

Article

Spatial–Temporal Evolution Analysis of the Development of Jingdang and Famen Townships in the Vicinity of the Capital City Site of the Western Zhou Dynasty in China

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Confusion matrix for land use classification accuracy verification from 1982 to 2022 (Table S1–Table S5).

Table S1. Confusion matrix accuracy verification on 1982 remote sensing images.

Ground Truth Pixels							
Type	CL	FL	GL	COL	UL	WA	Total
CL	144.00	2.00	3.00	5.00	1.00	0.00	155.00
FL	2.00	131.00	3.00	1.00	0.00	0.00	137.00
GL	3.00	13.00	140.00	1.00	1.00	2.00	160.00
COL	1.00	0.00	1.00	142.00	2.00	0.00	146.00
UL	0.00	4.00	0.00	1.00	106.00	1.00	112.00
WA	0.00	0.00	4.00	0.00	0.00	107.00	111.00
Total	150.00	150.00	151.00	150.00	110.00	110.00	821.00
Ground Truth Percent							
Type	CL	FL	GL	COL	UL	WA	Total
CL	96.00	1.33	1.99	3.33	0.91	0.00	18.88
FL	1.33	87.33	1.98	0.66	0.00	0.00	16.69
GL	2.00	8.67	92.72	0.67	0.91	1.82	19.49
COL	0.67	0.00	0.66	94.67	1.82	0.00	17.78
UL	0.00	2.67	0.00	0.67	96.36	0.91	13.64
WA	0.00	0.00	2.65	0.00	0.00	97.27	13.52
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Commission Error (CE) and Omission Error (OE)							
Type	CE Percent	OE Per- cent	CE Pixels (Number/Total number)		OE Pixels (Number/Total number)		
CL	7.10	4.00	11/155		6/150		
FL	4.38	12.67	6/137		19/150		
GL	12.50	7.28	20/160		11/151		
COL	2.74	5.33	4/146		8/150		
UL	5.36	3.64	6/112		4/110		
WA	3.60	2.73	4/111		3/110		
Producer's Accuracy (PA) and Use's Accuracy (UA)							
Type	PA Percent	UA Per- cent	PA Pixels (Number/Total number)		UA Pixels (Number/Total number)		
CL	96.00	92.90	144/150		144/155		
FL	87.33	95.62	131/150		131/137		
GL	92.72	87.50	140/151		140/160		
COL	94.67	97.26	142/150		142/146		
UL	96.36	94.64	106/110		106/112		
WA	97.27	96.40	107/110		107/111		
Overall Results							
Overall Accuracy				93.7881% (770/821)			

Kappa Coefficient

0.9252

Table S2. Confusion matrix accuracy verification on 1992 remote sensing images.

Ground Truth Pixels							
Type	CL	FL	GL	COL	UL	WA	Total
CL	143.00	2.00	3.00	1.00	3.00	2.00	154.00
FL	2.00	142.00	2.00	1.00	1.00	0.00	148.00
GL	3.00	6.00	145.00	2.00	1.00	3.00	160.00
COL	1.00	0.00	0.00	142.00	2.00	0.00	145.00
UL	1.00	0.00	1.00	4.00	103.00	3.00	112.00
WA	0.00	0.00	0.00	0.00	0.00	102.00	102.00
Total	150.00	150.00	151.00	150.00	110.00	110.00	821.00
Ground Truth Percent							
Type	CL	FL	GL	COL	UL	WA	Total
CL	95.33	1.33	1.99	0.67	2.73	1.82	18.76
FL	1.33	94.67	1.32	0.66	0.91	0.00	18.03
GL	2.00	4.00	96.03	1.33	0.90	2.72	19.49
COL	0.67	0.00	0.00	94.67	1.82	0.00	17.66
UL	0.67	0.00	0.66	2.67	93.64	2.73	13.64
WA	0.00	0.00	0.00	0.00	0.00	92.73	12.42
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Commission Error (CE) and Omission Error (OE)							
Type	CE Percent	OE Per- cent	CE Pixels (Number/Total number)		OE Pixels (Number/Total number)		
CL	7.14	4.67	11/154		7/150		
FL	4.05	5.33	6/148		8/150		
GL	9.38	3.97	15/160		6/151		
COL	2.07	5.33	3/145		8/150		
UL	8.04	6.36	9/112		7/110		
WA	0.00	7.27	0/102		8/110		
Producer's Accuracy (PA) and Use's Accuracy (UA)							
Type	PA Percent	UA Per- cent	PA Pixels (Number/Total number)		UA Pixels (Number/Total number)		
CL	95.33	92.86	143/150		143/154		
FL	94.67	95.95	142/150		142/148		
GL	96.03	90.63	145/151		145/160		
COL	94.67	97.93	142/150		142/145		
UL	93.64	91.96	103/110		103/112		
WA	92.73	100.00	102/110		102/102		
Overall Results							
Overall Accuracy			94.6407% (777/821)				

Kappa Coefficient

0.9354

Table S3. Confusion matrix accuracy verification on 2002 remote sensing images.

Ground Truth Pixels							
Type	CL	FL	GL	COL	UL	WA	Total
CL	144.00	5.00	1.00	1.00	0.00	0.00	151.00
FL	1.00	135.00	3.00	1.00	1.00	1.00	142.00
GL	2.00	3.00	143.00	1.00	2.00	1.00	152.00
COL	1.00	2.00	1.00	145.00	1.00	0.00	150.00
UL	1.00	2.00	2.00	2.00	104.00	1.00	112.00
WA	1.00	3.00	0.00	0.00	2.00	107.00	113.00
Total	150.00	150.00	150.00	150.00	110.00	110.00	820.00
Ground Truth Percent							
Type	CL	FL	GL	COL	UL	WA	Total
CL	96.00	3.33	0.67	0.67	0.00	0.00	18.41
FL	0.67	90.00	2.00	0.67	0.91	0.91	17.32
GL	1.33	2.00	95.33	0.67	1.82	0.91	18.54
COL	0.67	1.33	0.67	96.67	0.91	0.00	18.29
UL	0.66	1.34	1.33	1.32	94.54	0.91	13.66
WA	0.67	2.00	0.00	0.00	1.82	97.27	13.78
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Commission Error (CE) and Omission Error (OE)							
Type	CE Percent	OE Per- cent	CE Pixels (Number/Total number)		OE Pixels (Number/Total number)		
CL	4.64	4.00	1/151		6/150		
FL	4.93	10.00	7/142		15/150		
GL	5.92	4.67	9/152		7/150		
COL	3.33	3.33	5/150		5/150		
UL	7.14	5.45	8/112		6/110		
WA	5.31	273	6/113		3/110		
Producer's Accuracy (PA) and Use's Accuracy (UA)							
Type	PA Percent	UA Per- cent	PA Pixels (Number/Total number)		UA Pixels (Number/Total number)		
CL	96.00	95.36	144/150		144/151		
FL	90.00	95.07	135/150		135/142		
GL	95.33	94.08	143/150		143/152		
COL	96.67	96.67	145/150		145/150		
UL	94.55	92.86	104/110		104/112		
WA	97.27	94.69	107/110		107/113		
Overall Results							
Overall Accuracy				94.8780% (778/820)			

Kappa Coefficient

0.9383

Table S4. Confusion matrix accuracy verification on 2012 remote sensing images.

Ground Truth Pixels							
Type	CL	FL	GL	COL	UL	WA	Total
CL	145.00	1.00	2.00	18.00	1.00	1.00	168.00
FL	1.00	139.00	3.00	0.00	1.00	1.00	145.00
GL	1.00	4.00	143.00	1.00	1.00	3.00	153.00
COL	1.00	2.00	1.00	125.00	1.00	0.00	130.00
UL	1.00	1.00	1.00	0.00	105.00	0.00	108.00
WA	1.00	3.00	0.00	6.00	1.00	95.00	106.00
Total	150.00	150.00	150.00	150.00	110.00	100.00	810.00
Ground Truth Percent							
Type	CL	FL	GL	COL	UL	WA	Total
CL	96.67	0.67	1.33	12.00	0.91	1.00	20.74
FL	0.67	92.67	2.00	0.00	0.91	1.00	17.90
GL	0.67	2.67	95.33	0.67	0.91	3.00	18.89
COL	0.67	1.33	0.67	83.33	0.91	0.00	16.05
UL	0.65	0.66	0.67	0.00	95.45	0.00	13.33
WA	0.67	2.00	0.00	4.00	0.91	95.00	13.09
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Commission Error (CE) and Omission Error (OE)							
Type	CE Percent	OE Per- cent	CE Pixels (Number/Total number)		OE Pixels (Number/Total number)		
CL	13.69	3.33	23/168		5/150		
FL	4.14	7.33	6/145		11/150		
GL	6.54	4.67	10/153		7/150		
COL	3.85	16.67	5/130		25/150		
UL	2.78	4.55	3/108		5/110		
WA	10.38	5.00	11/106		5/100		
Producer's Accuracy (PA) and Use's Accuracy (UA)							
Type	PA Percent	UA Per- cent	PA Pixels (Number/Total number)		UA Pixels (Number/Total number)		
CL	96.67	86.31	145/150		145/168		
FL	92.67	95.86	139/150		139/145		
GL	95.33	93.46	143/150		143/153		
COL	83.33	96.15	125/150		125/130		
UL	95.45	97.22	105/110		105/108		
WA	95.00	89.62	95/100		95/106		
Overall Results							
Overall Accuracy				92.8395% (752/810)			

Kappa Coefficient

0.9137

Table S5. Confusion matrix accuracy verification on 2022 remote sensing images.

Ground Truth Pixels							
Type	CL	FL	GL	COL	UL	WA	Total
CL	142.00	2.00	2.00	3.00	1.00	1.00	151.00
FL	1.00	142.00	2.00	1.00	3.00	1.00	150.00
GL	5.00	3.00	144.00	2.00	3.00	2.00	159.00
COL	0.00	2.00	1.00	143.00	0.00	0.00	146.00
UL	2.00	1.00	1.00	1.00	102.00	1.00	108.00
WA	0.00	0.00	0.00	0.00	1.00	95.00	96.00
Total	150.00	150.00	150.00	150.00	110.00	100.00	810.00
Ground Truth Percent							
Type	CL	FL	GL	COL	UL	WA	Total
CL	94.67	1.33	1.33	2.00	0.91	1.00	18.64
FL	0.67	94.67	1.33	0.67	2.73	1.00	18.53
GL	3.33	2.00	96.00	1.33	2.73	2.00	19.63
COL	0.00	1.33	0.67	95.33	0.00	0.00	18.02
UL	1.33	0.67	0.67	0.67	92.72	1.00	13.33
WA	0.00	0.00	0.00	0.00	0.91	95.00	11.85
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Commission Error (CE) and Omission Error (OE)							
Type	CE Percent	OE Per- cent	CE Pixels (Number/Total number)		OE Pixels (Number/Total number)		
CL	5.96	5.33	9/151		8/150		
FL	5.33	5.33	8/150		8/150		
GL	9.43	4.00	15/159		6/150		
COL	2.05	4.67	3/146		7/150		
UL	5.56	7.27	6/108		8/110		
WA	1.04	5.00	1/96		5/100		
Producer's Accuracy (PA) and Use's Accuracy (UA)							
Type	PA Percent	UA Per- cent	PA Pixels (Number/Total number)		UA Pixels (Number/Total number)		
CL	94.67	94.04	142/150		142/151		
FL	94.67	94.67	142/150		142/150		
GL	96.00	90.57	144/150		144/159		
COL	95.33	97.95	143/150		143/146		
UL	92.73	94.44	102/110		102/108		
WA	95.00	98.96	95/100		95/96		
Overall Results							
Overall Accuracy				94.8148% (768/810)			

Kappa Coefficient	0.9374
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Land use transfer matrix data from 1982 to 2022 (Table S6–Table S9).

Table S6. Land use transfer matrix between 1982 and 1992 (km²).

		1992						Total	Decrease
		CL	FL	GL	COL	UL	WA		
1982	CL	94.11	0.00	0.00	2.47	1.04	0.79	98.41	4.30
	FL	0.18	34.51	0.44	0.00	0.01	0.00	35.14	0.63
	GL	0.40	0.47	24.64	0.00	0.01	0.50	26.02	1.38
	COL	2.04	0.08	0.05	6.58	0.05	0.02	8.82	2.24
	UL	0.93	0.57	0.25	0.07	0.46	0.11	2.39	1.93
	WA	0.04	0.04	0.09	0.00	0.08	1.13	1.38	0.25
Total		97.70	35.67	25.47	9.12	1.65	2.55	172.16	
Increase		3.59	1.16	0.83	2.54	1.19	1.42		

Table S7. Land use transfer matrix between 1992 and 2002 (km²).

		2002						Total	Decrease
		CL	FL	GL	COL	UL	WA		
1992	CL	88.45	1.80	0.67	6.11	0.55	0.12	97.70	9.25
	FL	1.82	30.91	2.64	0.19	0.08	0.05	35.69	4.78
	GL	0.98	2.40	20.62	0.11	1.26	0.10	25.47	4.85
	COL	1.83	0.11	0.04	7.02	0.10	0.03	9.13	2.11
	UL	0.55	0.16	0.14	0.12	0.54	0.10	1.61	1.07
	WA	0.40	0.22	0.32	0.06	0.11	1.45	2.56	1.11
Total		94.03	35.6	24.43	13.61	2.64	1.85	172.16	
Increase		5.58	4.69	3.81	6.59	2.10	0.40		

Table S8. Land use transfer matrix between 2002 and 2012 (km²).

		2012						Total	Decrease
		CL	FL	GL	COL	UL	WA		
2002	CL	89.34	2.23	0.08	1.62	0.63	0.12	94.02	4.68
	FL	3.59	30.42	0.95	0.27	0.28	0.08	35.59	5.17
	GL	0.35	1.09	22.64	0.00	0.03	0.31	24.42	1.78
	COL	0.86	0.03	0.03	12.58	0.05	0.05	13.60	1.02
	UL	0.91	0.25	0.25	0.01	1.17	0.09	2.68	1.51
	WA	0.11	0.06	0.09	0.01	0.01	1.57	1.85	0.28
Total		95.16	34.08	24.04	14.49	2.17	2.22	172.16	
Increase		5.82	3.66	1.40	1.91	1.00	0.65		

Table S9. Land use transfer matrix between 2012 and 2022 (km²).

		2022						Total	Decrease
		CL	FL	GL	COL	UL	WA		
2012	CL	88.01	1.19	0.42	4.80	0.62	0.01	95.05	7.04
	FL	1.09	31.43	1.15	0.03	0.29	0.01	34	2.57
	GL	0.37	1.19	22.14	0.03	0.08	0.14	23.95	1.81
	COL	1.14	0.06	0.10	13.05	0.13	0.00	14.48	1.43
	UL	0.52	0.04	0.17	0.12	1.63	0.00	2.48	0.85
	WA	0.39	0.25	0.08	0.15	0.10	1.23	2.2	0.97
Total		91.52	34.16	24.06	18.18	2.85	1.39	172.16	
Increase		3.51	2.73	1.92	5.13	1.22	0.16		