Forecasting and Evaluation of Ecosystem Services Supply-Demand Under SSP-RCP Scenarios in the Henan Segment of the Yellow River Basin, China

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Table S1. Driving factors for future landscape simulation.

Type of driving factor	Driving factor
Natural factor	DEM
	Slope aspect
	Slope gradient
	land surface relief
	precipitation
Socio-economic factor	GDP
	Population Density
Accessibility factor	Distance from the road
	Distance from the railway
	Distance from the streams

Table S2. Weight of each landscape's neighborhood extension capability.

Landscape	Arable land	Forest land	Grassland	Water bodies	Construction land	Unused land
Neighborhood weight	0.8	0.7	0.7	0.6	0.9	0.6

Table S3. Cost conversion coefficient among landscapes. A, B, C, D, E, and F stand for Cropland, Forest, Grassland, Waterbody, Urban, and Bare land respectively.

	SSP1-RCP2.6						SSP2-RCP4.5						SSP5-8.5					
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
A	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	1	1	0
B	1	1	1	0	0	0	1	1	1	0	1	0	1	1	1	0	1	0
C	1	1	1	0	1	0	1	1	1	0	1	0	1	1	1	0	1	0
D	1	1	1	1	0	0	1	0	0	1	1	0	1	0	0	1	1	0
E	0	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	1	0
F	0	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1

Note: 'o′ indicates that a transformation between LUC is unlikely to occur, while 'ı′ indicates that it is likely to occur. The coefficients are derived based on (Ding & Sun, 2023) considering factors such as [e.g., land use change probability, economic cost, environmental

impact, or expert judgment]. The numbers in each row of the table represent the cost conversion coefficients between different land use types, reflecting the difficulty of transitioning from different initial land types to other land types.

Reference: Supply-demand analysis of ecosystem services based on socioeconomic and cli mate scenarios in North China. Ecological Indicators. 2023, 146, 109906. https://doi.org/10.1016/j.ecolind.2023.109906

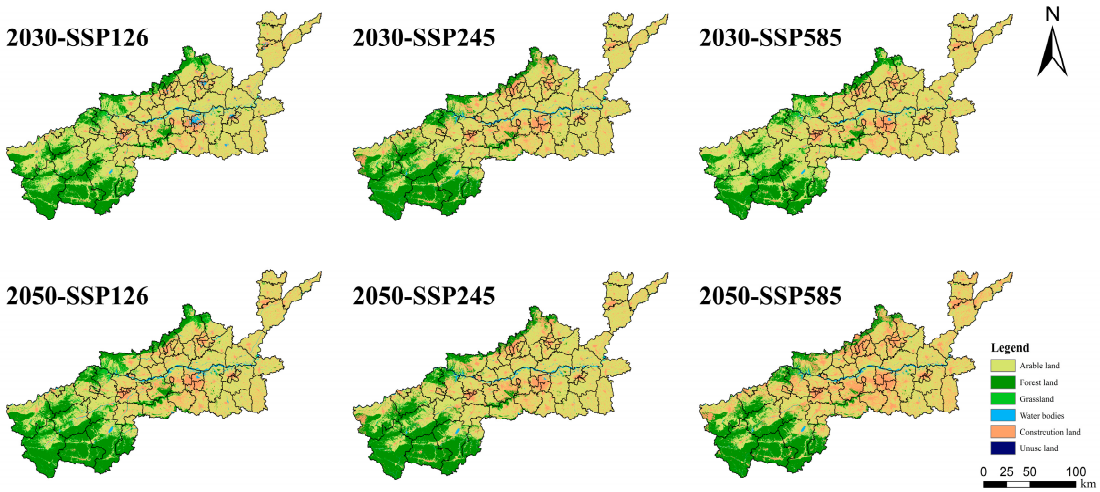


Figure S1. Spatial patterns of land use types under different SSP-RCP scenarios.

Table S4. Biophysical table of input parameters for the WY module of the InVEST model

LULC_desc	Lucode	K_c	root_depth	LULC_veg
Cropland	1	0.7	2100	1
Forest	2	1	6300	1
Grass	3	0.65	2600	1
Water	4	1	1	0
Construction	5	0.4	100	0
UnusedLand	6	0.3	300	1

Table S5. Z-value of water production input parameters, actual and simulated water production and error

Value-Z	Actual water yield ($\times 10^8 m^3$)	Simulated water yield ($\times 10^8 m^3$)	Error (%)
3.7	108.386	108.26	0.12%

Table S6. The regression parameters of GWR Model for the demand projections of WY

Model parameter	Kernel type	Bandwidth method	R^2	Adjusted R^2
Parameter value	Fixation	AICc	0.95	0.94



Figure S2. Spatial distribution of the North China plain, the North China mountains and Hilly areas, and the Hanzhong Basin.

Table S7. Carbon density of land use in the ecological zones of the HYRB(Mg/ha). **The carbon density values for different land use types were established by compiling carbon density values from multiple studies, and the mean synthesis method was ultimately used to calculate the carbon density for different land use types in this study.**

Ecological zone	Land use type	Aboveground carbon density	Belowground carbon density	Soil carbon density
North China mountains and Hilly areas	Farmland	0.00	0.00	67.90
	Forestland	35.24	8.97	111.41
	Grassland	1.34	7.63	65.70
	Water bodies	0.09	0.00	0.00
	Construction land	0.73	7.99	0.00
	Unused land	0.51	0.76	21.41
North China plain	Farmland	0.00	0.00	71.70
	Forestland	36.22	8.75	55.76
	Grassland	0.0012	1.63	40.81
	Water bodies	0.09	0.00	0.00
	Construction land	0.73	7.99	0.00
	Unused land	0.001	0.76	113.26
Hanzhong Basin	Farmland	0.00	0.00	78.85
	Forestland	46.04	8.76	107.22
	Grassland	1.20	1.04	53.07
	Water bodies	0.09	0.00	0.00
	Construction land	0.73	7.99	0.00
	Unused land	2.50	1.75	41.4

Table S8. Fitting curves for carbon emissions and R^2 at County (district) scale in HYRB

County (district)	Fitting Curve	R^2	County (district)	Fitting Curve	R^2
Boai	y=0.1184x-235.593	0.94	Qi	y=0.119x-236.901	0.96
Fanxian	y=0.1038x-206.41	0.95	Kaifeng	y=0.2509x-500.112	0.93
Fengqiu	y=0.1525x-303.654	0.94	Lankao	y=0.1674x-333.67	0.94
Fengquan	y=0.0614x-122.148	0.86	Laocheng	y=0.0619x-123.092	0.88
Hubin	y=0.0886x-176.222	0.87	Luanchuan	y=0.1202x-239.888	0.89
Hualong	y=0.2215x-440.648	0.93	Luolong	y=0.223x-444.54	0.91
Huixian	y=0.269x-535.419	0.89	Luoning	y=0.0607x-120.957	0.90
Huojia	y=0.1026x-203.928	0.92	Mengjin	y=0.2058x-409.766	0.93
Jiyuan	y=0.3573x-711.43	0.87	Kaifeng city district	y=0.2536x-504.841	0.94
Jiefang	y=0.0711x-141.416	0.90	Ruyang	y=0.0921x-183.476	0.92
Lingbao	y=0.2632x-523.436	0.87	Shangjie	y=0.0179x-35.486	0.89
Lushi	y=0.0463x-92.1921	0.91	Song	y=0.0969x-193.156	0.89
Macun	y=0.0539x-107.213	0.86	Tongxu	y=0.0952x-189.617	0.94
Mengzhou	y=0.1338x-266.139	0.93	Weishi	y=0.1418x-282.344	0.97
mianchi	y=0.1533x-304.813	0.87	Xigong	y=0.0667x-132.642	0.88
Muye	y=0.0927x-184.431	0.87	Xinan	y=0.1519x-302.514	0.90
Nanle	y=0.1294x-258.025	0.89	Xinmi	y=0.335x-667.228	0.95
Puyang	y=0.3073x-610.832	0.92	Xinzheng	y=0.459x-915.652	0.96
Qinyang	y=0.1314x-261.419	0.94	Xingyang	y=0.3826x-762.468	0.93
Qingfeng	y=0.1637x-325.744	0.95	Yanshi	y=0.2549x-507.632	0.96
Shanyang	y=0.1092x-217.408	0.90	Yichuan	y=0.2212x-440.811	0.94
Shanzhou	y=0.1336x-266.016	0.90	Yiyang	y=0.1997x-398.295	0.91
Taiqian	y=0.0654x-130.075	0.90	Zhongmou	y=0.5330x-1063.97	0.93
Weibin	y=0.0695x-138.277	0.93	Zhongyuan	y=0.2449x-487.71	0.90
Weihui	y=0.1561x-310.518	0.91	Chanhehuizu	y=0.0281x-55.8925	0.89
Wen	y=0.0949x-188.776	0.90	Dengfeng	y=0.2722x-542.132	0.92
Wuzhi	y=0.1999x-397.889	0.96	Erqi	y=0.1614x-321.508	0.92
Xinxiang	y=0.1896x-377.808	0.91	Gongyi	y=0.3004x-597.98	0.91
Xiuwu	y=0.1551x-308.766	0.92	Guanchenghuizu	y=0.2356x-469.464	0.91
Yanjin	y=0.1719x-342.636	0.93	Hongqi	y=0.0748x-148.957	0.89
Yima	y=0.0632x-125.901	0.92	Huiji	y=0.2056x-409.89	0.95
Yuanyang	y=0.3111x-620.138	0.95	Jili	y=0.046x-91.4235	0.89
Changyuan	y=0.291x-580.395	0.94	Jianxi	y=0.084x-167.147	0.90
Zhongzhan	y=0.0445x-88.5223	0.88	Jinshui	y=0.3234x-643.966	0.85

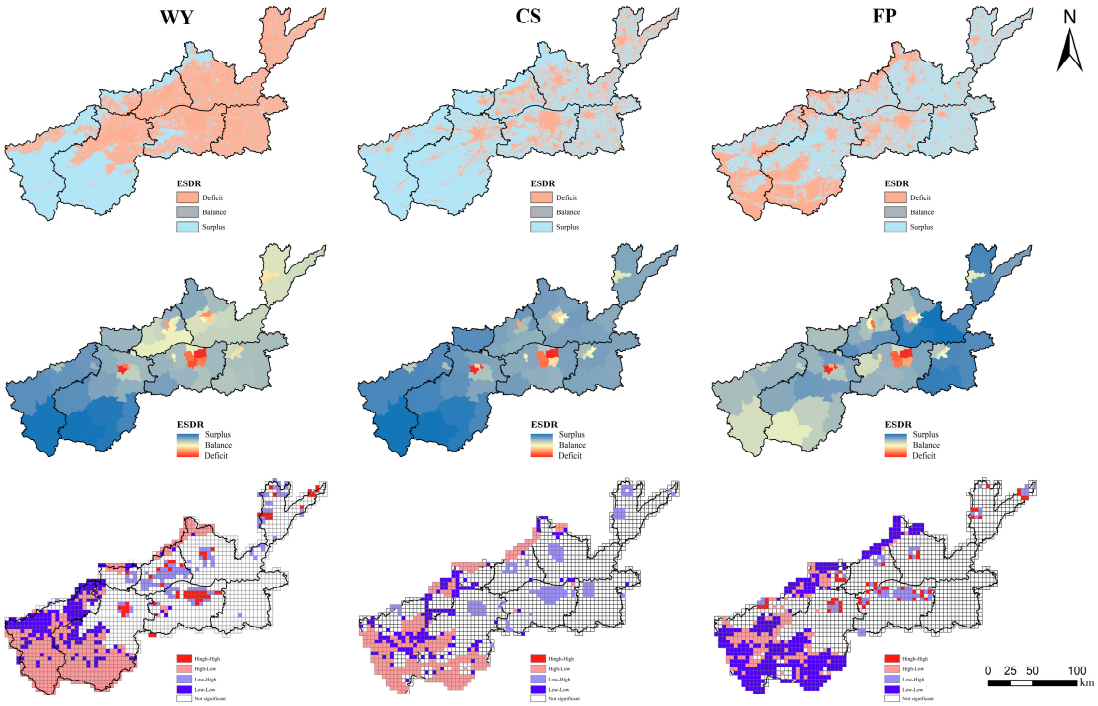


Figure S3. ESDR and Bivariate LISA cluster maps between the supply and demand in 2020. The first row is for ESs supply in 2020 and the second row is for ESs demand in 2020

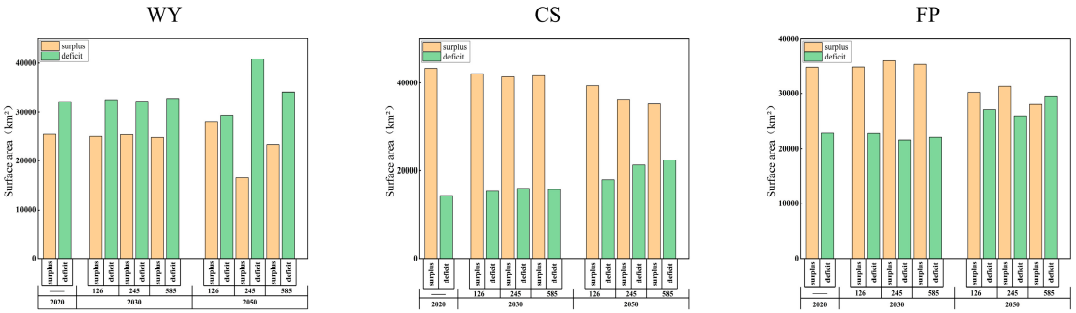


Figure S4. Size of the break-even zone under scenarios 2020-2050

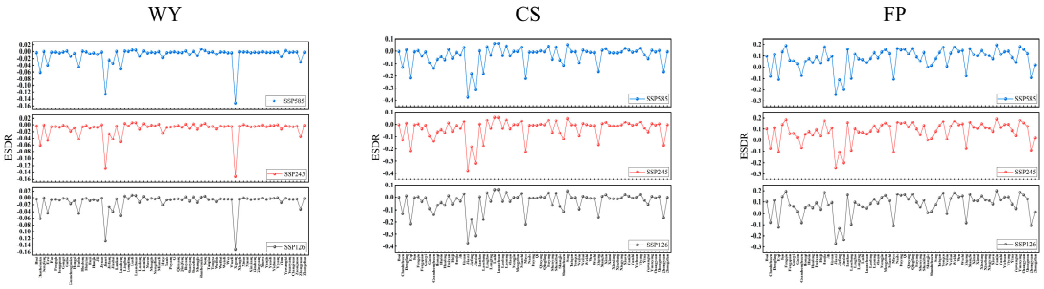


Figure S5. 2030 County supply/demand ratio under different scenarios

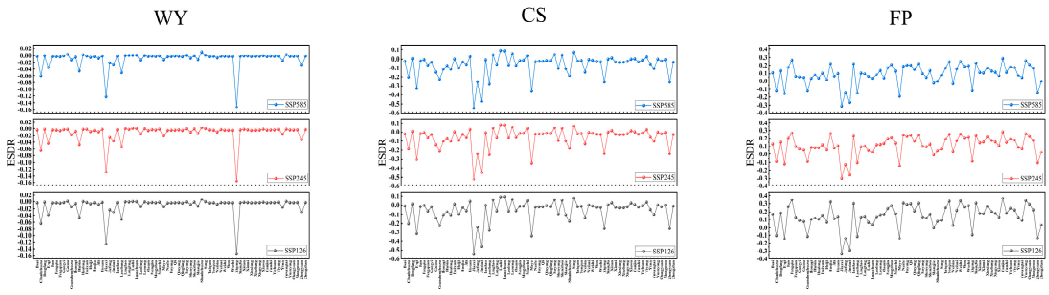


Figure S6. 2050 County supply/demand ratio under different scenarios

Term list

HYRB	Henan Segment of the Yellow River Basin
ESSD	Ecosystem Service Supply and Demand
ESs	Ecosystem Services
WY	Water yield
CS	Carbon storage
FP	Food production
ESDR	Ecosystem Service Demand-Supply Ratio
CMIP6	the sixth phase of the Coupled Model Intercomparison Project
RCPs	Representative Concentration Pathways
SSPs	Shared Socioeconomic Pathways
CA	Cellular automaton
PLUS	Patch-generating Land Use Simulation
GWR	Geographically weighted regression
CEADs	Carbon Emission Accounts and Datasets for China
LISA	Local Indicators of Spatial Association