Supplementary Materials

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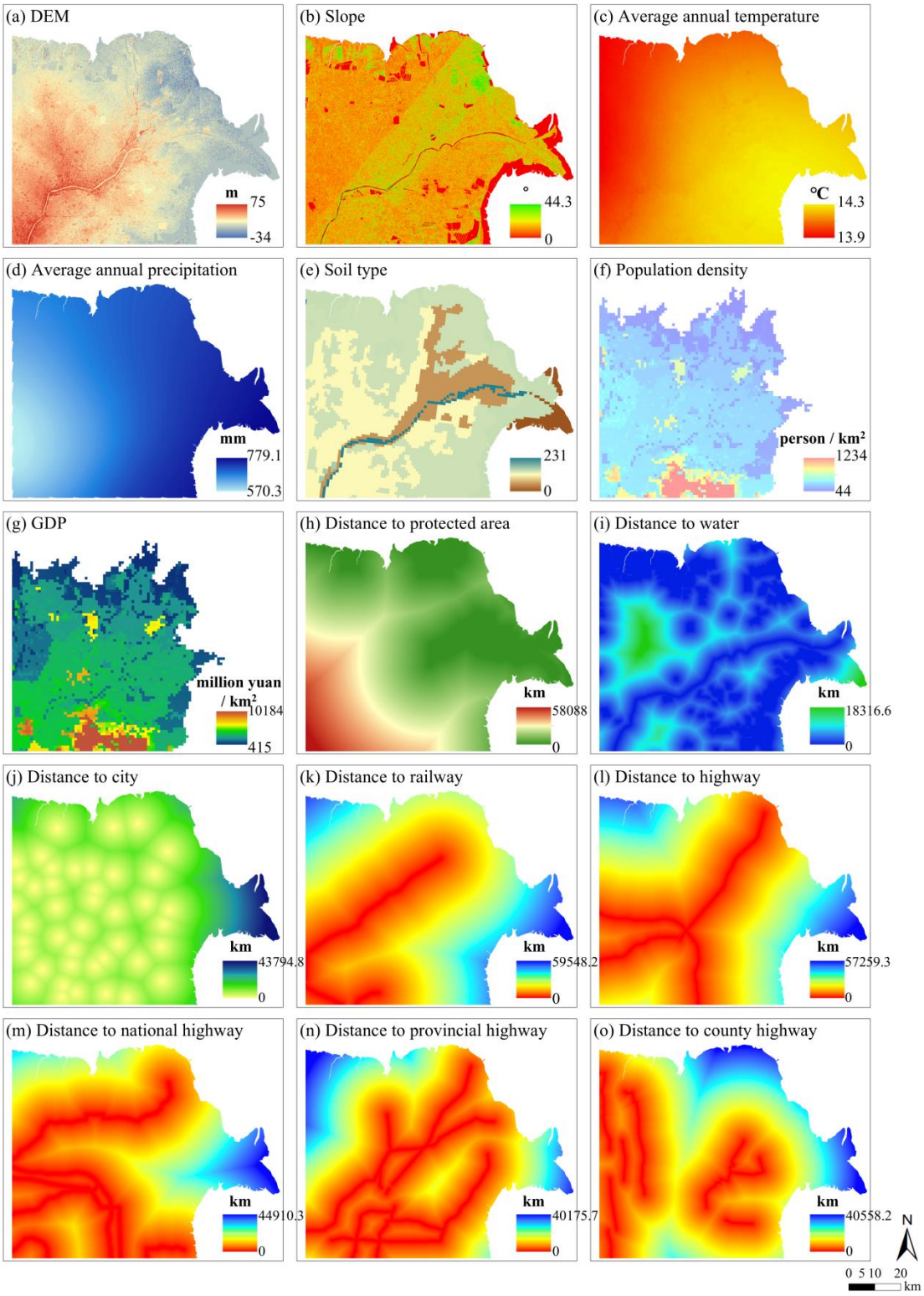


Figure S1. Driving factors of land use change simulation in the YRD.

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Table S1. Confusion matrix for classification accuracy of different land use types. (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

Land use type	PF	DR	WO	GR	RC	LA	RP	BO	WE	TF	SP	CA	CL	UL	Total
PF	3454	19049	0	1	0	3	745	0	0	0	277	0	4060	0	27589
DR	15735	550085	90	6385	7176	199	28896	744	7650	39	10746	17332	22446	0	667523
WO	36	2	6	0	3	0	47	0	0	0	43	0	99	0	236
GR	1610	5218	1841	9780	593	0	9475	102	19455	21744	9524	16539	14949	13	110843
RC	11	412	11	108	12942	0	18	3255	15	2868	5	107	210	0	19962
LA	0	1	0	50	0	11	175	0	18	0	0	30	80	0	365
RP	1619	1653	0	1125	21	0	13317	231	1791	191	1279	5686	4589	0	31502
BO	0	6	0	0	38	0	48	502	14	50	9	1	5	0	673
WE	140	1500	0	1187	49	0	1315	3473	4314	15831	10962	40557	4350	0	83678
TF	0	413	0	2912	624	0	1021	2714	1519	72560	207	4246	499	48	86763
SP	0	14	0	0	0	0	1766	0	307	11	7485	7971	1	0	17555
CA	0	3704	0	46	4	0	12	9	114	189	2271	20901	2197	0	29447
CL	2049	63238	9	1877	111	43	3112	23	2725	2663	22885	972	139977	0	239684
UL	2685	2192	0	999	98	0	3118	0	3033	3654	2340	13293	22291	425	54128
Total	27339	647487	1957	24470	21659	256	63065	11053	40955	119800	68033	127635	215753	4861369948	

Table S2. Neighborhood weight settings for different land use types. (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

Land use type	PF	DR	WO	GR	RC	LA	RP	BO	WE	TF	SP	CA	CL	UL
Neighborhood weight	0.0233	0.0528	0.0008	1.0000	0.0426	0 [1]	0.4064	0.0722	0.3603	0.5272	0.2879	0.7306	0.4412	0.1746

Table S3. Transfer cost matrix setting for the accuracy verification phase. (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

Land use type	PF	DR	WO	GR	RC	LA	RP	BO	WE	TF	SP	CA	CL	UL
PF	1	1	0	0	0	0	0	0	0	0	0	0	1	0
DR	0	1	0	0	0	0	0	0	0	0	0	0	1	0
WO	0	1	1	0	0	0	0	0	0	0	0	0	1	0
GR	0	1	0	1	0	0	0	0	0	1	0	1	1	0
RC	0	1	0	1	1	0	0	0	0	1	0	0	0	0
LA	0	1	0	1	0	1	0	0	0	0	0	0	1	1
RP	0	1	0	0	0	0	1	0	0	0	0	0	1	0

[1] According to the actual land expansion situation, the land use type with a weight of 0 was artificially set to 0.01.

BO	0	1	0	0	1	0	0	1	0	0	0	0	0	0
WE	0	1	0	0	0	0	0	0	1	1	1	1	0	0
TF	0	0	0	0	0	0	0	0	0	1	0	0	0	0
SP	0	0	0	0	0	0	0	0	0	0	1	1	0	0
CA	0	0	0	0	0	0	0	0	0	0	1	1	0	0
CL	0	1	0	0	0	0	0	0	0	0	0	0	1	0
UL	0	1	0	0	0	0	0	0	0	1	0	1	1	1

Table S4. Transfer cost matrix setting under Ecological Protection Scenario (EPS). (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

EPS	**PF**	**DR**	**WO**	**GR**	**RC**	**LA**	**RP**	**BO**	**WE**	**TF**	**SP**	**CA**	**CL**	**UL**
PF	1	1	1	1	1	1	1	1	1	1	0	0	1	0
DR	0	1	1	1	1	1	1	1	1	1	0	0	1	0
WO	0	0	1	1	1	1	1	1	1	1	0	0	0	0
GR	0	1	1	1	1	1	1	1	1	1	0	1	1	0
RC	0	0	1	1	1	1	1	1	1	1	0	0	0	0
LA	0	0	1	1	1	1	1	1	1	1	0	0	0	0
RP	0	0	1	1	1	1	1	1	1	1	0	0	0	0
BO	0	0	1	1	1	1	1	1	1	1	0	0	0	0
WE	0	0	1	1	1	1	1	1	1	1	1	1	0	0
TF	0	0	1	1	1	1	1	1	1	1	0	0	0	0
SP	0	0	1	1	1	1	1	1	1	1	1	1	0	0
CA	0	0	1	1	1	1	1	1	1	1	1	1	0	0
CL	0	1	1	1	1	1	1	1	1	1	0	0	1	0
UL	0	1	1	1	1	1	1	1	1	1	0	1	1	1

Table S5. Transfer cost matrix setting under Economic Growth Scenario (EGS). (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

EGS	**PF**	**DR**	**WO**	**GR**	**RC**	**LA**	**RP**	**BO**	**WE**	**TF**	**SP**	**CA**	**CL**	**UL**
PF	1	1	0	0	0	0	0	0	0	0	0	0	1	0
DR	0	1	0	0	0	0	0	0	0	0	0	0	1	0
WO	0	1	1	0	0	0	0	0	0	0	0	0	1	0
GR	0	1	0	1	0	0	0	0	0	1	0	1	1	0
RC	0	1	0	1	1	0	0	0	0	1	0	0	1	0
LA	0	1	0	1	0	1	0	0	0	0	0	0	1	1
RP	0	1	0	0	0	0	1	0	0	0	0	0	1	0
BO	0	1	0	0	1	0	0	1	0	0	0	0	1	0
WE	0	1	0	0	0	0	0	0	1	1	1	1	1	0
TF	0	0	0	0	0	0	0	0	0	1	0	0	1	0
SP	0	0	0	0	0	0	0	0	0	0	1	1	1	0
CA	0	0	0	0	0	0	0	0	0	0	1	1	1	0
CL	0	0	0	0	0	0	0	0	0	0	0	0	1	0
UL	0	1	0	0	0	0	0	0	0	1	0	1	1	1

Table S6. Changes in carbon storage corresponding to land transfer in the YRD from 1990 to 2020. (PF: paddy field; DR: dryland; WO: woodland; GR: grassland; RC: river and canal; LA: lake; RP: reservoir and pond; BO: bottomland; WE: wetland; TF: tidal flat; SP: salt pan; CA: culture area; CL: construction land; UL: unused land)

Land transfer	Transfer area (km^2)	Total carbon storage change ($\times10^3$ t)	Aboveground carbon storage change ($\times10^3$ t)	Belowground carbon storage change ($\times10^3$ t)	Soil carbon storage change ($\times10^3$ t)	Dead organic carbon storage change ($\times10^3$ t)
PF→PF	22.8915	0	0	0	0	0
PF→DR	114.1866	-90.2074	17.1280	-19.4117	-87.9237	0
PF→WO	0	0	0	0	0	0
PF→GR	0.009	-0.0014	0.0052	0.0011	-0.0088	0.0011
PF→RC	0.0315	-0.0556	-0.0228	-0.0145	-0.0173	-0.0009
PF→LA	0.0351	-0.0444	-0.0254	-0.0161	-0.0018	-0.0011
PF→RP	4.9122	-5.4525	-3.7824	-2.2596	0.7368	-0.1474
PF→BO	0	0	0	0	0	0
PF→WE	0	0	0	0	0	0
PF→TF	0	0	0	0	0	0
PF→SP	1.4193	-5.5778	-1.2064	-0.7097	-3.6192	-0.0426
PF→CA	0.0063	-0.0248	-0.0054	-0.0032	-0.0161	-0.0002
PF→CL	38.4723	-95.7960	-32.7015	-19.2362	-42.7043	-1.1542
PF→UL	0	0	0	0	0	0
Subtotal	181.9638	-197.1600	-20.6107	-41.6498	-133.5543	-1.3452
DR→PF	67.6161	53.4167	-10.1424	11.4947	52.0644	0
DR→DR	1933.8714	0	0	0	0	0
DR→WO	0.0135	0.0435	0.0327	0.0055	0.0019	0.0034
DR→GR	9.405	5.9252	4.0442	2.7275	-1.9751	1.1286
DR→RC	3.2643	-3.1827	-2.8563	-0.9466	0.7181	-0.0979
DR→LA	0.0261	-0.0124	-0.0228	-0.0076	0.0188	-0.0008
DR→RP	62.3412	-19.9492	-57.3539	-18.0789	57.3539	-1.8702
DR→BO	0.252	-0.3629	-0.2142	-0.0706	-0.0706	-0.0076
DR→WE	14.1579	-17.1311	-11.3263	-3.8226	-1.6989	-0.2832
DR→TF	0.0279	-0.0430	-0.0279	-0.0092	-0.0050	-0.0008
DR→SP	6.948	-21.8167	-6.9480	-2.2928	-12.3674	-0.2084
DR→CA	24.8886	-78.1502	-24.8886	-8.2132	-44.3017	-0.7467
DR→CL	177.0903	-301.0535	-177.0903	-58.4398	-60.2107	-5.3127
DR→UL	0	0	0	0	0	0
Subtotal	2299.9023	-382.3163	-286.7939	-77.6537	-10.4723	-7.3963
WO→PF	0.1521	-0.3696	-0.3909	-0.0365	0.0958	-0.0380
WO→DR	10.5849	-34.0834	-25.6155	-4.3398	-1.4819	-2.6462
WO→WO	0.4662	0	0	0	0	0
WO→GR	0.0009	-0.0023	-0.0018	-0.0001	-0.0003	-0.0001
WO→RC	0.0936	-0.3927	-0.3084	-0.0655	0.0075	-0.0262
WO→LA	0	0	0	0	0	0
WO→RP	0.1638	-0.5799	-0.5471	-0.1147	0.1278	-0.0459
WO→BO	0.0315	-0.1468	-0.1030	-0.0217	-0.0132	-0.0088
WO→WE	0	0	0	0	0	0
WO→TF	0	0	0	0	0	0
WO→SP	0.27	-1.7172	-0.9234	-0.1998	-0.5184	-0.0756

WO→CA	0	0	0	0	0	0
WO→CL	2.1186	-10.4235	-7.2456	-1.5678	-1.0169	-0.5932
WO→UL	0	0	0	0	0	0
Subtotal	13.8816	-47.7153	-35.1357	-6.3459	-2.7997	-3.4341
GR→PF	8.1864	1.3098	-4.7481	-0.9824	8.0227	-0.9824
GR→DR	385.7157	-243.0009	-165.8578	-111.8576	81.0003	-46.2859
GR→WO	8.055	20.8625	16.0295	0.9666	2.8193	1.0472
GR→GR	73.1655	0	0	0	0	0
GR→RC	3.2526	-5.2204	-4.2446	-1.8865	1.3986	-0.4879
GR→LA	0	0	0	0	0	0
GR→RP	73.9917	-70.2921	-99.8888	-42.9152	83.6106	-11.0988
GR→BO	0.4518	-0.9352	-0.5783	-0.2575	-0.0316	-0.0678
GR→WE	110.8611	-203.9844	-136.3592	-62.0822	9.9775	-15.5206
GR→TF	133.6833	-290.0928	-191.1671	-82.8836	4.0105	-20.0525
GR→SP	81.1008	-305.7500	-115.9741	-50.2825	-127.3283	-12.1651
GR→CA	172.3689	-649.8308	-246.4875	-106.8687	-270.6192	-25.8553
GR→CL	118.4571	-276.0050	-169.3937	-73.4434	-15.3994	-17.7686
GR→UL	0.0747	-0.1494	-0.1068	-0.0463	0.0149	-0.0112
Subtotal	1169.3646	-2023.0888	-1118.7766	-532.5393	-222.5241	-149.2488
RC→PF	0.0558	0.0985	0.0405	0.0257	0.0307	0.0017
RC→DR	8.4807	8.2687	7.4206	2.4594	-1.8658	0.2544
RC→WO	0.0378	0.1586	0.1246	0.0265	-0.0030	0.0106
RC→GR	0.5508	0.8840	0.7188	0.3195	-0.2368	0.0826
RC→RC	85.4019	0	0	0	0	0
RC→LA	0	0	0	0	0	0
RC→RP	0.0774	0.0507	-0.0035	0	0.0542	0
RC→BO	14.8572	-6.9086	0.3714	0.1486	-7.4286	0
RC→WE	0.0828	-0.0195	0.0062	0.0017	-0.0282	0.0008
RC→TF	11.0178	-6.2251	-1.3772	-0.4407	-4.4071	0
RC→SP	0.0243	-0.0526	-0.0030	-0.0010	-0.0486	0
RC→CA	0.5355	-1.1594	-0.0669	-0.0214	-1.0710	0
RC→CL	1.0836	-0.7856	-0.1355	-0.0433	-0.6068	0
RC→UL	0	0	0	0	0	0
Subtotal	122.2056	-5.6902	7.0959	2.4748	-15.6110	0.3501
LA→PF	0	0	0	0	0	0
LA→DR	0.6561	0.3116	0.5741	0.1903	-0.4724	0.0197
LA→WO	0	0	0	0	0	0
LA→GR	0.3366	0.3719	0.4393	0.1952	-0.3130	0.0505
LA→RC	0	0	0	0	0	0
LA→LA	1.1025	0	0	0	0	0
LA→RP	0.8316	0.1289	-0.0374	0	0.1663	0
LA→BO	0	0	0	0	0	0
LA→WE	0.1062	-0.0781	0.0080	0.0021	-0.0892	0.0011
LA→TF	0.0018	-0.0019	-0.0002	-0.0001	-0.0016	0

LA→SP	0	0	0	0	0	0
LA→CA	0.1512	-0.4029	-0.0189	-0.0060	-0.3780	0
LA→CL	0.4455	-0.5457	-0.0557	-0.0178	-0.4722	0
LA→UL	0	0	0	0	0	0
Subtotal	3.6315	-0.2162	0.9091	0.3637	-1.5602	0.0712
RP→PF	8.28	9.1908	6.3756	3.8088	-1.2420	0.2484
RP→DR	74.2896	23.7727	68.3464	21.5440	-68.3464	2.2287
RP→WO	0	0	0	0	0	0
RP→GR	0.5526	0.5250	0.7460	0.3205	-0.6244	0.0829
RP→RC	0.2511	-0.1645	0.0113	0	-0.1758	0
RP→LA	0	0	0	0	0	0
RP→RP	110.7207	0	0	0	0	0
RP→BO	1.1628	-1.3023	0.0814	0.0116	-1.3954	0
RP→WE	10.5156	-9.3589	1.2619	0.2103	-10.9362	0.1052
RP→TF	0.9657	-1.1782	-0.0773	-0.0386	-1.0623	0
RP→SP	39.1383	-110.3700	-3.1311	-1.5655	-105.6734	0
RP→CA	130.7304	-368.6597	-10.4584	-5.2292	-352.9721	0
RP→CL	35.3349	-48.7622	-2.8268	-1.4134	-44.5220	0
RP→UL	0	0	0	0	0	0
Subtotal	411.9417	-506.3073	60.3291	17.6485	-586.9500	2.6651
BO→PF	0	0	0	0	0	0
BO→DR	8.3241	11.9867	7.0755	2.3307	2.3307	0.2497
BO→WO	0	0	0	0	0	0
BO→GR	0	0	0	0	0	0
BO→RC	1.3653	0.6349	-0.0341	-0.0137	0.6827	0
BO→LA	0	0	0	0	0	0
BO→RP	0.3546	0.3972	-0.0248	-0.0035	0.4255	0
BO→BO	4.8852	0	0	0	0	0
BO→WE	0.0594	0.0137	0.0030	0.0006	0.0095	0.0006
BO→TF	0.198	-0.0198	-0.0297	-0.0099	0.0198	0
BO→SP	0.0369	-0.0627	-0.0055	-0.0018	-0.0554	0
BO→CA	0.0117	-0.0199	-0.0018	-0.0006	-0.0176	0
BO→CL	0.0522	-0.0136	-0.0078	-0.0026	-0.0031	0
BO→UL	0	0	0	0	0	0
Subtotal	15.2874	12.9164	6.9747	2.2992	3.3922	0.2503
WE→PF	14.445	28.8900	9.3893	6.3558	12.8561	0.2889
WE→DR	260.3925	315.0749	208.3140	70.3060	31.2471	5.2079
WE→WO	0	0	0	0	0	0
WE→GR	16.5168	30.3909	20.3157	9.2494	-1.4865	2.3124
WE→RC	1.107	0.2601	-0.0830	-0.0221	0.3764	-0.0111
WE→LA	0.0027	0.0020	-0.0002	-0.0001	0.0023	0
WE→RP	15.9588	19.4697	1.2767	0.6384	17.5547	0
WE→BO	3.906	-0.8984	-0.1953	-0.0391	-0.6250	-0.0391
WE→WE	41.0058	0	0	0	0	0

WE→TF	58.0095	-19.1431	-11.6019	-3.4806	-3.4806	-0.5801
WE→SP	69.1092	-133.3808	-13.8218	-4.1466	-114.7213	-0.6911
WE→CA	182.8161	-352.8351	-36.5632	-10.9690	-303.4747	-1.8282
WE→CL	100.1601	-49.0784	-20.0320	-6.0096	-22.0352	-1.0016
WE→UL	1.1988	-0.1918	-0.2398	-0.0719	0.1319	-0.0120
Subtotal	764.6283	-161.4399	156.7584	61.8107	-383.6549	3.6460
TF→PF	0	0	0	0	0	0
TF→DR	0.0045	0.0069	0.0045	0.0015	0.0008	0.0001
TF→WO	0	0	0	0	0	0
TF→GR	5.7357	12.4465	8.2021	3.5561	-0.1721	0.8604
TF→RC	2.5515	1.4416	0.3189	0.1021	1.0206	0
TF→LA	0	0	0	0	0	0
TF→RP	0.2565	0.3129	0.0205	0.0103	0.2822	0
TF→BO	11.9241	1.1924	1.7886	0.5962	-1.1924	0
TF→WE	0.0198	0.0065	0.0040	0.0012	0.0012	0.0002
TF→TF	313.3557	0	0	0	0	0
TF→SP	0.3285	-0.5256	0	0	-0.5256	0
TF→CA	7.902	-12.6432	0	0	-12.6432	0
TF→CL	1.7784	-0.2845	0	0	-0.2845	0
TF→UL	0.2655	0.0451	0	0	0.0451	0
Subtotal	344.1222	1.9987	10.3386	4.2673	-13.4679	0.8607
SP→PF	0 [2]	0	0	0	0	0
SP→DR	0	0	0	0	0	0
SP→WO	0	0	0	0	0	0
SP→GR	0	0	0	0	0	0
SP→RC	0	0	0	0	0	0
SP→LA	0	0	0	0	0	0
SP→RP	0	0	0	0	0	0
SP→BO	0	0	0	0	0	0
SP→WE	0	0	0	0	0	0
SP→TF	0	0	0	0	0	0
SP→SP	0	0	0	0	0	0
SP→CA	0	0	0	0	0	0
SP→CL	0	0	0	0	0	0
SP→UL	0	0	0	0	0	0
CA→PF	0	0	0	0	0	0
CA→DR	0	0	0	0	0	0
CA→WO	0	0	0	0	0	0
CA→GR	0	0	0	0	0	0
CA→RC	0	0	0	0	0	0
CA→LA	0	0	0	0	0	0
CA→RP	0	0	0	0	0	0

[2] There were no SP and CA land use types in the study area in 1990, so the carbon storage changes corresponding to their land transfer are not discussed.

CA→BO	0	0	0	0	0	0
CA→WE	0	0	0	0	0	0
CA→TF	0	0	0	0	0	0
CA→SP	0	0	0	0	0	0
CA→CA	0	0	0	0	0	0
CA→CL	0	0	0	0	0	0
CA→UL	0	0	0	0	0	0
CL→PF	0.9585	2.3867	0.8147	0.4793	1.0639	0.0288
CL→DR	89.7741	152.6160	89.7741	29.6255	30.5232	2.6932
CL→WO	0.0036	0.0177	0.0123	0.0027	0.0017	0.0010
CL→GR	4.0959	9.5434	5.8571	2.5395	0.5325	0.6144
CL→RC	0.2187	0.1586	0.0273	0.0087	0.1225	0
CL→LA	0.0279	0.0342	0.0035	0.0011	0.0296	0
CL→RP	3.321	4.5830	0.2657	0.1328	4.1845	0
CL→BO	0.0288	0.0075	0.0043	0.0014	0.0017	0
CL→WE	8.0847	3.9615	1.6169	0.4851	1.7786	0.0808
CL→TF	12.0501	1.9280	0	0	1.9280	0
CL→SP	94.5855	-136.2031	0	0	-136.2031	0
CL→CA	2.6991	-3.8867	0	0	-3.8867	0
CL→CL	441.4968	0	0	0	0	0
CL→UL	0	0	0	0	0	0
Subtotal	657.3447	35.1467	98.3760	33.2761	-99.9236	3.4182
UL→PF	0.036	0.0778	0.0306	0.0180	0.0281	0.0011
UL→DR	22.4289	30.7276	22.4289	7.4015	0.2243	0.6729
UL→WO	0	0	0	0	0	0
UL→GR	0.2529	0.5058	0.3616	0.1568	-0.0506	0.0379
UL→RC	0.0927	0.0366	0.0116	0.0037	0.0213	0
UL→LA	0	0	0	0	0	0
UL→RP	10.8855	11.4298	0.8708	0.4354	10.1235	0
UL→BO	11.574	-0.8102	1.7361	0.5787	-3.1250	0
UL→WE	0.0036	0.0006	0.0007	0.0002	-0.0004	0
UL→TF	34.3458	-5.8388	0	0	-5.8388	0
UL→SP	13.9041	-24.6103	0	0	-24.6103	0
UL→CA	52.1793	-92.3574	0	0	-92.3574	0
UL→CL	55.7757	-18.4060	0	0	-18.4060	0
UL→UL	0.6012	0	0	0	0	0
Subtotal	202.0797	-99.2444	25.4404	8.5944	-133.9911	0.7119