Supplementary Materials

Impacts of Land-Use Change on the Spatio-Temporal Patterns of Terrestrial Ecosystem Carbon Storage in the Gansu Province, Northwest China

Contents of this file

1. The uncertainty of carbon density

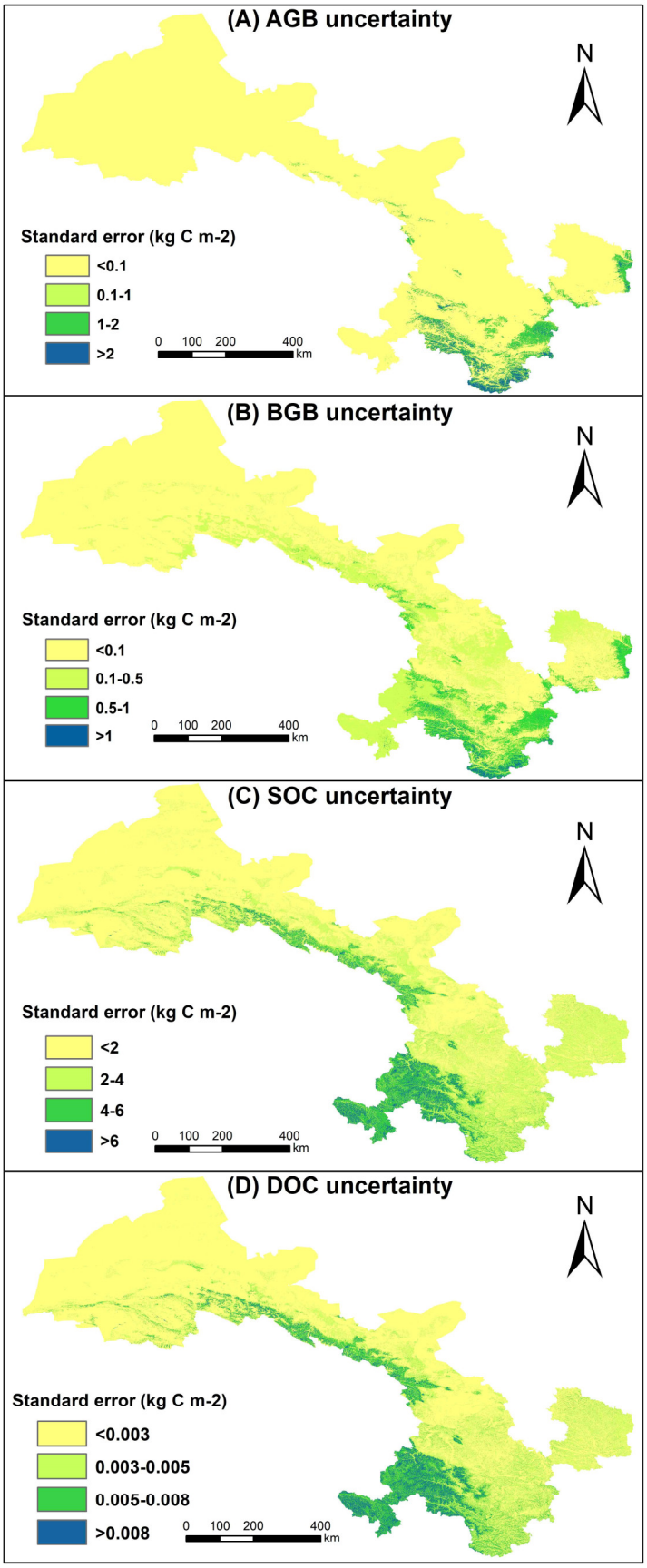

Figure S1. The spatial distribution of uncertainty (expressed as standard error) for each carbon density.

2. The detailed procedure of estimating carbon density for different periods

In this study, based on above- and below-ground biomass carbon density, and soil organic carbon density data in the standard period (2010s), we integrated the elements of temperature, precipitation, CO_2 fertilization effects, and the management of forest and agriculture to established empirical regression equations to calculate carbon density dynamics data under each land-use type in the historical periods (1980s, 2000s, and 2020s) and future periods (2030s and 2050s under the SSP126, SSP245, and SSP585 scenarios). The processes mainly consist of three steps: data preparation and pre-processing, establishing the regression equations, and calculating carbon density dynamics data for each period.

2.1 Data preparation and pre-processing

2.1.1 Carbon density maps

a. The above- and below-ground biomass carbon density of high-resolution are obtained from NASA ORNL DAAC.
b. The soil carbon density data are obtained from the Chinese High-Resolution National Soil Information Grid Basic Dataset with a spatial resolution of 90 m.
c. The dataset of "A dataset of Organic carbon storage and carbon dynamic in arid and semiarid China from 1980 to 2014", including the spatial distribution of carbon density (AGC, BGC, SOC, and DOC) in arid and semi-arid regions of China.

2.1.2 Influencing factors

a. The spatial distributions of mean temperature and precipitation in 1980s, 2000s, 2020s, 2030s, and 2050s were obtained from Peng et al. (https://data.tpdc.ac.cn/zh-hans/data/71ab4677-b66c-4fd1-a004-b2a541c4d5bf/) with the pre-processing of monthly scale of historical and future dataset. The effects of climate change on carbon dynamics over time were quantified by regressing the relationships between carbon density and climate variables over space.
b. The CO_2 fertilization effect was assessed with the changes of different periods to the base period and the assumption of a 15.5% increase in productivity for each 100 ppm rising of CO_2 concentration compared to the base period. The effect of CO_2 fertilization on biomass carbon density was then additionally added to the climate-induced effect based on procedure 1.
c. The difference in carbon density of forest species divided by the span of forest age is used as the carbon sequestration rate [69], and then the effect of forest management on carbon density is measured in combination with the carbon density

of the base period. The effect of management and natural growth on forest biomass carbon density was then additionally added to the above effects based on procedures 1 and 2.

d. After the field trial of multi-point in China, Cheng et al. [70] concluded that agricultural management could increase the agricultural SOC by 0.02 kg C m^{-2} on average, supplemented by a time span to correct for SOC density in farmland. The effect of agricultural managements on SOC density in farmland was also additionally added to the effects induced by climate and biomass changes.

2.2 Establishing the multiple linear regression equations

2.2.1 Above- and below-ground biomass carbon density with temperature and precipitation

We regressed the multiple linear regression relationships between vegetation biomass carbon density and temperature and precipitation based on the spatially distributed data points derived from raster layers (i.e., about 4.6 million points in total). The coefficients of the regression equations are shown below.

Table S1. The coefficients of multiple linear regression equations for both above- and below-ground biomass carbon density as a dependent variable of the temperature and precipitation.

Top-level categories	Sub-categories	AGC		BGC	
		PRE	TEM	PRE	TEM
1 Farmland	12 dry farmland	0.000197	0.021422	9.05E-05	-0.01928
2 Forest	21 wood land	0.006869	0.063487	0.001784	-0.01031
	22 shrubbery land	0.002553	0.108207	0.001263	-0.00579
	23 sparsely forested woodland	0.004321	0.066245	0.001543	-0.01358
	24 other forest land	0.00119	0.024238	0.000791	-0.05042
3 Grassland	31 high coverage grassland	0.001796	0.095273	0.001316	-0.01323
	32 middle coverage grassland	0.001159	0.022358	0.000935	-0.02542
	33 low coverage grassland	0.00038	0.002164	0.000454	-0.00772
4 Water	41 river and glacier	0	0	0	0
5 Built-up land	51 cities and towns	0.000145	-0.00263	0.000089	-0.0017
	52 rural settlements	3.46E-05	0.006652	-1.7E-06	-0.01877
	53 industry and traffic land	0.000565	-0.00813	0.000389	-0.01472
6 Other land	61 sandy land	0.000189	0.000229	0.000527	-0.00068
	62 Gobi	0.000198	7.36E-05	0.0005	-0.00169
	63 saline-alkali land	0.000178	-0.00236	0.000179	-0.00544
	64 swampland	0.000122	-0.0073	0.001063	-0.00517
	65 bare land	0.000453	0.000968	0.000506	-0.00264
	66 rock and gravel	0.000398	0.002428	0.000748	-0.00024
	67 alpine desert	0.000296	0.021335	0.000577	0.025023

2.2.2 Soil carbon density with above- and below-ground biomass carbon density, temperature, and precipitation

We also regressed the multiple linear regression relationships between soil organic carbon density and temperature, precipitation, and above- and below-ground biomass carbon density based on the spatially distributed data points derived from raster layers (i.e., about 4.6 million points in total). The coefficients of the regression equations are shown below.

Table S2. The coefficients of multiple linear regression equations for soil carbon density as a dependent variable of the precipitation, temperature, above- and below-ground biomass carbon density, temperature, and precipitation.

Top-level categories	Sub-categories	SOC			
		PRE	TEM	AGC	BGC
1 Farmland	12 dry farmland	0.006029599	-0.791372812	1.55362964	2.141083142
2 Forest	21 wood land	0.004630485	-1.894260015	0.227098747	1.356163289
	22 shrubbery land	0.006920127	-1.601780929	-0.998401926	5.771845704
	23 sparsely forested woodland	0.010671103	-1.490972572	-1.600452571	6.310689849
	24 other forest land	0.014440896	-1.564306802	-0.183875384	4.051364583
3 Grassland	31 high coverage grassland	0.014683917	-1.366679391	-1.302431957	6.032943896
	32 middle coverage grassland	0.018523116	-0.649982054	-2.590096459	8.313697096
	33 low coverage grassland	0.013779964	-0.208326455	3.825273507	11.28861913
4 Water	41 river and glacier	0.016497544	-0.29739037	0.494744063	15.04759077
5 Built-up land	51 cities and towns	0.00443446	-0.36441646	8.184681786	6.699415775
	52 rural settlements	0.00548865	-0.720668162	2.334115283	3.180822031
	53 industry and traffic land	0.011776928	-0.413893351	1.844301675	10.30405306
6 Other land	61 sandy land	0.004092661	-0.043404464	12.42160144	22.34852121
	62 Gobi	0.00258486	-0.084764329	9.801403801	23.25338506
	63 saline-alkali land	-0.002247733	-0.234647046	9.86380685	19.38647673
	64 swampland	0.00953956	-0.671068457	9.601896096	9.740369996
	65 bare land	0.010658346	-0.204879549	3.212742153	13.57744147
	66 rock and gravel	0.006686388	-0.067359686	-3.979062371	30.58633815
	67 alpine desert	0.01181091	0.591463466	-4.518298434	24.5570386

2.2.3 Dead organic carbon density with soil biomass carbon density

Based on the carbon density data (c), the linear regression relationship between SOC density and DOC density was established with an empirical regression equation ($y=0.0041x+5.1899$, $R^2=0.6897$).

2.3 Calculating the carbon density dynamics data for each period

Based on the linear regression relationships and the difference of mean temperature and mean precipitation between each interdecadal, the first edition carbon density data were calculated for each interdecadal period. After that, the four major carbon pools

were corrected with CO_2 fertilization effect, forest management correction for forest land, and farm management correction for SOC in farmland; finally the corrected carbon density dynamic data for each period were as follows.

Table S3. The AGC density of different land-use types from 1980 to 2050.

Top-level categories	Sub-categories	1980	2000	2020	SSP126		SSP245		SSP585	
					2030	2050	2030	2050	2030	2050
1 Farmland	12 dry farmland	0.21	0.23	0.27	0.29	0.32	0.30	0.34	0.30	0.37
2 Forest	21 wood land	1.48	1.84	3.04	3.46	4.14	3.47	4.30	3.51	4.58
	22 shrubbery land	0.51	0.72	1.25	1.47	1.81	1.48	1.90	1.50	2.04
	23 sparsely forested woodland	0.70	0.91	1.61	1.86	2.24	1.86	2.33	1.88	2.50
	24 other forest land	0.19	0.25	0.44	0.51	0.62	0.51	0.65	0.52	0.69
3 Grassland	31 high coverage grassland	0.56	0.57	0.82	0.92	1.03	0.92	1.10	0.93	1.20
	32 middle coverage grassland	0.27	0.26	0.37	0.40	0.44	0.41	0.47	0.41	0.51
	33 low coverage grassland	0.07	0.07	0.09	0.09	0.10	0.09	0.10	0.09	0.11
4 Water	41 river and glacier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Built-up land	51 cities and towns	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.08	0.09
	52 rural settlements	0.21	0.22	0.25	0.26	0.26	0.26	0.29	0.26	0.31
	53 industry and traffic land	0.09	0.09	0.11	0.11	0.10	0.11	0.11	0.11	0.12
6 Other land	61 sandy land	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
	62 Gobi	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	63 saline-alkali land	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.05
	64 swampland	0.14	0.13	0.14	0.14	0.14	0.14	0.15	0.14	0.16
	65 bare land	0.03	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.06
	66 rock and gravel	0.01	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.04
	67 alpine desert	0.01	0.02	0.05	0.06	0.09	0.06	0.09	0.07	0.10

Table S4. The BGC density of different land-use types from 1980 to 2050.

Top-level categories	Sub-categories	1980	2000	2020	SSP126		SSP245		SSP585	
					2030	2050	2030	2050	2030	2050
1 Farmland	12 dry farmland	0.19	0.18	0.19	0.18	0.17	0.18	0.18	0.19	0.19
2 Forest	21 wood land	0.26	0.72	1.40	1.69	2.20	1.70	2.28	1.71	2.38
	22 shrubbery land	0.38	0.58	0.91	1.04	1.26	1.05	1.32	1.06	1.39
	23 sparsely forested woodland	0.24	0.47	0.87	1.03	1.30	1.03	1.34	1.04	1.41
	24 other forest land	0.31	0.35	0.46	0.48	0.52	0.48	0.54	0.48	0.56
3 Grassland	31 high coverage grassland	0.63	0.61	0.74	0.76	0.77	0.77	0.83	0.77	0.89
	32 middle coverage grassland	0.33	0.31	0.37	0.38	0.37	0.38	0.39	0.38	0.42
	33 low coverage grassland	0.15	0.15	0.17	0.17	0.17	0.18	0.18	0.18	0.20
4 Water	41 river and glacier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Built-up land	51 cities and towns	0.12	0.13	0.14	0.14	0.14	0.15	0.16	0.15	0.17
	52 rural settlements	0.15	0.15	0.15	0.14	0.12	0.14	0.14	0.14	0.14
	53 industry and traffic land	0.13	0.13	0.14	0.13	0.12	0.13	0.13	0.14	0.14
6 Other land	61 sandy land	0.06	0.06	0.08	0.08	0.08	0.08	0.09	0.08	0.09

	62 Gobi	0.05	0.05	0.06	0.07	0.07	0.07	0.07	0.07	0.08
	63 saline-alkali land	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.09	0.10
	64 swampland	0.50	0.50	0.57	0.59	0.60	0.60	0.65	0.61	0.70
	65 bare land	0.09	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.13
	66 rock and gravel	0.07	0.08	0.09	0.10	0.10	0.10	0.11	0.10	0.11
	67 alpine desert	0.08	0.09	0.14	0.16	0.19	0.17	0.21	0.17	0.23

Table S5. The SOC density of different land-use types from 1980 to 2050.

Top-level categories	**Sub-categories**	**1980**	**2000**	**2020**	**SSP126**		**SSP245**		**SSP585**	
					2030	**2050**	**2030**	**2050**	**2030**	**2050**
1 Farmland	12 dry farmland	9.29	8.92	9.02	8.97	9.00	8.99	8.89	8.95	8.76
2 Forest	21 wood land	18.94	18.62	18.89	18.22	17.60	18.26	17.41	18.18	17.06
	22 shrubbery land	18.45	18.39	19.13	18.69	18.43	18.75	18.35	18.69	18.19
	23 sparsely forested woodland	12.47	12.53	13.78	13.47	13.49	13.51	13.31	13.44	13.10
	24 other forest land	14.66	13.51	13.75	12.91	12.00	12.94	11.68	12.87	11.40
3 Grassland	31 high coverage grassland	19.39	18.13	18.57	17.82	16.89	17.85	16.73	17.82	16.68
	32 middle coverage grassland	11.71	10.72	11.65	11.28	10.89	11.29	10.71	11.28	10.79
	33 low coverage grassland	6.01	5.79	6.36	6.31	6.24	6.34	6.32	6.35	6.50
4 Water	41 river and glacier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Built-up land	51 cities and towns	6.24	6.01	6.14	5.96	5.71	5.98	5.75	5.98	5.79
	52 rural settlements	9.56	9.05	8.94	8.51	7.96	8.54	7.89	8.50	7.78
	53 industry and traffic land	5.65	5.27	5.57	5.29	4.94	5.32	4.91	5.30	4.93
6 Other land	61 sandy land	1.68	1.80	2.20	2.24	2.24	2.27	2.41	2.29	2.56
	62 Gobi	1.74	1.75	2.00	1.98	1.90	2.00	2.04	2.01	2.14
	63 saline-alkali land	3.33	3.19	3.09	2.91	2.61	2.95	2.76	2.95	2.83
	64 swampland	16.10	15.43	15.98	15.76	15.38	15.85	15.76	15.90	16.17
	65 bare land	3.17	3.08	3.36	3.28	3.15	3.31	3.24	3.31	3.33
	66 rock and gravel	2.45	2.53	3.01	3.08	3.08	3.12	3.32	3.14	3.54
	67 alpine desert	0.46	1.14	3.00	3.99	5.12	4.00	5.62	4.11	6.35

Table S6. The DOC density of different land-use types from 1980 to 2050.

Top-level categories	**Sub-categories**	**1980**	**2000**	**2020**	**SSP126**		**SSP245**		**SSP585**	
					2030	**2050**	**2030**	**2050**	**2030**	**2050**
1 Farmland	12 dry farmland	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2 Forest	21 wood land	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
	22 shrubbery land	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07
	23 sparsely forested woodland	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.06	0.05
	24 other forest land	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05
3 Grassland	31 high coverage grassland	0.08	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07
	32 middle coverage grassland	0.05	0.04	0.05	0.05	0.04	0.05	0.04	0.05	0.04
	33 low coverage grassland	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4 Water	41 river and glacier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5 Built-up land	51 cities and towns	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
	52 rural settlements	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
	53 industry and traffic land	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
6 Other land	61 sandy land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	62 Gobi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	63 saline-alkali land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	64 swampland	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.07	0.07
	65 bare land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	66 rock and gravel	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	67 alpine desert	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03

3. The LUCC simulation and CS distribution for 2030 and 2050

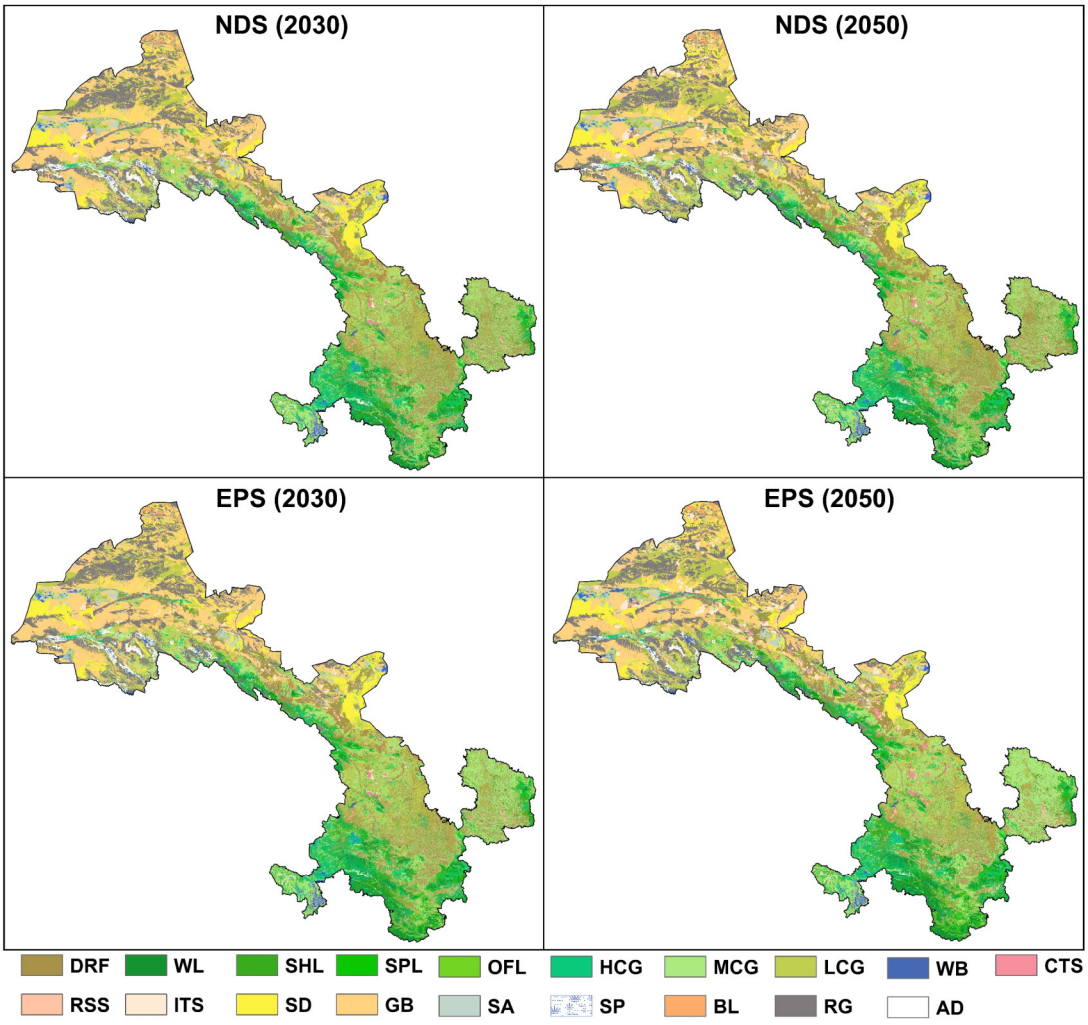

Figure S2. Spatial distribution of LUCC of 2030 and 2050 in Gansu under NDS and EPS.

4. Carbon storage under different LUCC and climate change scenarios

Table S7. The CS of each land-use type in the Gansu Province from 1980 to 2020.

Top-level categories	Sub-categories	1980	2000	2020
1 Farmland	12 dry farmland	628.71±156.92	614.34±153.27	608.14±151.88
2 Forest	21 wood land	291.35±73.58	297.9±79.68	331.69±97.56
	22 shrubbery land	311.22±71.18	312.67±73.78	347.28±86.21
	23 sparsely forested woodland	98.85±24.24	101.13±25.9	117.6±32.41
	24 other forest land	8.19±1.94	7.86±1.88	12.86±3.12
3 Grassland	31 high coverage grassland	534.33±128.03	500.54±120.38	535.06±131.72
	32 middle coverage grassland	742.78±195.25	677.87±178.27	758.73±201.22
	33 low coverage grassland	358±107.24	344.34±103.12	372.71±111.96
4 Water	41 river and glacier	0	0	0
5 Built-up land	51 cities and towns	2.39±0.7	2.53±0.75	5.78±1.71
	52 rural settlements	27.21±6.55	27.87±6.71	32.26±7.78
	53 industry and traffic land	1.31±0.4	1.26±0.39	7.25±2.22
6 Other land	61 sandy land	50.85±25.94	54.4±27.82	64.91±33.14
	62 Gobi	131.55±65.34	132.18±65.49	149.18±74.03
	63 saline-alkali land	28.95±10.92	27.84±10.51	24.55±9.24
	64 swampland	43.89±11.09	42.03±10.62	42.24±10.71
	65 bare land	13.05±4.95	12±4.57	13.76±5.23
	66 rock and gravel	114.41±48.68	119.46±51.09	149.36±63.76
	67 alpine desert	6.15±2.59	14.29±5.74	28.74±11.49

Table S8. The CS from 1980 to 2020 only under the LUTC effect.

Top-level categories	Sub-categories	1980	2000	2020
1 Farmland	12 dry farmland	615.88±153.53	624.87±155.77	608.93±151.8
2 Forest	21 wood land	305.54±85.87	305.08±85.74	308.45±86.69
	22 shrubbery land	322.06±78.07	318±77.08	326.74±79.2
	23 sparsely forested woodland	107.79±28.78	106.27±28.37	105.83±28.25
	24 other forest land	7.47±1.8	7.70±1.85	12.14±2.92
3 Grassland	31 high coverage grassland	498.81±121.52	497.75±121.26	510.84±124.45
	32 middle coverage grassland	688.33±181.98	684.55±180.98	698.57±184.69
	33 low coverage grassland	347.93±104.39	346.56±103.98	341.01±102.31
4 Water	41 river and glacier	0	0	0
5 Built-up land	51 cities and towns	2.27±0.67	2.49±0.74	5.54±1.64
	52 rural settlements	25.19±6.07	27.16±6.54	31.75±7.65
	53 industry and traffic land	1.19±0.37	1.23±0.38	6.65±2.04
6 Other land	61 sandy land	57.57±29.37	57.48±29.33	56.04±28.59

	62 Gobi	138.3±68.58	137.86±68.36	135.64±67.26
	63 saline-alkali land	26.69±10.07	26.75±10.1	24.25±9.15
	64 swampland	41.94±10.62	41.85±10.6	40.45±10.25
	65 bare land	12.71±4.83	11.99±4.56	12.54±4.77
	66 rock and gravel	127.42±54.46	128.52±54.93	134.84±57.63
	67 alpine desert	29.64±11.87	29.63±11.87	23.41±9.37

Table S9. The CS of each land-use type in the Gansu Province of 2030 and 2050 with Future Climate Scenarios (SSP126, SSP245, and SSP585) under NDS.

Top-level categories	Sub-categories	ssp126		ssp245		ssp585	
		2030	2050	2030	2050	2030	2050
1 Farmland	12 dry farmland	601.95±150.09	656.04±163.45	603.63±150.55	650.96±162.3	601.49±150.26	644.82±160.98
2 Forest	21 wood land	317.4±97.08	323.31±104.53	318.31±97.37	324.16±105.91	317.86±97.53	324.57±107.91
	22 shrubbery land	343.29±87.22	343.84±90.31	344.44±87.61	345.04±91.38	343.99±87.68	345.76±92.67
	23 sparsely forested woodland	120.45±34.28	132.32±39.15	120.87±34.34	131.94±39.4	120.56±34.36	132.16±40.11
	24 other forest land	10.98±2.68	9.72±2.4	11.02±2.69	9.52±2.37	10.96±2.68	9.37±2.34
3 Grassland	31 high coverage grassland	496.04±123.45	469.22±118.3	497.06±123.77	468.13±119.25	496.74±123.73	471.2±121.19
	32 middle coverage grassland	771.66±205.52	713.26±190.4	772.36±205.95	705.16±189.14	772.09±205.79	714.3±192.44
	33 low coverage grassland	383.29±114.96	425.94±128.01	384.95±115.76	432.52±129.87	385.66±115.93	445.87±134.17
4 Water	41 river and glacier	0	0	0	0	0	0
5 Built-up land	51 cities and towns	8.61±2.54	10.3±3.04	8.64±2.55	10.39±3.08	8.63±2.55	10.5±3.11
	52 rural settlements	35.32±8.5	32.78±7.86	35.44±8.53	32.63±7.86	35.32±8.49	32.32±7.77
	53 industry and traffic land	18.8±5.76	40.02±12.26	18.89±5.79	39.94±12.25	18.83±5.79	40.22±12.36
6 Other land	61 sandy land	65.32±33.27	64.72±32.99	66.15±33.69	69.52±35.51	66.6±33.98	74.03±37.76
	62 Gobi	139.21±69.32	117.71±58.49	141.01±69.99	125.99±62.58	141.6±70.32	132.61±65.79
	63 saline-alkali land	23.03±8.68	20.07±7.57	23.35±8.79	21.25±8.04	23.33±8.79	21.78±8.23
	64 swampland	40.19±10.21	41.01±10.44	40.41±10.27	42.14±10.75	40.55±10.32	43.33±11.09
	65 bare land	14.7±5.58	12.31±4.67	14.82±5.62	12.68±4.83	14.83±5.64	13.09±4.98
	66 rock and gravel	153.44±65.66	143.54±61.32	155.35±66.47	154.81±66.31	156.55±66.87	165.27±70.47
	67 alpine desert	30.26±12.07	31.3±12.48	30.35±12.14	34.33±13.68	31.21±12.48	38.73±15.44

Table S10. The CS of each land-use type in the Gansu Province of 2030 and 2050 with Future Climate Scenarios (SSP126, SSP245, and SSP585) under EPS.

Top-level categories	Sub-categories	ssp126		ssp245		ssp585	
		2030	2050	2030	2050	2030	2050
1 Farmland	12 dry farmland	529.17±131.94	440.64±109.79	530.65±132.35	437.23±109.01	528.77±132.1	433.11±108.13
2 Forest	21 wood land	342.87±104.88	413.68±133.74	343.85±105.19	414.77±135.51	343.37±105.36	415.29±138.07
	22 shrubbery land	366.63±93.16	388.74±102.1	367.87±93.57	390.09±103.31	367.38±93.64	390.91±104.77
	23 sparsely forested woodland	154.54±43.98	182.11±53.88	155.07±44.06	181.59±54.23	154.68±44.08	181.88±55.2
	24 other forest land	50.67±12.37	79.11±19.56	50.81±12.4	77.46±19.26	50.56±12.35	76.25±19.03

3 Grassland	31 high coverage grassland	504.24±125.49	458.85±115.69	505.28±125.81	457.79±116.61	504.95±125.78	460.79±118.51
	32 middle coverage grassland	779.41±207.59	806.33±215.24	780.12±208.02	797.17±213.82	779.85±207.86	807.51±217.55
	33 low coverage grassland	385.07±115.5	412.75±124.05	386.74±116.3	419.13±125.85	387.45±116.47	432.06±130.02
4 Water	41 river and glacier	0	0	0	0	0	0
5 Built-up land	51 cities and towns	8.66±2.55	18.18±5.36	8.7±2.57	18.35±5.44	8.69±2.57	18.53±5.49
	52 rural settlements	35.7±8.59	48.71±11.68	35.83±8.62	48.48±11.68	35.7±8.58	48.03±11.55
	53 industry and traffic land	18.69±5.73	42.15±12.91	18.78±5.76	42.05±12.9	18.72±5.75	42.35±13.02
6 Other land	61 sandy land	65.38±33.3	63.18±32.2	66.21±33.73	67.87±34.67	66.67±34.01	72.28±36.86
	62 Gobi	138.4±68.92	116.87±58.07	140.19±69.58	125.09±62.14	140.77±69.91	131.66±65.32
	63 saline-alkali land	22.38±8.43	18.84±7.11	22.69±8.54	19.94±7.54	22.68±8.54	20.44±7.72
	64 swampland	38.89±9.88	32.85±8.36	39.11±9.94	33.75±8.61	39.24±9.99	34.71±8.88
	65 bare land	14.42±5.47	15.95±6.06	14.53±5.52	16.43±6.26	14.54±5.54	16.96±6.45
	66 rock and gravel	153.18±65.54	144.97±61.93	155.08±66.35	156.35±66.97	156.27±66.76	166.91±71.17
	67 alpine desert	29.78±11.88	23.81±9.49	29.87±11.95	26.12±10.4	30.71±12.28	29.46±11.75

Table S11. The CS of 2030 and 2050 only under the LUTC effect.

Top-level categories	**Sub-categories**	**2020**	**NDS**		**EPS**	
			2030	**2050**	**2030**	**2050**
1 Farmland	12 dry farmland	608.93±151.8	604.9±150.8	656.14±163.57	531.77±132.57	440.71±109.87
2 Forest	21 wood land	308.45±86.69	294.85±82.87	293.25±82.42	318.52±89.52	375.21±105.45
	22 shrubbery land	326.74±79.2	324.32±78.62	320.41±77.67	346.38±83.96	362.24±87.81
	23 sparsely forested woodland	105.83±28.25	107.82±28.78	113.72±30.36	138.33±36.93	156.51±41.78
	24 other forest land	12.14±2.92	10.93±2.63	10.24±2.46	50.42±12.12	83.3±20.02
3 Grassland	31 high coverage grassland	510.84±124.45	488.78±119.08	482.29±117.5	496.86±121.05	471.63±114.9
	32 middle coverage grassland	698.57±184.69	729.91±192.97	695.43±183.86	737.25±194.91	786.17±207.85
	33 low coverage grassland	341.01±102.31	352.77±105.84	396.33±118.91	354.41±106.33	384.06±115.23
4 Water	41 river and glacier	0	0	0	0	0
5 Built-up land	51 cities and towns	5.54±1.64	8.49±2.5	10.6±3.13	8.55±2.52	18.7±5.52
	52 rural settlements	31.75±7.65	36.42±8.77	36.05±8.68	36.81±8.86	53.57±12.9
	53 industry and traffic land	6.65±2.04	18.14±5.56	41.37±12.68	18.03±5.53	43.56±13.36
6 Other land	61 sandy land	56.04±28.59	55.29±28.21	54.82±27.97	55.35±28.24	53.52±27.31
	62 Gobi	135.64±67.26	127.66±63.3	112.01±55.55	126.91±62.93	111.21±55.15
	63 saline-alkali land	24.25±9.15	24.11±9.1	23.33±8.81	23.44±8.85	21.9±8.27
	64 swampland	40.45±10.25	38.96±9.87	40.7±10.31	37.7±9.55	32.6±8.26
	65 bare land	12.54±4.77	13.69±5.21	11.92±4.53	13.42±5.11	15.44±5.87
	66 rock and gravel	134.84±57.63	135.36±57.86	126.42±54.04	135.12±57.76	127.68±54.58
	67 alpine desert	23.41±9.37	18.65±7.47	15.05±6.03	18.35±7.35	11.45±4.59
	SUM	3383.62±958.66	3391.05±959.44	3440.08±968.48	3447.62 ±974.09	3549.46±998.72

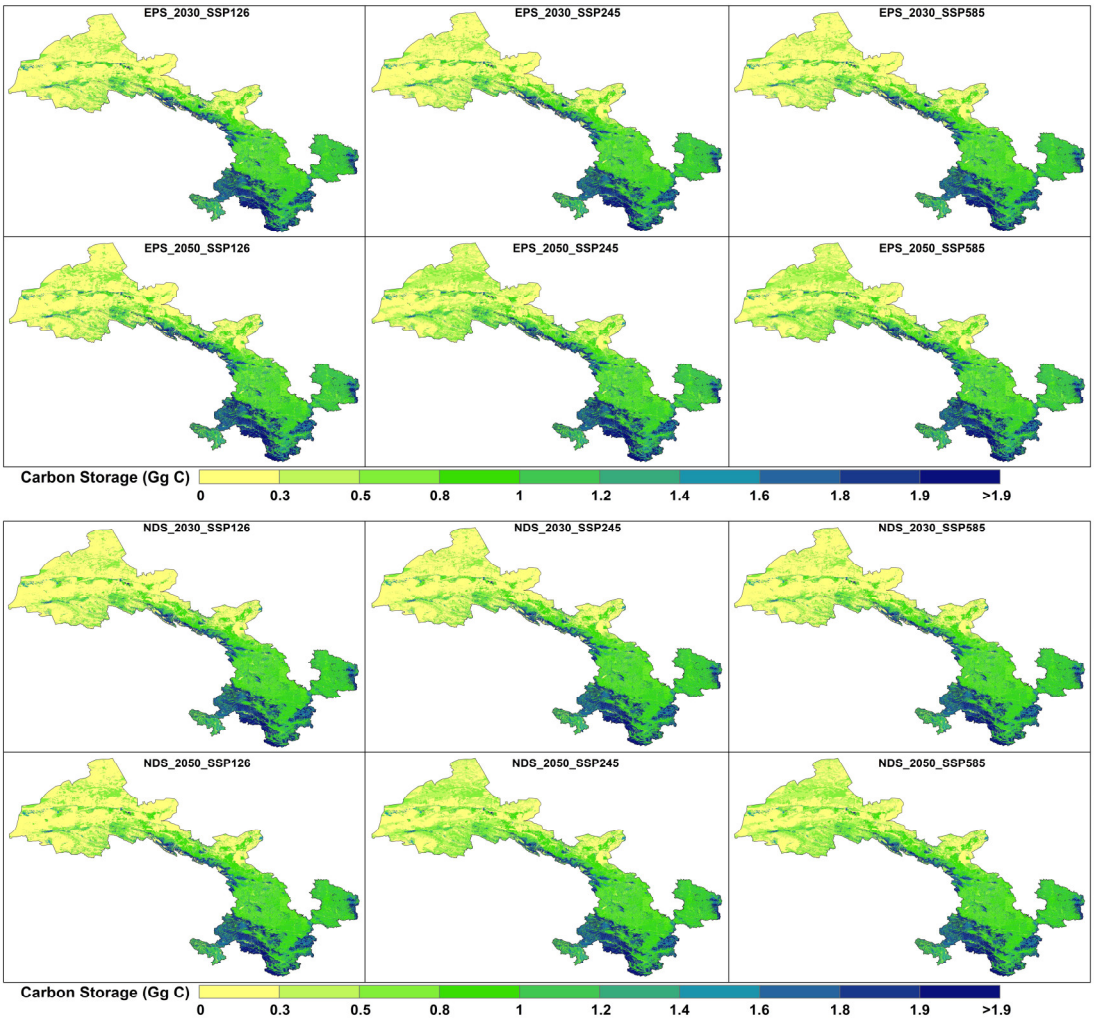

Figure S3. Spatial distribution of CS in 2030 and 2050 in Gansu under the LUCC Scenarios (NDS and EPS) and Future Climate Scenarios (SSP126, SSP245, and SSP585). Note: Carbon storage per pixel (300m * 300m).

5. The fire statistics of the Gansu Province from 2000 to 2017

Table S12. Fire statistics of the Gansu Province from 2000 to 2017.

Year	Fire incidence	Total burning area (ha)	Affected forest area (ha)	Fire source	
				Artificial fire source	Other fire source
2000	27	185	11	23	4
2001	14	25	19.3	13	1
2002	10	20	2.5	6	4
2003	30	2353.6	724.1	27	3
2004	24	41	7.8	20	4
2005	4	9	1	3	1
2006	12	9.7	8.2	12	0
2007	7	4	1	5	2
2008	15	10	3	13	2
2009	29	78	2	26	3
2010	18	273	38	13	5
2011	7	144	24	2	5

2012	11	85	8	7	4
2013	16	32	9	12	4
2014	21	101	37	21	0
2015	8	15	11	8	0
2016	9	264	101	9	0
2017	6	15	11	6	0