Supplementary Material for

The spatiotemporal dynamics of ecosystem services driven by human modification over the past seven decades: a case study of Sihu agricultural watershed

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Table S1. The rice yield in different countries of different years.

Rice（t）	1950	1980	1990	2001	2010	2018
Jingzhou	225800	748210	315065	274160	230790	219575
Jiangling	-	-	295910	285460	293965	284725
Jianli	270190	774340	933735	777330	1338505	1402975
Honghu	128400	461460	479980	485185	649630	699000
Qianjiang	96140.7085	311694.2642	371617.97	246233.2638	344945.6297	394973.2362
Shashi	2500	-	92585	65890	86145	73025
Shayang	160326.8423	495893.8931	729512.9747	552259.1743	624411.9092	630488.6113
Shishou	32726.976	89481.776	94344.16	87564.864	51669.5	64429.25
Total	916084.5268	2881079.933	3312750.105	2774082.302	3620062.039	3769191.098

Table S2. The cotton yield in different countries of different years.

Cotton（t）	1950	1980	1990	2001	2010	2018
Jingzhou	5637	16467.55	9899	11140.3335	13960	4245
Jiangling	-	-	9107	13025.25	10424	4444.5
Jianli	8289	12713.8	16704.4	16830.5715	28877	12319.5
Honghu	3739.5	11539.27	15266.6665	9733.3335	10357.3335	4615.75
Qianjiang	3888.7244	12101.2169	15530.8229	24400.879	30331.4735	7596.6824
Shashi	63	-	2585.4	4296.2	4749	2064.25
Shayang	1045.1311	6029.032	10278.0728	8148.0576	9363.992	2858.3043
Shishou	1659.312	2815.9176	4596.32	4695.066667	12361.5	6525
Total	24321.6675	61666.7865	83967.6822	92269.69177	120424.299	44668.9867

Table S3. The oil crop yield in different countries of different years.

Oil crop（t）	1950	1980	1990	2001	2010	2018
Jingzhou	7251.3	8299.4675	25932.8	43333.3335	57679	44162.25
Jiangling	-	-	24218.6	47648.5	70084	74518.75
Jianli	4501.2	14908.48	47025.9	80220.143	119038.3335	119321.75
Honghu	4733.5	9178.75	26466.6665	45950	83033.3335	86470
Qianjiang	2436.7516	5021.8487	24640.8449	59087.163	77539.0561	60185.187
Shashi	-	-	6245.2	6881	10098	8056.75
Shayang	2948.5191	12295.5076	52210.5534	89594.1934	115298.3404	121486.2397
Shishou	1006.4248	2849.08728	10161.5104	15378.22933	26317.75	28660.5
Total	22877.6955	52553.14108	216902.0752	388092.5622	559087.8135	542861.4267

Table S4. The freshwater products in different countries of different years.

Freshwater products（t）	1950	1980	1990	2001	2010	2018
Jingzhou	4269	15997.28	36062.4	43212	117864.6665	128660.75
Jiangling	-	-	16800.4	21135	29973	34099.75
Jianli	7374.3	19996.6	69120	122475	261554.6665	292312.75
Honghu	11931	23062.6	118701.8	187442.25	392863	454807.75
Qianjiang	1486.4292	9431.63	42380.5311	60000.6054	90081.6514	103344.7457
Shashi	62	-	21130.4	39050.75	54198	55327
Shayang	1848.7536	9361.3119	63388.8907	83224.7788	163896.86	184756.3198
Shishou	646.024	1330.504	9040.84	19701.616	19342.07	20328.27
Total	27617.5068	79179.9259	376625.2618	576242.0002	1129773.914	1273637.336

Table S5. The sensitive analysis of parameters through SWAT-CUP in outlet of Sihu watershed.

Parameters	P-Value	t-Stat
1:R__CN2.mgt	0.00	8.79
15:V__CH_N2.rte	0.00	4.04
10:V__ESCO.hru	0.00	3.08
13:R__SLSUBBSN.hru	0.01	-2.63
5:R__SOL_AWC(..).sol	0.02	2.25
21:V__SMTMP.bsn	0.03	-2.12
18:V__RCHRG_DP.gw	0.07	1.81
9:V__REVAPMN.gw	0.09	-1.71
14:V__CH_K2.rte	0.13	1.53
8:V__GW_REVAP.gw	0.14	-1.50
22:V__SMFMX.bsn	0.22	-1.22
12:R__OV_N.hru	0.30	1.04
19:V__SURLAG.bsn	0.32	1.00
2:V__ALPHA_BF.gw	0.38	-0.88
17:V__EPCO.hru	0.44	-0.77
4:V__GWQMN.gw	0.46	-0.74
16:V__ALPHA_BNK.rte	0.51	0.67
6:R__SOL_K(..).sol	0.57	0.57
11:R__HRU_SLP.hru	0.64	-0.47
7:R__SOL_BD(..).sol	0.71	-0.37
20:V__SFTMP.bsn	0.85	-0.19
23:V__SMFMN.bsn	0.87	-0.16
3:V__GW_DELAY.gw	0.97	0.04

Table S6. The simulation results of monthly runoff during the period of model calibration (2015-2017) and model validation (2018-2019).

	Parameters	Wateshed oullet (FLOW_OUT_16)
2015-2017	R2	0.79
	Nash-Suttcliffe (NS)	0.77

2018-2019	R2	0.75
	Nash-Suttcliffe (NS)	0.73

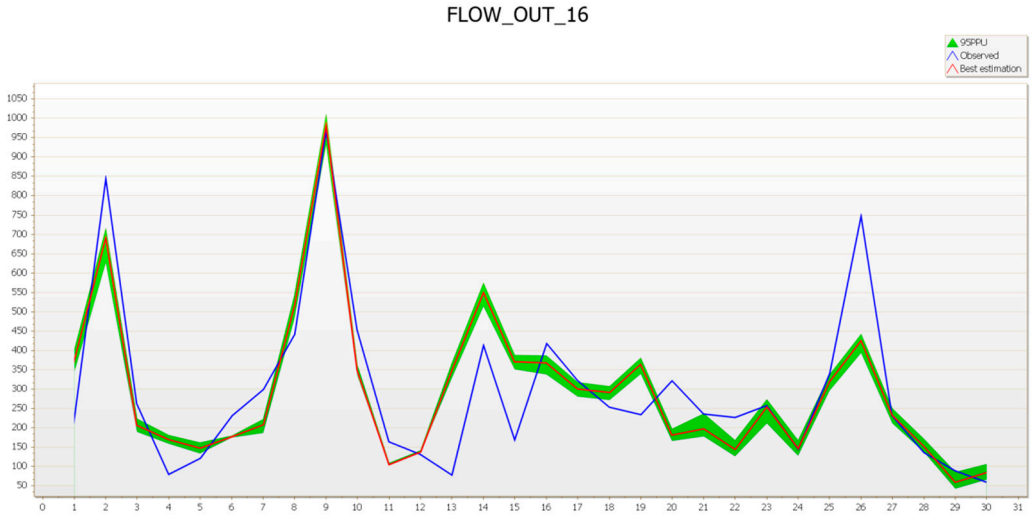

Figure 1. The observed value and predicted value on monthly runoff of watershed outlet (FLOW_OUT_16) in 2015-2019.

Table S7. The Biophysical table for the habitat quality model (the parameters in the habitat quality model are cited from references[1–4].

			Threats				
		Habitat score	Agriculture	settlements	Road	Canals	Levees
Properties	Weight	-	0.7	0.9	0.5	0.5	0.5
	Maximum distance (km)	-	3	5	3	3	3
	Function		Exponential	Exponential	Linear	Linear	Linear
Relative sensitivity of different land-use classes to threats	Wetland	0.9	0.8	0.7	0.5	0.7	0.5
	Lake	0.9	0.8	0.7	0.5	0.7	0.5
	Settlement	0	0	0	0	0	0
	Agriculture	0.4	0	0.5	0.5	0.5	0.5
	Ponds	0.3	0.7	0.5	0.5	0.5	0.5

Table S8. The biodiversity of Honghu Lake in different decades (the data of biological species is from the relevant reference[5–9].)

Biological specials	**1950s**	**1980s**	**1990s**	**2010s**
Fish	114	79	57	49
Aquatic Plant	158	68	94	93
Benthos	98	66	71	18
Bird	167	167	130	49
Biodiversity index	1.468	1.361	1.353	1.041

Table S9. The livestock breeding pollution

Countries	Pig	Cow	Sheep	Poultry	TN (t)	TP(t)
Jingzhou	368500	1487	9515	16531800	3089.681	892.790
Jiangling	263200	3979	6809	5244400	1663.493	480.681
Jianli	725000	5068	1630	14572500	4448.252	1285.361
Honghu	355200	2322	1741	3779800	1868.286	539.858
Shayang	917000	48013	23234	12036400	5928.229	1713.013
Qianjiang	787100	12476	15160	10668180	4518.149	1305.558
Sum	3416000	73345	58089	62833080	21516.089	6217.261

Table S10. The aquaculture pollution

Countries	Freshwater Products（t）	TN (t)	TP(t)
Jingzhou	108579	146.038755	10.315005
Shashi	43753	58.847785	4.156535
Jiangling	29259	39.353355	2.779605
Jianli	256754	345.33413	24.39163
Honghu	394247	530.262215	37.453465
Shayang	171848	231.13556	16.32556
Qianjiang	103632	139.38504	9.84504
Sum	1108072	1490.35684	105.26684

Table S11. The rural life pollution

Countries	Population（ten thousand）	TN (t)	TP(t)
Jingzhou	46.97	729.088	62.322
Shashi	117.85	1829.316	156.369
Jiangling	29.28	454.496	38.850
Jianli	66.81	1037.052	88.647
Honghu	26.65	413.672	35.360
Shayang	11.73	182.078	15.564
Qianjiang	51.1785	794.414	67.906
Sum	350.4685	5440.117	465.018

Table S12. The Biophysical table for the Nutrients Delivery model

description	lucode	load_n	eff_n	crit_len_n	load_p	eff_p	crit_len_p	proportion_subsurface_n
Nodata	0	0	0	0	0	0	0	0
Wetland	1	0	0.46	300	0	0.62	300	0
Lake	2	0	0.36	150	0	0.52	150	0
Settlement	3	5.793	0	30	0.495	0	30	0
Agriculture	4	18	0.15	30	3	0.15	30	0
Pond	5	9.5	0.15	30	0.55	0.15	30	0

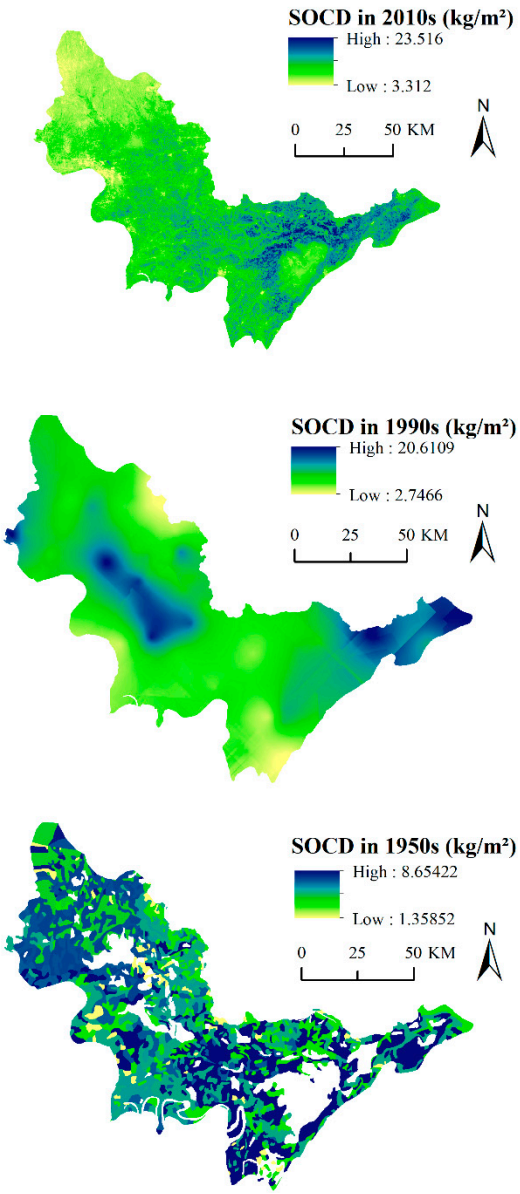

Figure S2. The soil organic matter and PH value in 1950s, 1990s, 2010s. (The data of SOCD in 2010s was based on the research of Liu et al and downloaded from National Earth System Data Center (http://www.geodata.cn (accessed on3 February 2023)). SOCD in 1990s was generated by ordinary kriging method based on the data of 112 soil profiles from soil chronicles. SOCD in 1950s was extracted from the soil map of Jingzhou in 1959.

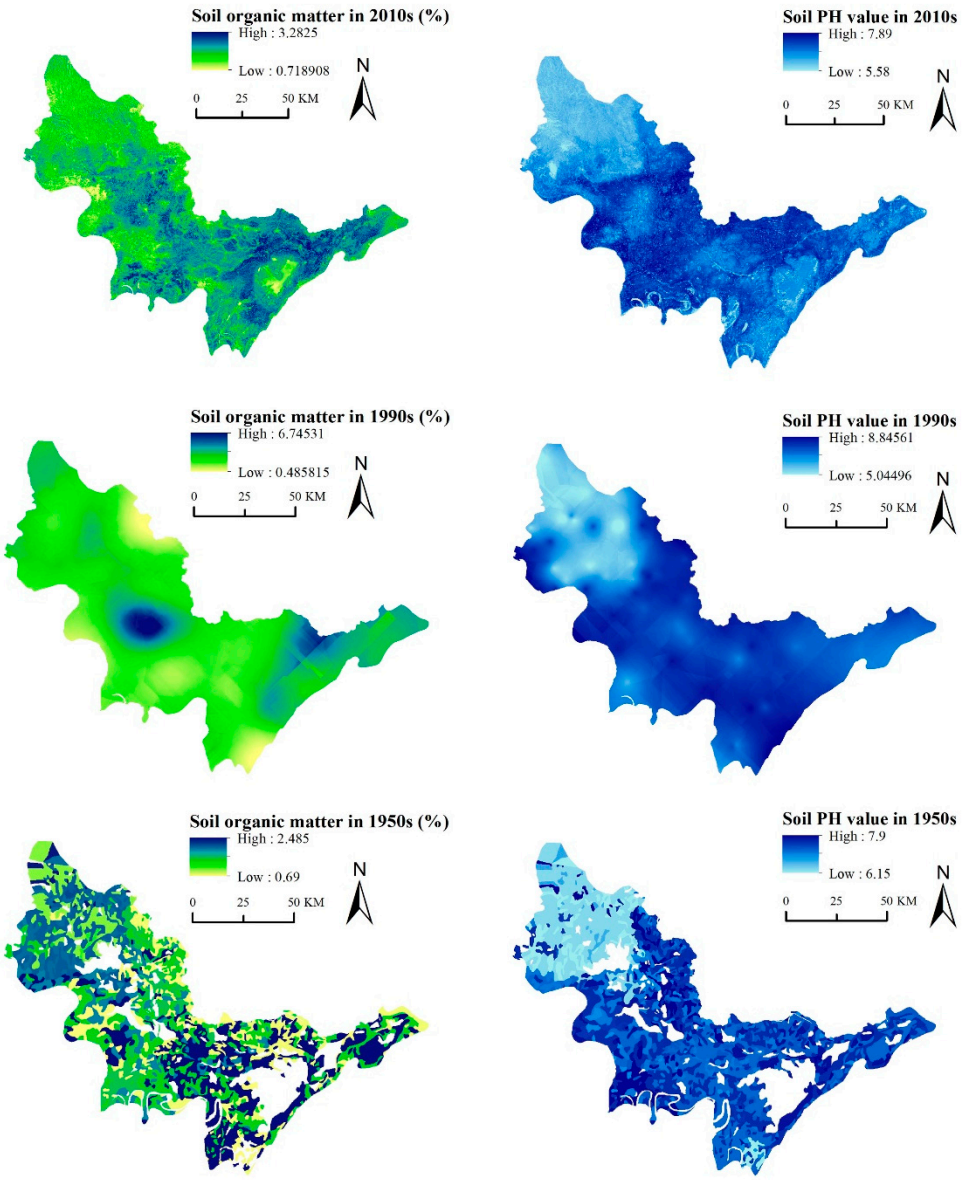

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Table S13. Overview of potential human modification drivers of ecosystem services

Human modification drivers	Description	Unit	Source
Lake reclamation intensity	Lake area	hm^2/km^2	The land use data
Population density	The total number of people per square kilometers	$Inhabitants/km^2$	the rural statistical yearbook of Hubei, the statistical yearbook of Jingzhou and the statistical yearbook of Jingmen
Fertilizer intensity	The total yearly fertilizer of per square kilometers	$t/km^2 \cdot y$	

Insecticide intensity	The total yearly fertilizer of per square kilometers	$t/km^{2}{\cdot}y$	(http://data.cnki.net (accessed on3 February 2023)).
Hydraulic engineering intensity	The total ditch length of per square kilometers	Km/km^{2}	The map of ditch distribution in 1980s and 2010s were obtained from Jingzhou Sihu Basin Engineering Management Bureau

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