	170.478	0.000	43,367,687
21	-5.575	0.011	-24.539	0.002	-14.207	0.011	-34.494	0.004	3,262,607
22	0.233	0.032	12.809	0.000	0.458	0.025	13.86	0.000	21,180,308
23	-0.152	0.032	-7.571	0.000	-0.176	0.025	-5.165	0.000	3,734,644
24	1.33	0.018	34.784	0.000	1.833	0.015	30.697	0.001	7,474,185
25	-0.055	0.007	-3.367	0.000	-0.471	0.006	-16.222	0.000	21,987,229
26	1.217	0.105	52.224	0.000	2.181	0.095	52.959	0.000	8,271,775
27	1.053	0.036	49.92	0.000	1.403	0.03	36.892	0.000	15,176,747
28	1.511	0.026	171.561	0.000	2.775	0.022	175.438	0.000	80,234,672
29	1.476	0.124	53.387	0.000	2.636	0.12	57.542	0.000	1,491,868
30	1.144	0.109	89.546	0.000	1.628	0.091	75.082	0.000	9,954,400
31	21.631	0.358	421.268	0.001	40.021	0.346	429.85	0.001	2,407,179
32	-3.024	0.068	-140.88	0.000	-4.83	0.06	-129.55	0.000	6,194,130
33	4.152	0.077	873.534	0.000	6.603	0.055	774.337	0.000	139,011,318
34	1.658	0.006	86.736	0.000	3.238	0.005	92.04	0.000	28,420,486
35	3.332	0.114	289.154	0.000	5.849	0.109	284.562	0.000	50,128,178
36	-2.295	0.082	-38.43	0.001	-4.546	0.081	-38.89	0.001	29,896,197

Note: Columns 2 to 5 present the baseline regression results for the buffer zones of 36 sample projects, with the NDVI as the dependent variable. Columns 6 to 9 replace the dependent variable with the kNDVI. “Obs.” denotes the number of project observations.

Supplementary Table S4. T test of individual project sites.

Project ID	Before	After	Diff1	T-Test	Treat	Control	Diff2	T-Test
1	0.769	0.821	0.052	330.98	0.794	0.802	-0.008	-72.29
2	0.780	0.797	0.018	188.09	0.788	0.788	0.000	0.62
3	0.850	0.871	0.021	239.40	0.860	0.830	0.030	417.88
4	0.827	0.852	0.025	610.49	0.839	0.828	0.012	374.00
5	0.666	0.688	0.022	21.67	0.677	0.660	0.017	23.01
6	0.834	0.862	0.028	312.68	0.848	0.847	0.001	14.41
7	0.835	0.860	0.025	409.83	0.847	0.845	0.001	32.52
8	0.654	0.707	0.053	189.04	0.680	0.633	0.046	228.58
9	0.851	0.872	0.021	230.23	0.861	0.834	0.027	350.36
10	0.864	0.876	0.012	239.41	0.870	0.847	0.023	358.27
11	0.819	0.846	0.027	182.64	0.832	0.827	0.005	48.71
12	0.836	0.860	0.024	529.84	0.848	0.841	0.006	159.32
13	0.769	0.796	0.026	183.79	0.782	0.777	0.005	48.19
14	0.765	0.812	0.047	133.54	0.788	0.783	0.005	20.33
15	0.816	0.847	0.031	298.50	0.831	0.815	0.016	173.56
16	0.734	0.776	0.043	102.33	0.754	0.766	-0.012	-39.33
17	0.826	0.864	0.038	345.19	0.844	0.824	0.021	225.73
18	0.758	0.814	0.056	250.56	0.785	0.786	-0.001	-9.49
19	0.845	0.863	0.018	240.53	0.853	0.839	0.014	217.32
20	0.830	0.872	0.042	635.50	0.850	0.852	-0.002	-38.75
21	0.800	0.846	0.046	287.49	0.822	0.835	-0.013	-108.96
22	0.804	0.815	0.011	52.17	0.809	0.804	0.005	29.22
23	0.834	0.853	0.019	160.78	0.843	0.825	0.018	191.89
24	0.823	0.871	0.048	317.90	0.846	0.860	-0.014	-110.57
25	0.833	0.857	0.023	219.40	0.844	0.823	0.021	212.78
26	0.819	0.852	0.033	92.05	0.835	0.742	0.092	181.51
27	0.709	0.746	0.037	67.69	0.727	0.754	-0.028	-67.71
28	0.716	0.768	0.052	83.21	0.741	0.799	-0.058	-141.13
29	0.847	0.877	0.030	126.74	0.862	0.860	0.001	5.53
30	0.766	0.830	0.065	556.74	0.796	0.799	-0.003	-31.51
31	0.598	0.674	0.075	254.51	0.635	0.769	-0.134	-665.01
32	0.709	0.736	0.027	38.25	0.722	0.687	0.035	51.98
33	0.794	0.851	0.057	486.18	0.821	0.836	-0.014	-152.61
34	0.755	0.781	0.026	56.03	0.768	0.731	0.036	93.35
35	0.623	0.735	0.112	254.92	0.677	0.679	-0.003	-7.66
36	0.070	0.150	0.080	746.53	0.109	0.076	0.032	474.70

Note: “Before” refers to the average NDVI values in the pre-implementation phase. “After” denotes the average NDVI values for the years from 2012 to 2022, indicating the post-implementation phase. “Mean” signifies the overall average NDVI values across all projects. “Control” represents the average NDVI values for the control group.

Supplementary Table S5. T test of individual buffer zones.

Buffer ID	Before	After	Diff1	T-Test	Treat	Control	Diff2	T-Test
1	0.757	0.806	0.049	2305.88	0.781	0.772	0.008	552.23
2	0.795	0.814	0.018	559.98	0.804	0.797	0.007	312.10
3	0.835	0.863	0.028	269.60	0.848	0.792	0.056	634.08
4	0.754	0.804	0.050	249.06	0.778	0.697	0.081	506.22
5	0.541	0.581	0.040	157.74	0.560	0.677	-0.117	-716.50
6	0.807	0.842	0.035	389.08	0.824	0.818	0.006	95.71
7	0.828	0.853	0.025	220.22	0.840	0.836	0.004	50.97
8	0.688	0.738	0.051	241.89	0.712	0.653	0.059	362.05
9	0.817	0.834	0.017	474.87	0.825	0.802	0.024	927.18
10	0.825	0.835	0.011	265.05	0.830	0.829	0.000	9.43
11	0.803	0.824	0.021	687.07	0.813	0.808	0.005	234.73
12	0.814	0.833	0.019	587.60	0.823	0.803	0.020	826.33
13	0.545	0.576	0.031	98.22	0.560	0.579	-0.019	-94.86
14	0.782	0.817	0.035	941.42	0.799	0.796	0.003	108.48
15	0.796	0.811	0.014	392.85	0.803	0.794	0.010	368.96
16	0.757	0.795	0.038	853.75	0.775	0.784	-0.009	-275.08
17	0.786	0.823	0.036	1038.67	0.804	0.769	0.035	1424.40
18	0.770	0.824	0.054	1666.31	0.796	0.774	0.022	948.68
19	0.827	0.843	0.016	645.31	0.835	0.814	0.021	1133.36
20	0.768	0.810	0.043	807.47	0.788	0.811	-0.023	-646.13
21	0.433	0.450	0.016	37.35	0.441	0.497	-0.056	-189.85
22	0.760	0.778	0.018	233.77	0.769	0.811	-0.042	-812.42
23	0.818	0.835	0.017	166.44	0.826	0.836	-0.010	-140.30
24	0.778	0.827	0.049	349.20	0.802	0.849	-0.048	-246.12
25	0.782	0.790	0.008	108.17	0.786	0.789	-0.003	-52.72
26	0.779	0.812	0.033	392.23	0.795	0.732	0.063	836.36
27	0.744	0.774	0.030	353.03	0.758	0.783	-0.025	-418.94
28	0.761	0.801	0.039	1057.73	0.780	0.783	-0.003	-105.50
29	0.876	0.886	0.010	78.47	0.881	0.884	-0.003	-30.00
30	0.793	0.842	0.048	745.75	0.817	0.811	0.006	122.74
31	0.573	0.743	0.171	746.97	0.654	0.760	-0.106	-585.45
32	0.749	0.773	0.024	222.74	0.761	0.780	-0.019	-263.55
33	0.804	0.856	0.052	2717.74	0.829	0.868	-0.040	-2835.1
34	0.742	0.757	0.014	193.84	0.749	0.748	0.001	13.90
35	0.689	0.772	0.082	1513.24	0.729	0.709	0.020	523.21
36	0.141	0.200	0.058	649.93	0.169	0.165	0.004	62.174

Note: “Before” refers to the average NDVI values in the pre-implementation phase. “After” denotes the average NDVI values for the years from 2012 to 2022 indicating the post-implementation phase. “Mean” signifies the overall average NDVI values across all projects. “Control” represents the average NDVI values for the control group.

Supplementary Table S6. Robustness check.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1:3 nearest	1:5 nearest	Aggregate project	Aggregate buffer	Size adjusted	2007-2017	2009-2015
DID	0.0219*** (291.23)	0.0219** (289.92)	0.0296*** (4.14)	0.0055*** (3.06)	0.0020*** (17.21)	0.0119*** (30.35)	0.0144*** (29.10)
Obs.	106,578,240	106,582,930	1,656	1,656	54,159,106	8,088,606	5,148,618
R ²	0.86	0.86	0.96	0.96	0.67	0.58	0.58

	(8)	(9)	(10)	(11)	(12)	(13)
	1km 1:1	1km 1:1-3	Spatial SE	Staggered did	Forest_City=1	Forest_City=0
DID	0.0044*** (1.98)	0.006*** (3.25)	0.0091*** (2.84)	0.0032*** (14.39)	0.0010*** (2.66)	0.0220*** (84.55)
Obs.	9,504	19,008	16,918,564	12,495,452	11,660,730	4,772,367
R ²	0.96	0.97	0.58		0.59	0.28

	(14)	(15)	(16)	(17)	(18)
	National_Park=1	National_Park=0	Reserve_Forest=2	Reserve_Forest=1	Reserve_Forest=0
DID	0.0099*** (44.12)	0.0054*** (11.83)	0.0035*** (9.11)	0.0138*** (25.50)	0.0073*** (10.49)
Obs.	6,599,342	9,833,755	9,318,591	4,773,692	2,340,814
R ²	0.20	0.60	0.28	0.78	0.23

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; T-statistics are reported in parentheses (except for column 11). All columns include two-way fixed effects. Columns 1 and 2 show the results using different pixel matching outcomes, specifically the third and fifth nearest neighbors, respectively. Columns 3 and 4 display the aggregated project-level outcomes, where treatment and control pixels are aggregated for both project sites and buffer zones. Column 5 presents the results of an alternative grid processing approach that adjusts the number of observations for each buffer zone based on its size. Column 6 and 7 present the results of using study period of 2007-2017 and 2009-2015, respectively. Columns 8 and 9 utilize lower resolution (1km×1km) NDVI data, with column 8 using nearest neighbor matching and column 9 employing the top three nearest neighbors matching. Column 10 incorporates spatially robust standard errors to account for potential spatial autocorrelation. Column 11 replaces the intervention year with the application submission year for each project, following the staggered difference-in-differences framework proposed by Callaway and Sant'Anna (2021)¹. For column 11, ATT is reported with the z-values in the parentheses.

To examine whether our analysis results were influenced by other forest restoration projects or local environmental and ecological initiatives, we conducted robustness checks using representative projects. First, we considered the “National Forest City” program², initiated in 2004, which has awarded this title to 219 cities to date. We categorized our study projects into two groups: those located in counties designated as National Forest Cities and those in non-designated counties. The corresponding outcomes of baseline regression are presented in columns 12 and 13. Second, we considered the National Forest Parks³, established continuously since 2006, with China now hosting nearly 900 such parks. We divided our study projects into two groups: those in counties with

National Forest Parks and those without. The corresponding outcomes of baseline regression are shown in columns 14 and 15. Lastly, we considered the National Reserve Forest Project⁴, which designates areas as key construction zones and moderate construction zones based on natural conditions and other factors. According to the list of counties within the project's scope, we categorized our study projects into three groups: those in counties designated as key construction areas, those in moderate implementation areas, and those beyond the project's construction scope. The results are presented in columns 16-18. Notably, across all three policy-based groupings, the estimated effects remained significantly positive. This consistency indicates that our primary findings are robust to the presence of these forest restoration and environmental programs, mitigating concerns about potential confounding influences from these related initiatives to some extent.

Supplementary Table S7. Land use change

	(1) Forest	(2) Cultivated	(3) Grass	(4) Water	(5) Resident	(6) Unused
DID	0.005*** (6.41)	0.002*** (3.34)	0.005*** (8.70)	0.001*** (2.91)	-0.010*** (-34.47)	-0.003*** (-18.52)
post	-0.002*** (-2.72)	-0.014*** (-20.78)	-0.007*** (-13.22)	0.004*** (12.34)	0.019*** (75.78)	-0.001 (-5.46)
treat	-0.027*** (-56.41)	-0.004*** (8.44)	0.023*** (64.10)	-0.001*** (-5.79)	0.000 (1.44)	0.001 (11.68)
Cons.	0.441*** (371.30)	0.077*** (68.93)	0.468*** (530.5)	0.019*** (39.41)	-0.005*** (-11.13)	-0.000 (-0.49)
Obs.	3,689,625					
R ²	0.261	0.153	0.217	0.261	0.119	0.495

Note: *p < 0.10, **p < 0.05, ***p < 0.01; T-statistics in parentheses. Columns 1-6 presents the land use change of all projects for the forest land, farmland, grassland, water area, residential area, and unused land, respectively.

Supplementary Table S8. Project-level sample sizes.

Project ID	Project size	5-km buffer size	Control pool
1	67,404	5,745,913	7,714,004
2	363,900	2,119,508	6,196,655
3	61,054	1,921,103	9,863,194
4	439,734	2,506,444	6,451,283
5	5,864	179,469	5,964,796
6	64,603	3,327,156	8,154,565
7	151,439	2,135,344	6,102,731
8	58,780	3,430,284	6,451,283
9	25,821	1,131,532	4,038,793
10	78,306	869,315	3,573,048
11	42,809	1,910,698	4,622,267
12	109,106	1,064,928	2,366,509
13	128,864	5,612,265	14,439,939
14	8,576	772,716	5,728,102
15	34,145	1,368,873	4,038,793
16	9,981	1,162,629	7,261,515
17	32,638	2,255,939	2,777,441
18	24,810	1,410,789	6,542,067
19	67,338	1,789,599	2,366,509
20	105,422	942,786	5,570,416
21	36,960	2,290,075	17,109,096
22	8,859	460,450	6,196,655
23	30,344	2,598,543	7,503,247
24	91,021	5,202,382	10,315,414
25	17,453	477,984	3,602,251
26	4,021	179,828	5,213,675
27	4,166	329,955	7,542,131
28	8,500	1,744,232	1,956,386
29	9,817	1,038,165	30,784,970
30	68,144	6,925,761	20,940,090
31	46,142	1,674,901	21,599,203
32	1,676	134,655	4,745,923
33	62,681	3,052,663	9,838,569
34	6,545	617,846	4,608,943
35	20,373	1,089,743	1,957,359
36	95,436	654,070	76,168,318
Total	2,392,732	70,128,543	350,306,140

Supplementary Table S9. The outcomes of matching.

	Group	Treat Mean	Control Mean	%bias	reduction %bias	T-statistic	P-value
Panel A: County-level matching							
GDP	Unmatched	13.253	13.367	-0.855	177.409	-0.847	0.401
	Matched	13.253	13.166	0.662		0.513	0.609
Per_GDP	Unmatched	9.570	9.692	-1.259	173.022	-1.147	0.257
	Matched	9.570	9.483	0.919		0.641	0.523
revenue	Unmatched	10.014	10.121	-1.056	140.704	-0.615	0.541
	Matched	10.014	9.971	0.430		0.194	0.846
1st Ind.	Unmatched	0.281	0.235	19.712	90.891	2.627	0.011
	Matched	0.281	0.276	1.796		0.232	0.817
2nd Ind.	Unmatched	0.349	0.427	-18.292	62.475	-4.686	0.000
	Matched	0.349	0.375	-6.864		-1.282	0.203
Forest	Unmatched	0.524	0.390	34.522	109.703	3.168	0.003
	Matched	0.524	0.542	-3.350		-0.361	0.719
Panel B: Pixel-level matching in project areas							
Solar radiation	Unmatched	4974.945	5209.49	-4.502	158.819	-1.696	0.090
	Matched	4974.945	4846.597	2.648	158.819	0.625	0.534
Precipitation	Unmatched	1083.239	774.148	39.927	94.842	3.805	0.000
	Matched	1083.239	1061.381	2.059	94.842	0.119	0.905
NDVI	Unmatched	0.7871	0.6174	27.502	97.774	2.995	0.003
	Matched	0.7871	0.7824	0.612	97.774	0.160	0.873
Forest land	Unmatched	0.714	0.381	87.402	93.389	1.682	0.102
	Matched	0.714	0.675	5.778	93.389	0.199	0.844
Grassland	Unmatched	0.103	0.148	-30.405	100	-1.742	0.090
	Matched	0.103	0.103	0.000	100	-0.006	0.995
Residential area	Unmatched	0.024	0.039	-38.462	100	-0.919	0.365
	Matched	0.024	0.024	0.000	100	0.077	0.939
Unused land	Unmatched	0.008	0.021	-61.905	67.692	-2.556	0.015
	Matched	0.008	0.010	-20	67.692	-0.342	0.735
Water area	Unmatched	0.042	0.161	-73.913	110.407	-3.429	0.002
	Matched	0.042	0.039	7.692	110.407	0.093	0.927
Plain	Unmatched	0.056	0.147	-61.905	59.077	-2.139	0.039
	Matched	0.056	0.075	-25.333	59.077	-0.442	0.661
Hill	Unmatched	0.147	0.203	-27.586	213.281	-1.030	0.310
	Matched	0.147	0.112	31.25	213.281	0.656	0.516
Gently undulating mountain	Unmatched	0.226	0.112	101.786	20.618	1.492	0.145
	Matched	0.226	0.125	80.8	20.618	1.322	0.195
Moderately undulating mountain	Unmatched	0.336	0.156	115.385	79.608	2.054	0.048
	Matched	0.336	0.272	23.529	79.608	0.733	0.468

Panel C: Pixel-level matching in buffer zones							
Solar radiation	Unmatched	4904.686	5209.49	-5.851	124.352	-1.684	0.092
	Matched	4904.686	4835.786	1.425	124.352	0.558	0.578
Precipitation	Unmatched	1054.009	774.148	36.151	97.014	3.785	0
	Matched	1054.009	1042.754	1.079	97.014	0.059	0.953
NDVI	Unmatched	7818.671	6173.657	26.646	98.547	2.513	0.012
	Matched	7818.671	7788.516	0.387	98.547	-0.064	0.95
Forest land	Unmatched	0.661	0.381	73.491	103.216	1.968	0.057
	Matched	0.661	0.677	-2.363	103.216	-0.116	0.908
Grassland	Unmatched	0.143	0.148	-3.378	298.806	-0.104	0.917
	Matched	0.143	0.134	6.716	298.806	0.188	0.852
Water area	Unmatched	0.014	0.039	-64.103	112	-5.391	0
	Matched	0.014	0.013	7.692	112	0.655	0.517
Residential area	Unmatched	0.014	0.021	-33.333	100	-2.165	0.037
	Matched	0.014	0.014	0	100	-0.013	0.99
Unused land	Unmatched	0.012	0.161	-92.547	109.823	-14.15	0
	Matched	0.012	0.011	9.091	109.823	0.078	0.938
Plain	Unmatched	0.053	0.147	-63.946	123.797	-6.997	0
	Matched	0.053	0.046	15.217	123.797	0.521	0.606
Hill	Unmatched	0.121	0.203	-40.394	137.724	-2.277	0.029
	Matched	0.121	0.105	15.238	137.724	0.458	0.65
Gently undulating mountain	Unmatched	0.212	0.112	89.286	61.722	1.504	0.142
	Matched	0.212	0.158	34.177	61.722	0.812	0.422
Moderately undulating mountain	Unmatched	0.277	0.156	77.564	96.657	1.534	0.134
	Matched	0.277	0.27	2.593	96.657	0.09	0.929

Note: The 'Reduction |%Bias|' column in our statistical table plays a critical role in assessing the effectiveness of our matching methodology. This column quantifies the change in percentage bias before and after matching, offering a clear measure of improvement in the balance between the treatment and control groups.

Supplementary information of forest offset projects from CCER programs

Supplementary Table S10. Information flowing between project (projects in the same city)

Repeated city	Project name	Research sample	Public Comment Start Date
Beijing City	Beijing Fangshan District Abandoned Mine Ecological Restoration	YES	2015-01-28
	Beijing Fangshan District Plain Carbon Sink Afforestation Project	NO	2015-01-26
	Fangshan District Shilou Carbon Sink Afforestation Project	NO	2015-04-27
Chengde City	Carbon sequestration project in Fengning State Forest Farm	YES	2016-12-02
	Saihanba Forest Management Carbon Sequestration Project	YES	2015-08-12
	Saihanba Jixielin Carbon Sink Afforestation Project	YES	2015-08-12
	Feng Ning Qiansong Dam Forest Carbon Sinks Afforestation Project Phase I	NO	2014-12-12
Yunfu City	Guangdong Yunan Carbon Sequestration Afforestation Project	YES	2016-12-30
Yunfu City, Zhaoqing City	Guangdong Xijiang Forestry Carbon Sequestration Afforestation Project	YES	2016-04-07
Meizhou City	Guangdong Changlong Carbon Sink Afforestation Project	YES	2013-12-16
	Dabu Carbon Sink Afforestation Project	NO	2015-04-16
	Fengshun Carbon Sink Afforestation Project	NO	2016-04-14
	Fengxi Modern Forestry Development Co., Ltd. Carbon Sequestration Afforestation Project	NO	2016-06-04
Daxing'anling Area	Heilongjiang Province Forestry Bureau Daxingan Mountains Shibazhan Carbon Sink Afforestation Project	YES	2016-01-29
	Xilinji Carbon Sequestration Afforestation Project	YES	2017-01-14
	Heilongjiang Tuqiang Forestry Carbon Sequestration Afforestation Project	NO	2015-03-26
Xianning City	Hubei Tongshan Bamboo Forest Carbon Sink Project	YES	2016-12-20
	Hubei Tongshan Bamboo Carbon Sink Afforestation Project	YES	2015-06-19
	Hubei Tongshan Carbon Sequestration Afforestation Project	NO	2016-10-31
	Hubei Jiayu Carbon Sequestration Afforestation Project	NO	2017-02-07
	Hubei Chongyang Ecology and Afforestation Project	NO	2017-03-15
Jingzhou City, Tianmen City, Xiantao City, Xianning City,	Hubei Changxing Carbon Sequestration Afforestation Project	YES	2016-09-14
Pingxiang City	Jiangxi Pingxiang Lianhua County Carbon Sequestration Afforestation Project of Gaotianyan Ecological Forest Farm	YES	2016-12-30
	Jiangxi Pingxiang Lianhua County Carbon Sequestration Afforestation Project	YES	2016-11-21
Puer City	Yunnan Jinggu Longevity Forest Carbon Sink Afforestation Project	YES	2016-06-04
	Yunnan Yunjin Forestry Development Co., Ltd. Carbon Sequestration Afforestation Project	NO	2015-07-22
	Yunnan Pu'er Kemao Forestation Co., Ltd. Carbon Sequestration Afforestation Project	NO	2016-01-14
Lishui City	Zhejiang Jingning She Nationality Autonomous County Bamboo Forest Management Carbon Project	YES	2016-11-14
	Zhejiang Suichang Bamboo Forest Project	YES	2016-11-14

Repeated city	Project name	Research sample	Public Comment Start Date
Xing'an League	Inner Mongolia Horqin Right Wing Front Banner Reforestation of Degraded Land Carbon Sink Project	YES	2015-06-05
	Inner Mongolia Zhalaite Carbon Sink Afforestation Project	NO	2016-03-07
Sanming City	Fujian Ninghua Futan Carbon Afforestation Project	YES	2016-12-02
	Jinsen Forest Co., Ltd. Forest Management Carbon Sequestration Project	NO	2016-06-04
Hulunbuir City	Inner Mongolia HongHua ErJi Degraded Land Carbon Sink Afforestation Project	NO	2015-07-14
	Daxinganling Songling Forestry Carbon Sequestration Afforestation Project	NO	2016-04-28
	China Inner Mongolia Forest Industry Group Co., Ltd. Root River Forest Industry Carbon Sequestration Afforestation Project	NO	2014-12-19
	Inner Mongolia Yi River Forest Management Carbon Sequestration Project	NO	2015-10-27
	Inner Mongolia Wuerqi Forest Management Carbon Sequestration Project	NO	2015-10-27
	Mangui Carbon Sink Afforestation Project	NO	2015-12-18
	Inner Mongolia Jinhe Forest Industry co., Ltd. Carbon Sequestration Project	NO	2016-11-08
Yichun City	Heilongjiang Green Crest Forest Carbon Sequestration Project	NO	2015-02-04
	Heilongjiang Hongxing Forestry Bureau Forest Management Carbon Sequestration Project	NO	2016-06-24
Jilin City	Jilin Hongshi Forest Management Carbon Project	NO	2015-05-15
	Jilin Baishishan Bureau Forest Management Carbon Sequestration Project	NO	2015-06-11
Yanbian Korean Autonomous Prefecture	Jilin Helong Forest Management Carbon Sequestration Project	NO	2015-06-18
	Changbai Mountain Forest Industry Group Co., Ltd. Wang Qinglin Branch Carbon Sequestration Project in Forest Management	NO	2015-12-30
	Dunhua Forestry Bureau Forest Management Carbon Sequestration Project	NO	2016-04-28
	Changbai Mountain Forest Industry Group Co., Ltd. Tianqiaoling Forestry Carbon Sequestration Project in Forest Management	NO	2016-06-16
	Changbai Mountain Forest Industry Group Antu Forest Management Project	NO	2016-08-09
Baishan City	Jilin Quanyang Forestry Bureau Forest Management Carbon Sequestration Project	NO	2015-07-22
	Jilin Quanyang Forestry Bureau Forest Management Project	NO	2015-11-05
	Jilin Sanchazi Forest Management Bureau Carbon Sequestration Project	NO	2015-12-02
	Jilin Songjianghe Forest Management Carbon Sink Project	NO	2016-03-07
	Jilin Wangou Forestry Bureau Forest Management Carbon Sequestration Project	NO	2016-04-29
	Jilin Lushuihe Forest Management Bureau Carbon Sequestration Project	NO	2016-05-30
	Jilin Changbai Forest Management Bureau of Forestry Management Carbon Sequestration Project	NO	2016-04-14
Ganzhou City	Jiangxi Huichang Salt Sequestration Afforestation Project	NO	2016-06-04
	Jiangxi Anyuan Carbon Sink Afforestation Project	NO	2016-07-06
Ordos City	Yili Resources Group Inner Mongolia Kubuqi Desert Afforestation Project	NO	2015-06-30
	Yitai Group Hangjinqi Carbon Sequestration Project	NO	2016-11-18

Note: the projects in bold are those with positive spillover estimations.

Supplementary Table S11. Basic information of sample projects

Province	City	County	Name	Size (hectare)	Public Comment Start Date
Sichuan	Liangshan Yi autonomous region	Mianning County, Jinyang County	Audi Panda Habitat Restoration Multiple Benefits of Forest Carbon Sink Afforestation Project	335.17	2015-09-29
Beijing	Fangshan	Fangshan District	Beijing Fangshan District Abandoned Mine Ecological Restoration	595.70	2015-01-28
Hebei	Chengde	Fengning Manchu Autonomous County	Carbon Sequestration Project in Fengning State Forest Farm	4679.50	2016-12-02
Fujian	Longyan	Yongding District	Fujian Yongding Carbon Sequestration Afforestation Project	3530.23	2016-12-30
Guangdong	Shaoguan	Wengyuan County	Guangdong Wengyuan Carbon Sequestration Afforestation Project	12105.25	2017-01-07
Guangdong	Yunfu; Zhaoqing	Gaoyao District, Yun'an District,Deqing County, Yunan County,Fengkai County, Xinxing County	Guangdong Xijiang Forestry Carbon Sequestration Afforestation Project	3288.14	2016-04-07
Guangdong	Yunfu	Yunan County	Guangdong Yunan Carbon Sequestration Afforestation Project	8781.46	2016-12-30
Guangdong	Meizhou	Wuhua County	Guangdong Changlong Carbon Sink Afforestation Project	867.10	2013-12-16
Guangxi	Hezhou	Babu District	Guangxi Guishan Lintian Carbon Sink Afforestation Project	5384.29	2016-04-09
Guizhou	Tongren	Jiangkou County	Guizhou Jiangkou County Carbon Sequestration Afforestation Project	679.01	2016-07-19
Hebei	Zhangjiakou	Guyuan County	Hebei Zhangjiakou Carbon Sink Afforestation Project	1328.36	2016-05-17
Henan	Xinyang	Xin County	Henan Xin County Shawo Town Carbon Sequestration Afforestation Rich Peasant Project	353.51	2016-05-06
Heilongjiang	Daxing'anling Area	Tahe County	Heilongjiang Forestry Bureau Daxingan Mountains Shibazhan Carbon Sink Afforestation Project	3348.89	2016-01-29
Heilongjiang	Mudanjiang	Linkou County	Heilongjiang Linkou Carbon Sink Afforestation Project	667.00	2015-08-26
Hubei	Jingzhou;Tian men;Xiantao; Xianning	Honghu City, TianmenCity, Xiantao City,Jianli City, Jiayu County	Hubei Changxing Carbon Sequestration Afforestation Project	10040.87	2016-09-14

Province	City	County	Name	Size (hectare)	Public Comment Start Date
Hubei	Xianning	Tongshan County	Hubei Tongshan Bamboo Forest Carbon Sink Project	28353.97	2016-12-20
Hubei	Xianning	Tongshan County	Hubei Tongxian Bamboo Carbon Sink Afforestation Project	701.28	2015-06-19
Hubei	Xiaogan	Dawu County, Anlu City, Hanchuan City, Xiaonan District	Hubei Xiaogan Carbon Sequestration Afforestation Project	5376.29	2017-02-07
Hunan	Chenzhou	Zixing City	Hunan Zixing Carbon Sink Afforestation Project	2666.67	2015-11-25
Jiangxi	Pingxiang	Lianhua County	Jiangxi Pingxiang Lianhua County Carbon Sequestration Afforestation Project of Gaotianyan Ecological Forest Farm	2149.07	2016-12-30
Jiangxi	Pingxiang	Lianhua County	Jiangxi Pingxiang Lianhua County Carbon Sequestration Afforestation Project	2729.70	2016-11-21
Hebei	Chengde	Paddock Manchu Mongolian Autonomous County	Saihanba Forest Management Carbon Sequestration Projects	27216.60	2015-08-12
Hebei	Chengde	Paddock Manchu Mongolian Autonomous County	Saihanba Jixielin Carbon Sink Afforestation Project	3950.72	2015-08-12
Xinjiang	Kashgar Region	Makati County	Xinjiang Markit County Afforestation Carbon Sequestration Project	6701.19	2016-04-12
Jiangsu	Yancheng	Sheyang County	Yancheng Sheyang County Jin Hailin Field Afforestation Carbon Sequestration	411.32	2016-04-15
Yunnan	Lincang	Fengqing County	Disney Yunnan Vegetation Restoration of Degraded Land Carbon Sink Afforestation Project	1870.90	2016-04-28
Yunnan	Puer	Jinggu Dai and Yi Autonomous County	Yunnan Jinggu Longevity Forest Carbon Sink Afforestation Project	7546.90	2016-06-04
Yunnan	Diqing Tibetan Autonomous Prefecture	Shangri-La City	Yunnan Shangri-La Revegetation Forest Carbon Sink Afforestation Project	156.18	2016-05-06
Zhejiang	Wenzhou	Cangnan County	Zhejiang Cangnan Carbon Sink Afforestation Project	542.28	2016-04-06
Zhejiang	Huzhou	Anji County	Zhejiang Anji Bamboo Forest Management Carbon Sequestration Project	1426.98	2016-05-12
Zhejiang	Lishui	Jingning She Autonomous County	Zhejiang Jingning She Nationality Autonomous County Bamboo Forest Management Carbon Project	5515.89	2016-11-14
Zhejiang	Lishui	Suichang County	Zhejiang Suichang Bamboo Forest Project	8640.18	2016-11-14

Province	City	County	Name	Size (hectare)	Public Comment Start Date
Zhejiang	Shaoxing	Zhuji City	Zhejiang Zhuji Bamboo Forest Carbon Sink Project	6182.29	2016-11-14
Inner Mongolia	Xing'an League	Horqin Right Wing Front Banner	Inner Mongolia Horqin Right Wing Front Banner Reforestation of Degraded Land Carbon Sink Project	2248.70	2015-06-05
Fujian	Sanming	Ninghua County	Fujian Ninghua Futan Carbon Afforestation Project	3485.08	2016-12-02

Supplementary References

1. Callaway, B. & Sant'Anna, P. H. C. Difference-in-Differences with multiple time periods. *J. Econom.* **225**, 200–230 (2021).
2. Zhang, Y., Zhang, T., Zeng, Y., Cheng, B. & Li, H. Designating National Forest Cities in China: Does the policy improve the urban living environment? *For. Policy Econ.* **125**, 102400 (2021).
3. Chen, Z. *et al.* National forest parks in China: Origin, evolution, and sustainable development. *Forests* **10**, 323 (2019).
4. Zhang, F. *et al.* China's National Reserve Forest Project contribution to carbon neutrality and path to profitability. *For. Policy Econ.* **160**, 103146 (2024).