

1 Table S1 Comparison of remotely interpreted land-use data with land survey data.

Land-use type	Area of remote sensing interpretation (S)	Area of survey data (T)	The proportion of area error to land survey area ((S-T)/T*100%)	User's accuracy
Cropland	17529	15071	16.30%	90.21%
Woodland	2794	9553	-70.75%	87.43%
Grassland	23447	20242	15.83%	92.04%
Construction land	2490	3504	-28.94%	86.83%
Water Area	1023	1081	-5.35%	83.86%
Unused land	4665	2497	86.80%	91.62%

Area error rate is 31% (the proportion of error area to land survey area).

2 Table S2 Categories of land use

Land-use type	First land survey		Second land survey		Third land survey	
	Land code	Land type	Land code	Land type	Land code	Land type
Cropland	11	Paddy fields				
	12	fields on hill tops which depend on rains for water	011	Paddy fields	0101	Paddy fields
	13	irrigated land	012	irrigated land	0102	irrigated land
	14	dry land	013	dry land	0103	dry land
	15	vegetable field				
	21	Orchards	021	Orchards	0201	Orchards
	25	Other Gardens				
	22	mulberry field	023	Other Gardens	0204	Other Gardens
	87	A ridge in sloping farmland used for water storage and slope protection	123	A ridge in sloping farmland used for water storage and slope protection	1203	A ridge in sloping farmland used for water storage and slope protection
	63	rural roads	104	rural roads	1006	rural roads
Woodland	77	ditch	117	ditch	1107	ditch
	31	closed forest land	031	closed forest land	0301	arbor forest
					0302	bamboo forest
	32	shrub forest	032	shrub forest	0305	shrub forest
	33	scatterd woodland				
	34	un-closed afforestation land	033	other wooded land	0307	other wooded land
	35	slash				
Grassland	36	nursery land				
	41	natural grassland	041	natural grassland	0401	natural grassland
	42	artificial grassland	042	artificial grassland	0403	artificial grassland
	43	other grassland	043	other grassland	0404	other grassland
Construct ion land	81	barren grassland				
	50A	cities	201	cities	201	cities
	51B	towns	202	towns	202	towns
	52	rural settlements	203	villages	203	villages

Land-use type	First land survey		Second land survey		Third land survey	
	Land code	Land type	Land code	Land type	Land code	Land type
	53	separate industrial and mining land	204	mining sites	204	mining sites
	54	saltpan				
	55	special land	205	special land	205	special land
	61	railways	101	railways	1001	railways
					1002	land for rail transit
	62	highway land	102	highway land	1003	highway land
	64	civilian airport	105	airport site	1007	airport site
	65	port and dock land	106	port and dock land	1008	port and dock land
			107	and for pipelines	1009	and for pipelines
	78	hydraulic engineering land	118	hydraulic engineering land	1109	hydraulic engineering land
Water area	71	rivers	111	rivers	1101	rivers
	72	lakes	112	lakes	1102	lakes
	73	reservoirs	113	reservoirs	1103	reservoirs
	74	ponds	114	ponds	1104	ponds
	75	reed land			0304	forest swamps
					0306	scrub swamp
					0402	swamp grassland
	76	mudflat	116	inland mudflats	1106	inland mudflats
	83	swamps	125	swamps	1108	swamps
			122	agricultural land for facilities	1202	agricultural land for facilities
Unused land	82	saline soil	124	saline soil	1204	saline soil
	84	sandy land	126	sandy land	1205	sandy land
	85	bare ground	127	bare ground	1206	bare ground
	86	bare gravel land			1207	bare gravel land
	88	other unused land				

3 Table S3 Parameters of ELAS under the four scenarios in Ningxia

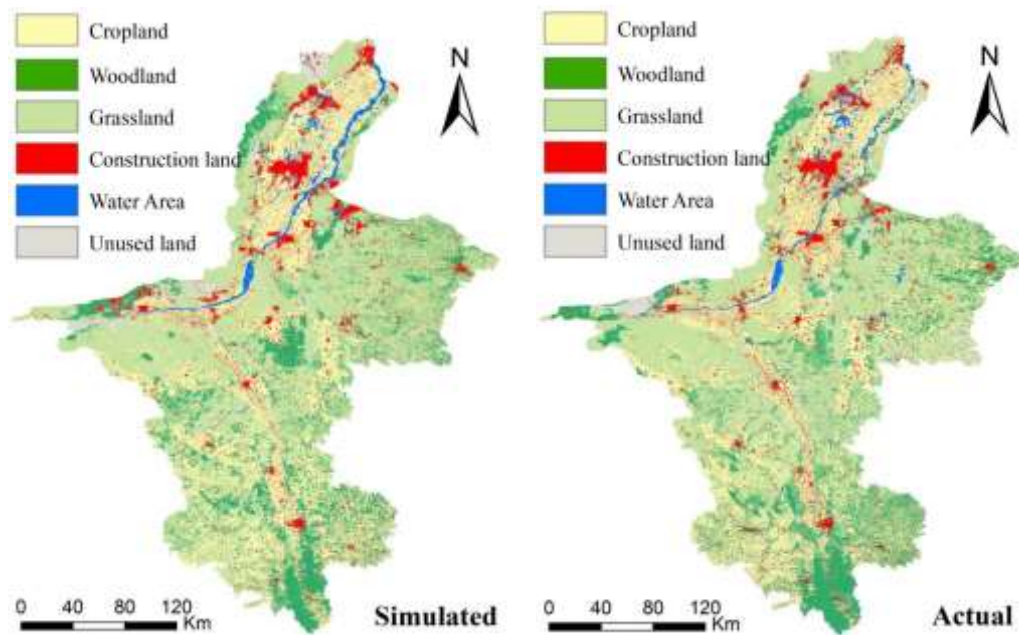
Scenario		Cropland	Woodland	Grassland	Construction land	Water Area	Unused land
2000-2020		0.51	0.69	0.54	0.61	0.7	0.9
	ND	0.51	0.69	0.54	0.61	0.7	0.9
2020-2030	RED	0.6	0.72	0.6	0.85	0.6	0.78
	ELP	0.3	0.5	0.65	0.5	0.7	0.92
	SD	0.3	0.76	0.62	0.65	0.75	0.88

4 Table S4 Parameters of cost matrix under the four scenarios (ND/RED/ELP/SD) in Ningxia

Land-use type	Cropland	Woodland	Grassland	Construction land	Water Area	Unused land
Cropland	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\0\0\0	1\0\0\0
Woodland	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\0\0\0	1\1\0\0
Grassland	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1
Construction land	1\0\0\1	1\0\1\1	1\0\1\1	1\1\1\1	1\0\0\0	1\0\0\0
Water Area	1\0\1\1	1\0\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\0\0\1
Unused land	1\1\1\1	1\1\1\1	1\1\1\1	1\1\1\1	1\0\1\1	1\1\1\1

0 means no conversion and 1 means conversion is possible

5 Fig S1 Comparison of simulated and actual LULC in 2020.



6 Table S5. The equivalent coefficients of ecosystem service provided by per unit area of terrestrial ecosystems in China.

Ecosystem services	Farmland	Forest	Grassland	Water area	Built-up land	Unused land
Food production	1.00	0.33	0.43	0.49	0.00	0.02
Raw material	0.39	2.98	0.36	0.33	0.00	0.04
Gas regulation	0.72	4.32	1.50	0.94	0.00	0.06
Climate regulation	0.97	4.07	1.56	4.65	0.00	0.13
Water regulation	0.77	4.09	1.52	17.57	0.00	0.07
Waste treatment	1.39	1.72	1.32	14.75	0.00	0.26
Soil maintenance	1.47	4.02	2.24	0.77	0.00	0.17
Biodiversity protection	1.02	4.51	1.87	3.49	0.00	0.40
Landscape aesthetics	0.17	2.08	0.87	4.50	0.00	0.24
Total	7.90	28.12	11.67	47.47	0.00	1.39

Source: Xie et al. (2003, 2008).

7 Table S6 Ecological service value per unit area of different terrestrial ecosystems in Ningxia, unit: CNY/ha/ year

Primary Classification	Secondary Classification	Cropland	Woodland	Grassland	Construct ion land	Water Area	Unused land
Supply services	Food production	2327.50	768.08	1000.83	0.00	1144.52	46.55
	Raw material	907.73	6935.95	837.90	0.00	757.00	93.10
Regulating service	Air regulation	1675.80	10054.80	3491.25	0.00	2182.32	139.65
	Climate regulation	2257.68	9472.93	3630.90	0.00	10813.57	302.58
	Water conservation	1792.18	9519.48	3537.80	-8094.82	40895.11	162.93
	Waste treatment	3235.23	4003.30	3072.30	-5702.38	34327.65	605.15
Support services	Soil formation and protection	3421.43	9356.55	5213.60	0.00	1781.94	395.68
	Biodiversity conservation	2374.05	10497.03	4352.43	0.00	8199.52	931.00
Cultural	Recreation and	395.68	4841.20	2024.93	558.60	10465.06	558.60

services	culture						
Total		18387.25	65449.30	27161.93	-13238.60	110486.69	3235.23

8 Table S7 Land use and ESV transfer matrix of Ningxia from 2000 to 2030 unit:km²、10⁹CNY/km2

Scenarios			Cropland	Woodland	Grassland	Construction land	Water Area	Unused land
2000-2020	Cropland	Area	—	1602.90	1216.26	1049.95	105.24	140.16
		ESV	—	75.44	10.67	-33.21	9.69	-2.12
	Woodland	Area	1147.49	—	1300.12	157.09	47.17	93.82
		ESV	-54.00	—	-49.78	-12.36	2.12	-5.84
	Grassland	Area	4011.91	4041.70	—	835.86	170.04	925.89
		ESV	-35.20	154.75	—	-33.77	14.17	-22.15
	Construction land	Area	323.20	110.64	164.73	—	28.29	27.78
		ESV	10.22	8.71	6.66	—	3.50	0.46
	Water Area	Area	318.45	88.28	68.23	65.56	—	10.79
		ESV	-29.33	-3.98	-5.68	-8.11	—	-1.16
	Unused land	Area	1039.54	811.41	2881.54	280.56	176.19	—
		ESV	15.75	50.48	68.95	-4.62	18.90	—
	Total ESV increase		25.97	289.37	86.27	0.00	48.38	0.46
	Total ESV reduction		-118.54	-3.98	-55.46	-92.07	0.00	-31.27
2020-ND	Cropland	Area	—	211.53	82.76	71.15	0.08	0.00
		ESV	—	16.41	1.33	-7.43	0.00	-0.24
	Woodland	Area	360.60	—	168.68	29.60	0.03	0.00
		ESV	-12.15	—	-4.84	-5.04	0.00	-0.81
	Grassland	Area	2288.76	1600.83	—	248.86	47.33	0.00
		ESV	-13.57	42.43	—	-15.98	0.00	-12.24
	Construction land	Area	0.00	0.00	0.00	—	0.00	0.00
		ESV	7.46	7.70	1.90	—	0.00	0.11
	Water Area	Area	1.08	0.23	22.89	4.09	—	0.00
		ESV	-4.13	-0.69	-0.01	-0.85	—	0.00
	Unused land	Area	0.60	0.36	0.00	0.20	0.00	—
		ESV	3.61	9.07	4.94	-5.55	0.00	—
	Total ESV increase		11.07	75.6	8.16	0.00	0.00	0.11
	Total ESV reduction		-29.85	-0.69	-4.85	-34.85	0.00	-13.30
2020-RED	Cropland	Area	—	211.53	82.76	71.15	0.08	0.00
		ESV	—	9.96	0.73	-2.25	0.01	0.00
	Woodland	Area	360.60	—	168.68	29.60	0.03	0.00
		ESV	-16.97	—	-6.46	-2.33	0.00	0.00
	Grassland	Area	2288.76	1600.83	—	248.86	47.33	0.00
		ESV	-20.08	61.29	—	-10.05	3.94	0.00
	Construction land	Area	0.00	0.00	0.00	—	0.00	0.00
		ESV	0.00	0.00	0.00	—	0.00	0.00
	Water Area	Area	1.08	0.23	22.89	4.09	—	0.00
		ESV	-0.10	-0.01	-1.91	-0.51	—	0.00
	Unused land	Area	0.60	0.36	0.00	0.20	0.00	—
		ESV	0.01	0.02	0.00	0.00	0.00	—
	Total ESV increase		0.01	71.27	0.73	0.00	3.95	0.00
	Total ESV reduction		-37.15	-0.01	-8.37	-15.14	0.00	0.00
2020-ELP	Cropland	Area	—	7.62	4.66	0.00	0.00	0.02
		ESV	—	0.36	0.04	0.00	0.00	0.00
	Woodland	Area	28.38	—	185.27	0.00	0.07	0.40
		ESV	-1.34	—	-7.09	0.00	0.00	-0.02
	Grassland	Area	664.83	3852.98	—	0.00	57.64	698.08
		ESV	-5.83	147.52	—	0.00	4.80	-16.70
	Construction land	Area	0.00	1.20	0.00	—	0.00	0.00
		ESV	0.00	0.09	0.00	—	0.00	0.00

2020-SD	Water Area	Area	4.93	25.83	18.86	0.00	—	0.12
		ESV	-0.45	-1.16	-1.57	0.00	—	-0.01
	Unused land	Area	113.47	1102.23	312.20	0.00	11.18	—
		ESV	1.72	68.57	7.47	0.00	1.20	—
	Total ESV increase		1.72	216.55	7.51	0.00	6.01	0.00
	Total ESV reduction		-7.62	-1.16	-8.66	0.00	0.00	-16.74
	Cropland	Area	—	8.57	4.48	18.04	0.00	0.02
		ESV	—	0.40	0.04	-0.57	0.00	0.00
	Woodland	Area	26.89	—	154.46	51.30	0.05	0.30
		ESV	-1.27	—	-5.91	-4.04	0.00	-0.02
	Grassland	Area	669.81	3584.82	—	263.02	62.56	658.79
		ESV	-5.88	137.25	—	-10.63	5.21	-15.76
	Construction land	Area	15.38	23.60	13.02	—	0.01	0.04
		ESV	0.49	1.86	0.53	—	0.00	0.00
	Water Area	Area	4.77	26.47	18.24	4.68	—	1.15
		ESV	-0.44	-1.19	-1.52	-0.58	—	-0.12
	Unused land	Area	113.57	1032.25	296.27	46.83	11.86	—
		ESV	1.72	64.22	7.09	-0.77	1.27	—
	Total ESV increase		2.21	203.73	7.65	0.00	6.49	0.00
	Total ESV reduction		-7.58	-1.19	-7.43	-16.58	0.00	-15.91