Supplementary Material

Supplementary Tables

Table S1. Comparison of the mean absolute error (MAE), mean absolute percentage error (MAPE), root mean square error (RMSE), determination coefficient (R^2), and the Akaike Information Criterion (AIC) of candidate SOC models.

Episode	**1980**	**1980**	**1980**	**1980**	**2022**	**2022**	**2022**	**2022**
Model	1	2	3	4	5	6	7	8
Nonlinearity*	P	P	S	S	P	P	S	S
Climate	MAI	PET10	MAP MAI	MAP10 MAI10	MAT	MAT10	MAT10 MAI10	PET10 MAI10
Landscape	Slope	Sope	Slope	Slope Elevation	Slope	Slope	Slope Elevation	Slope
Management**	GI	GI	GI	GI	GI	GI	GI	GI
Performance								
MAE (g kg^{-1})	2.99	2.61	0.96	1.01	3.16	3.13	1.49	2.24
MAPE (%)	22.31	20.08	6.41	6.73	29.73	29.92	16.05	21.61
RMSE (g kg^{-1})	3.65	3.20	1.20	1.26	3.86	3.92	2.07	2.91
R2	0.70	0.77	0.92	0.91	0.87	0.86	0.93	0.88
AIC	148.25	141.96	116.03	119.11	189.74	190.71	169.88	189.03
Score								
MAE	4	3	1	2	4	3	1	2
MAPE	4	3	1	2	3	4	1	2
RMSE	4	3	1	2	3	4	1	2
R2	4	3	1	2	3	4	1	2
AIC	4	3	1	2	3	4	1	2
Total score	24	15	5	10	16	19	5	10
Rank	4	3	1	2	3	4	1	2

* P, third order polynomial function; S, cubic spline function.
** GI, grazing intensity.

Table S2. SOC model coefficients for episode 1980.

Regressor	Type	Coefficient	t-value	p
slope	Linear	2.28	3.18	0.0214
Land use intensity				
G0	Intercept	12.18	6.34	0.0010
G1	Intercept	22.48	3.10	0.0236
G2	Intercept	11.85	-0.16	0.8793
G3	Intercept	3.87	-4.41	0.0056
			F-value	
MAP	Nonlinear		3.27	0.0997
Order 1	Cubic spline	-18.73		
Order 2	Cubic spline	-23.86		
Order 3	Cubic spline	-16.93		
Order 4	Cubic spline	-5.52		
Order 5	Cubic spline	29.96		
Order 6	Cubic spline	35.62		
Order 7	Cubic spline	45.01		
Order 8	Cubic spline	29.03		
Order 9	Cubic spline	19.51		
MAI	Nonlinear		4.95	0.0396
Order 1	Cubic spline	21.11		
Order 2	Cubic spline	23.98		
Order 3	Cubic spline	19.78		
Order 4	Cubic spline	4.08		
Order 5	Cubic spline	-28.57		
Order 6	Cubic spline	-45.65		
Order 7	Cubic spline	-41.34		
Order 8	Cubic spline	-33.00		
Order 9	Cubic spline	-8.07		

Table S3. SOC model coefficients for episode 2022.

Regressor	Type	Coefficient	t-value	p
Slope	Linear	2.82	3.21	0.0066
Elevation	Linear	0.05	2.78	0.0146
Land use intensity				
G0	Intercept	-42.80	4.41	0.0056
G1	Intercept	-18.25	5.50	1.49e-4
G2	Intercept	-21.07	3.68	1.02e-3
G3	Intercept	-11.48	1.92	8.21e-6
			F-value	
MAT10	Nonlinear		8.99	2.79e-4
Order 1	Cubic spline	4.58		
Order 2	Cubic spline	0.99		
Order 3	Cubic spline	-5.54		
Order 4	Cubic spline	-23.38		
Order 5	Cubic spline	-16.41		
Order 6	Cubic spline	-11.88		
Order 7	Cubic spline	-6.35		
Order 8	Cubic spline	-13.80		
Order 9	Cubic spline	1.29		
MAI10	Nonlinear		2.18	0.0830
Order 1	Cubic spline	-1.21		
Order 2	Cubic spline	-0.94		
Order 3	Cubic spline	3.23		
Order 4	Cubic spline	8.95		
Order 5	Cubic spline	8.04		
Order 6	Cubic spline	8.83		
Order 7	Cubic spline	2.00		
Order 8	Cubic spline	8.18		
Order 9	Cubic spline	-4.87		

Table S4. The mean, median, standard error, and lower and upper limits of the 95% confidence interval of the SOC covariates' relative importance in explaining the SOC variabilities based on a bootstrap evaluation of 1,000 replications. Different letters in parentheses indicate significant differences at $p < 0.05$.

Covariate	Mean (%)	Median (%)	SE (%)	Lower (%)	Upper (%)
Episode 1980s					
Climate	13.66 (e)	11.43 (e)	0.31	2.97	46.42
MAP	7.18	5.82	0.17	1.51	26.54
MAI	6.48	5.41	0.15	1.50	24.71
Landscape	37.53 (c)	36.89 (c)	0.50	9.86	70.44
Slope	37.53	36.89	0.50	9.86	70.44
Management	48.81 (b)	49.09 (b)	0.48	20.06	78.07
Grazing intensity	48.81	49.09	0.48	20.06	78.07
Episode 2022					
Climate	65.45 (a)	66.14 (a)	0.35	41.00	85.16
MAT10	39.38	39.16	0.21	27.00	53.60
MAI10	26.07	26.21	0.22	12.93	39.20
Landscape	19.15 (d)	17.52 (d)	0.29	7.07	43.91
Slope	7.07	5.54	0.18	1.20	26.54
Elevation	12.08	11.90	0.17	2.23	23.39
Management	15.39 (e)	15.40 (e)	0.24	3.32	30.60
Grazing intensity	15.39	15.40	0.24	3.32	30.60

Supplementary Figure

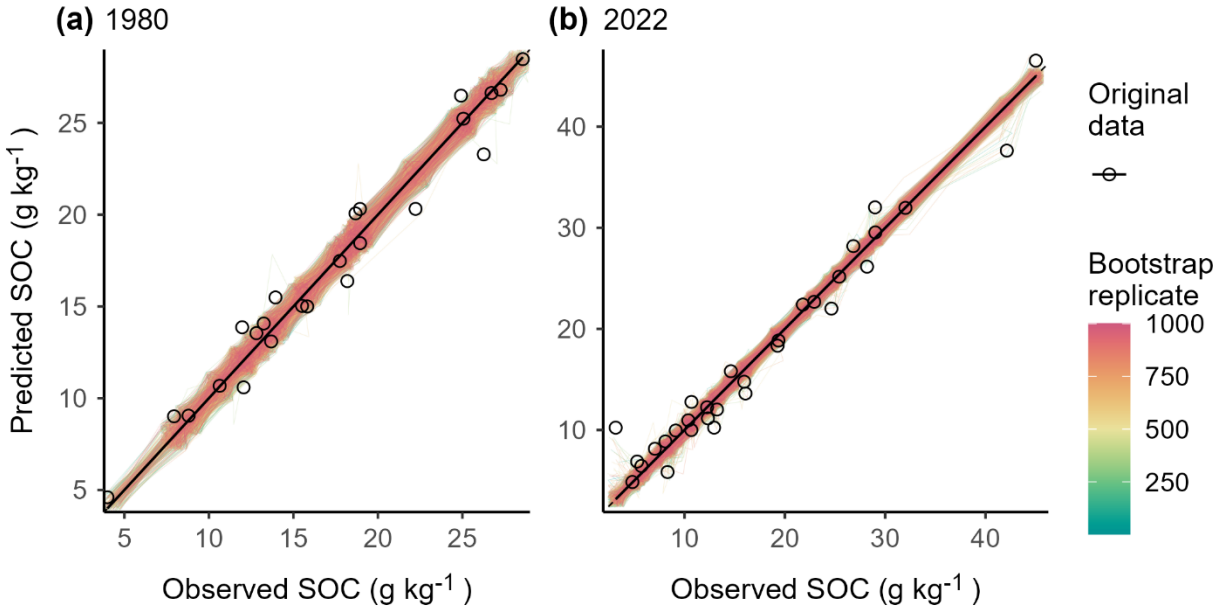

Figure S1. Comparison between the field-observed and model-predicted SOC contents. Each color line represents one model prediction using bootstrapping (N = 1,000).