

Supplementary S1

Sensitivity and Uncertainty Analysis of Carbon Density Parameters

This supplementary section presents the complete results of the sensitivity and uncertainty analyses described in Section 3.2.2 of the main text. Table S1 lists the results of the one-at-a-time (OAT) sensitivity analysis conducted for 2018. Table S2 presents the results of the one-at-a-time (OAT) sensitivity analysis conducted for 2023. Figure S1 presents the results of the Monte Carlo (MC) uncertainty analysis for 2018, while Figure S2 presents the corresponding MC uncertainty analysis results for 2023. Figure S3 presents the results of the analysis of the corresponding changes in Monte Carlo uncertainty from 2018 to 2023. Taken together, these analyses assess the robustness of carbon stock estimates under historical land-use conditions in the face of uncertainty in carbon density parameters.

The results indicate that, in 2018, the overall uncertainty in regional total carbon stocks regarding carbon density parameters was relatively stable (CV=4.05%); this stability increased slightly by 2023. Forest soil carbon stocks were identified as a key source of uncertainty, but the increase in carbon stocks was primarily driven by the enhanced compensatory effect of forest expansion for the reduction in cropland.

Table S1. Sensitivity analysis (2018).

Land_use	Carbon_pool	Sensitivity_coefficient
Cropland	C_soil	0.365214
Cropland	C_below	0.287409
Forestland	C_soil	0.121989
Cropland	C_above	0.107955
Forestland	C_below	0.067441
Forestland	C_above	0.028158
Water	C_soil	0.007312
Water	C_below	0.006341
Grassland	C_soil	0.002389
Grassland	C_below	0.002150
Cropland	C_dead	0.001569
Forestland	C_dead	0.001008
Grassland	C_above	0.000534
Water	C_above	0.000480
Water	C_dead	0.000045
Grassland	C_dead	0.000008

Table S2. Sensitivity analysis (2023).

Land_use	Carbon_pool	Sensitivity_coefficient
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Cropland	C_soil	0.300408
Cropland	C_below	0.236409
Forestland	C_soil	0.192897
Forestland	C_below	0.106642
Cropland	C_above	0.088799
Forestland	C_above	0.044525
Water	C_soil	0.007358
Water	C_below	0.006381
Grassland	C_soil	0.006193
Grassland	C_below	0.005573
Forestland	C_dead	0.001593
Grassland	C_above	0.001384
Cropland	C_dead	0.001290
Water	C_above	0.000483
Water	C_dead	0.000045
Grassland	C_dead	0.000020

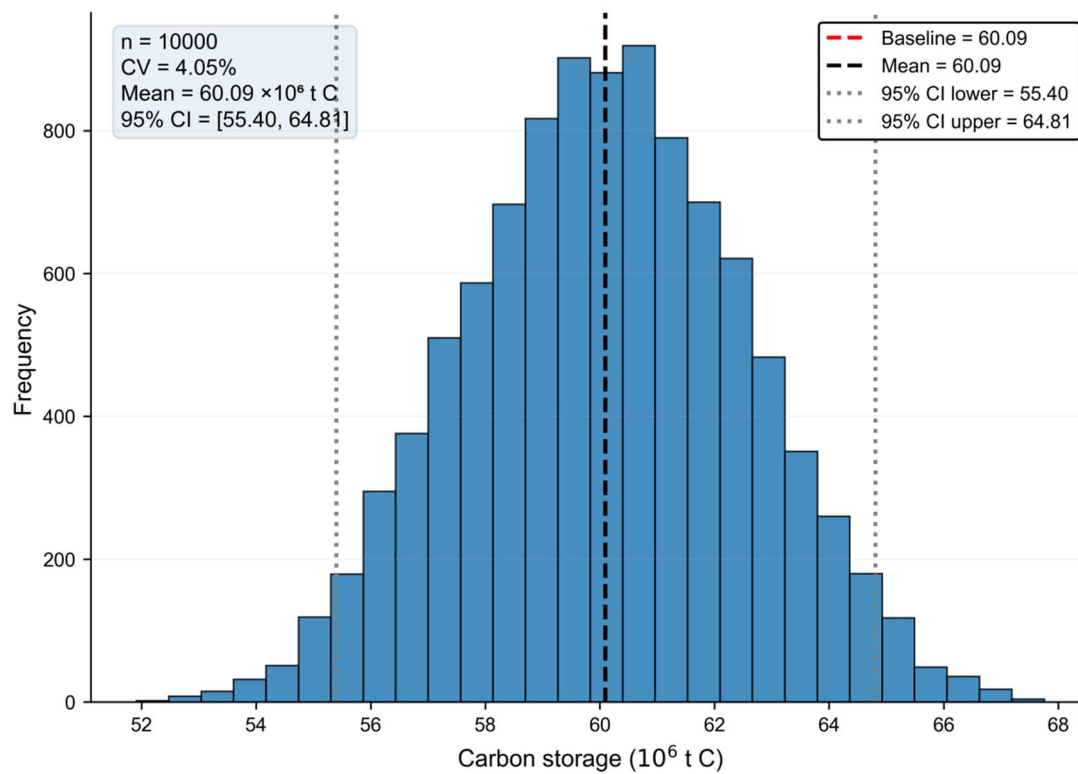


Figure S1. Monte Carlo uncertainty analysis (2018).

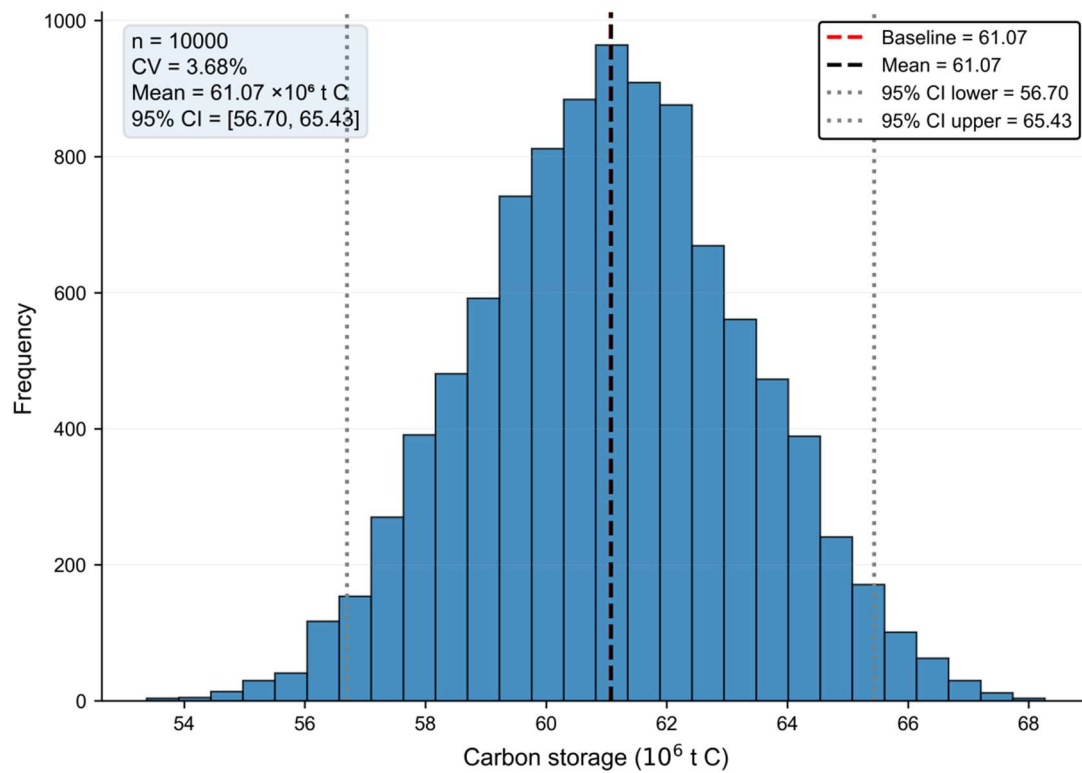


Figure S2. Monte Carlo uncertainty analysis (2023).

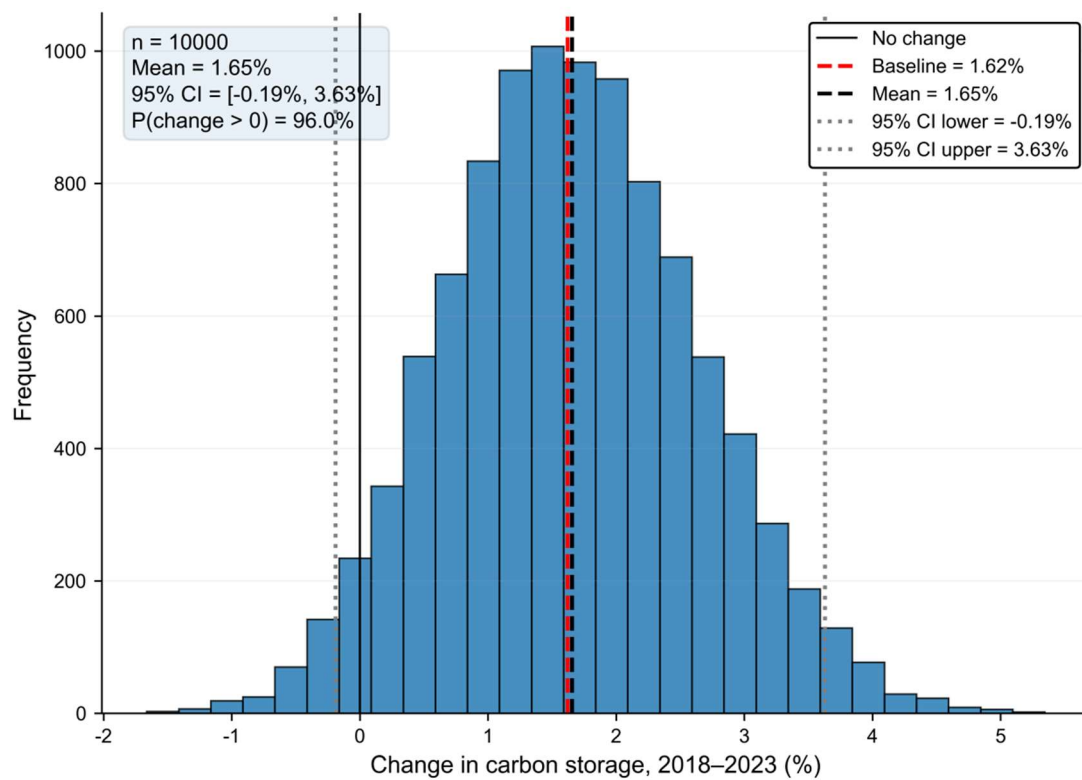


Figure S3. Monte Carlo analysis of uncertainty variations.

Supplementary S2

Annual Precipitation Data

This supplementary section presents data on the spatial distribution of annual precipitation for the two years described in Section 3.2.3 of the main text. Figure S4 shows the results for the spatial distribution of precipitation in 2018, and Figure S5 shows the results for the spatial distribution of precipitation in 2023.

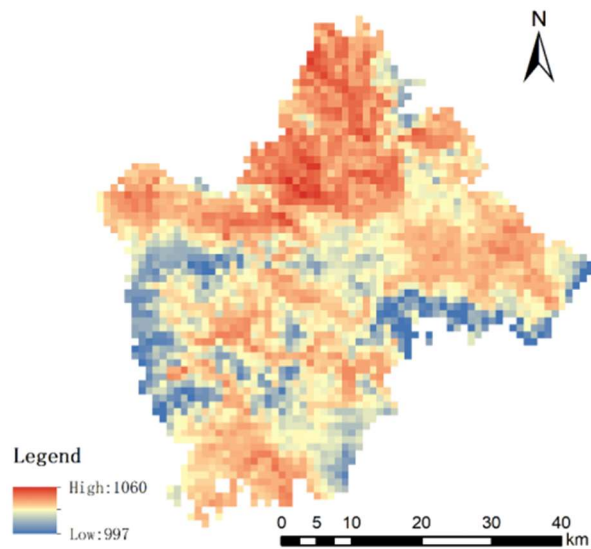


Figure S4. Spatial distribution of annual precipitation in the study area (2018).

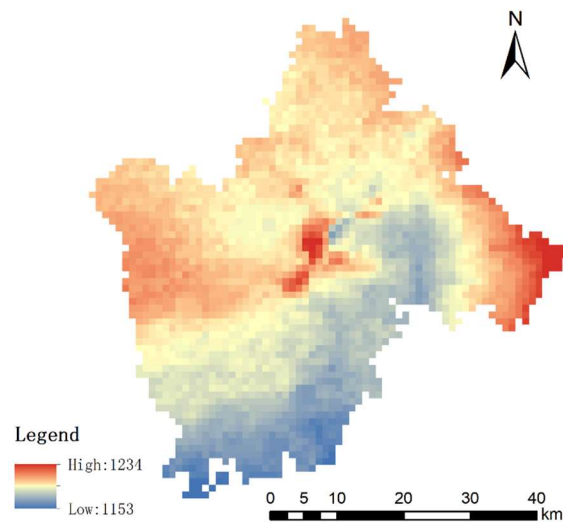


Figure S5. Spatial distribution of annual precipitation in the study area (2023).

Supplementary S3

Comprehensive Ecosystem Services Index

This supplementary section presents the complete results of the joint uniform extreme value normalization of the two-year data described in Section 5.6 of the main text. Figure S6 shows the results for the equal-weighting scheme in 2018, and Figure S7 shows the results for the equal-weighting scheme in 2023.

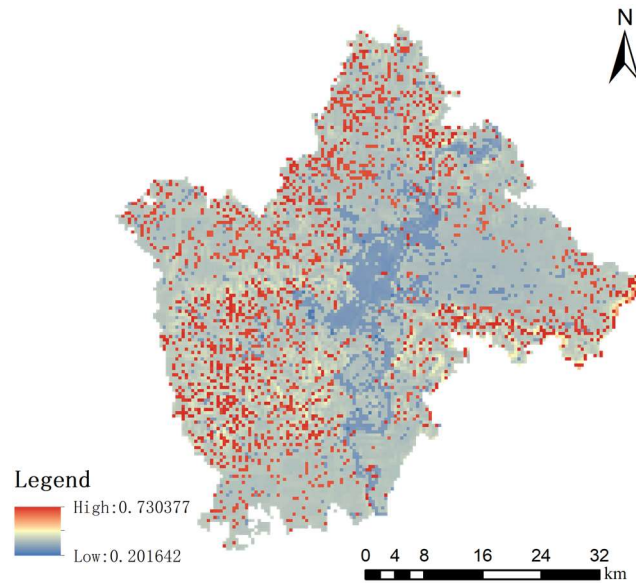


Figure S6. Comprehensive ecosystem services index (2018).

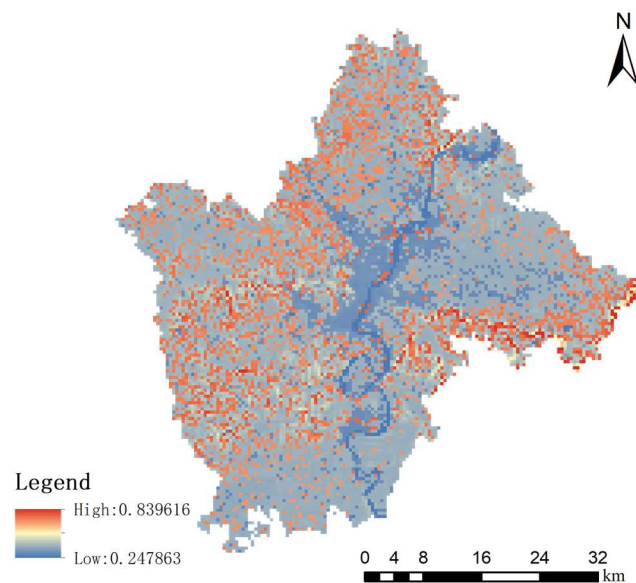


Figure S7. Comprehensive ecosystem services index (2023).