

Qingyang	266	267	270	270	270	6688607	6094314	5978324	2029988	7081499
Dingxi	301	301	303	303	304	2901643	3049178	3310768	767389	3562609
Longnan	283	286	288	287	288	2625279	3151353	3398884	1093212	3792273
Qinghai	375	371				14314738				
Xining	203	201	203	206	207	10657811	11316193	12481677	10086748	12864137
Haidong	172	170	171	172	173	3656927	3843963	4227986	1653467	4514606
Ningxia	692	664				27379176				
Yinchuan	196	179	184	189	193	13886244	14938590	16177071	11039244	19014824
Shizuishan	77	75	75	74	74	4672622	4823793	5135744	3771905	6059184
Wuzhong	144	140	142	143	144	3834317	4048073	4424283	1895152	5345336
Guyuan	153	150	150	151	151	2010289	2170391	2398058	1176599	3031944
Zhongwei	122	120	121	122	122	2975704	3168907	3391289	1716928	4029947
Xinjiang	306	297				33091423				
Urumqi	267	267	268	223	222	24614698	26316398	24589766	27075290	30997659
Karamay	39	30	30	31	31	8476725	6294299	6209989	7445034	8981420

Supplemental Files (3): The transfer experience of city officials in the Yellow River basin

ID	former	succession	time	POINT_X_1	POINT_Y_1	POINT_X_2	POINT_Y_2
1	Baiyin	Lanzhou	4	104.18	36.54	103.75	36.07
2	Dingxi	Dingxi	1	104.62	35.58	104.62	35.58
3	Dingxi	Lanzhou	3	104.62	35.58	103.75	36.07
4	Jiayuguan	Jiayuguan	3	98.27	39.8	98.27	39.8
5	Jiayuguan	Jiuquan	1	98.27	39.8	98.51	39.75
6	Jiayuguan	Lanzhou	1	98.27	39.8	103.75	36.07
7	Jiayuguan	Pingliang	1	98.27	39.8	106.68	35.54
8	Jiayuguan	Wuwei	1	98.27	39.8	102.63	37.93
9	Jinchang	Dingxi	1	102.17	38.5	104.62	35.58
10	Jinchang	Jinchang	1	102.17	38.5	102.17	38.5
11	Jinchang	Lanzhou	3	102.17	38.5	103.75	36.07
12	Jiuquan	Lanzhou	6	98.51	39.75	103.75	36.07
13	Pingliang	Lanzhou	3	106.68	35.54	103.75	36.07
14	Pingliang	Pingliang	1	106.68	35.54	106.68	35.54
15	Pingliang	Tianshui	1	106.68	35.54	105.72	34.58
16	Qingyang	Baiyin	1	107.62	35.73	104.18	36.54
17	Qingyang	Lanzhou	3	107.62	35.73	103.75	36.07
18	Qingyang	Qingyang	1	107.62	35.73	107.62	35.73
19	Tianshui	Lanzhou	3	105.72	34.58	103.75	36.07
20	Tianshui	Zhangye	1	105.72	34.58	100.45	38.94
21	Wuwei	Baiyin	1	102.63	37.93	104.18	36.54
22	Wuwei	Lanzhou	4	102.63	37.93	103.75	36.07
23	Zhangye	Lanzhou	1	100.45	38.94	103.75	36.07
24	Zhangye	Qingyang	1	100.45	38.94	107.62	35.73
25	Zhangye	Xi'An	1	100.45	38.94	108.95	34.26
26	Anyang	Anyang	1	114.35	36.1	114.35	36.1
27	Anyang	Zhengzhou	4	114.35	36.1	113.65	34.76
28	Hebi	Anyang	1	114.16	35.94	114.35	36.1
29	Hebi	Hebi	3	114.16	35.94	114.16	35.94
30	Hebi	Shangqiu	1	114.16	35.94	115.65	34.44
31	Hebi	Taiyuan	1	114.16	35.94	112.57	37.87
32	Hebi	Zhengzhou	2	114.16	35.94	113.65	34.76
33	Jiaozuo	Jiaozuo	1	113.22	35.25	113.22	35.25
34	Jiaozuo	Zhengzhou	4	113.22	35.25	113.65	34.76
35	Kaifeng	Kaifeng	2	114.35	34.79	114.35	34.79
36	Kaifeng	Zhengzhou	2	114.35	34.79	113.65	34.76
37	Luoyang	Xi'An	1	112.43	34.67	108.95	34.26
38	Luoyang	Zhengzhou	3	112.43	34.67	113.65	34.76
39	Luohe	Luohe	2	114.04	33.57	114.04	33.57
40	Luohe	Zhengzhou	2	114.04	33.57	113.65	34.76
41	Nanyang	Nanyang	1	112.54	33	112.54	33
42	Nanyang	Zhengzhou	4	112.54	33	113.65	34.76
43	Pingdingshan	ingdingsha	1	113.3	33.74	113.3	33.74
44	Pingdingshan	Xinxiang	1	113.3	33.74	113.87	35.31
45	Pingdingshan	Zhengzhou	4	113.3	33.74	113.65	34.76
46	Puyang	Puyang	1	115.02	35.7	115.02	35.7
47	Puyang	Zhengzhou	6	115.02	35.7	113.65	34.76
48	Sanmenxia	Nanyang	1	111.2	34.78	112.54	33
49	Sanmenxia	Sanmenxia	2	111.2	34.78	111.2	34.78
50	Shangqiu	Shangqiu	1	115.65	34.44	115.65	34.44
51	Shangqiu	Zhengzhou	3	115.65	34.44	113.65	34.76
52	Shangqiu	Zhumadian	1	115.65	34.44	114.04	32.98
53	Xinxiang	Jiaozuo	1	113.87	35.31	113.22	35.25
54	Xinxiang	Xinxiang	1	113.87	35.31	113.87	35.31
55	Xinxiang	Zhengzhou	3	113.87	35.31	113.65	34.76
56	Xinyang	ingdingsha	1	114.07	32.13	113.3	33.74

57	Xinyang	Xinyang	2	114.07	32.13	114.07	32.13
58	Xinyang	Zhengzhou	1	114.07	32.13	113.65	34.76
59	Xuchang	Luoyang	1	113.82	34.03	112.43	34.67
60	Xuchang	Xinyang	1	113.82	34.03	114.07	32.13
61	Xuchang	Xuchang	1	113.82	34.03	113.82	34.03
62	Xuchang	Zhengzhou	3	113.82	34.03	113.65	34.76
63	Zhengzhou	Zhengzhou	4	113.65	34.76	113.65	34.76
64	Zhoukou	Zhengzhou	1	114.64	33.63	113.65	34.76
65	Zhoukou	Zhoukou	3	114.64	33.63	114.64	33.63
66	Zhumadian	Luoyang	1	114.04	32.98	112.43	34.67
67	Zhumadian	Luohe	1	114.04	32.98	114.04	33.57
68	Zhumadian	Zhengzhou	1	114.04	32.98	113.65	34.76
69	Zhumadian	Zhumadian	2	114.04	32.98	114.04	32.98
70	Bayannur	Bayannur	2	107.38	40.75	107.38	40.75
71	Bayannur	Hohhot	2	107.38	40.75	111.66	40.82
72	Baotou	Hohhot	4	109.85	40.67	111.66	40.82
73	Baotou	Ulangab	1	109.85	40.67	113.12	41.02
74	Erdos	Erdos	1	109.97	39.63	109.97	39.63
75	Erdos	Hohhot	4	109.97	39.63	111.66	40.82
76	Hohhot	Hohhot	4	111.66	40.82	111.66	40.82
77	Wuhai	Hohhot	1	106.82	39.67	111.66	40.82
78	Wuhai	Wuhai	2	106.82	39.67	106.82	39.67
79	Wuhai	Ulangab	1	106.82	39.67	113.12	41.02
80	Ulangab	Hohhot	3	113.12	41.02	111.66	40.82
81	Ulangab	Ulangab	2	113.12	41.02	113.12	41.02
82	Guyuan	Wuzhong	1	106.28	36.01	106.2	37.99
83	Guyuan	Yinchuan	3	106.28	36.01	106.27	38.47
84	Shizuishan	Guyuan	1	106.38	39.02	106.28	36.01
85	Shizuishan	Wuzhong	1	106.38	39.02	106.2	37.99
86	Shizuishan	Yinchuan	3	106.38	39.02	106.27	38.47
87	Wuzhong	Yinchuan	4	106.2	37.99	106.27	38.47
88	Yinchuan	Yinchuan	5	106.27	38.47	106.27	38.47
89	Zhongwei	Guyuan	1	105.17	37.52	106.28	36.01
90	Zhongwei	Yinchuan	4	105.17	37.52	106.27	38.47
91	Binzhou	Binzhou	2	118.02	37.37	118.02	37.37
92	Dezhou	Jinan	3	116.29	37.45	117.01	36.67
93	Dezhou	Linyi	1	116.29	37.45	118.34	35.07
94	Dongying	Dongying	2	118.5	37.46	118.5	37.46
95	Dongying	Jinan	4	118.5	37.46	117.01	36.67
96	Heze	Heze	1	115.45	35.25	115.45	35.25
97	Heze	Jinan	3	115.45	35.25	117.01	36.67
98	Jinan	Jinan	3	117.01	36.67	117.01	36.67
99	Jining	Jinan	4	116.58	35.41	117.01	36.67
100	Jining	Jining	2	116.58	35.41	116.58	35.41
101	Liaocheng	Jinan	2	115.99	36.45	117.01	36.67
102	Liaocheng	Liaocheng	1	115.99	36.45	115.99	36.45
103	Liaocheng	Linyi	1	115.99	36.45	118.34	35.07
104	Linyi	Jinan	4	118.34	35.07	117.01	36.67
105	Linyi	Linyi	1	118.34	35.07	118.34	35.07
106	Linyi	Qingdao	1	118.34	35.07	120.36	36.13
107	Linyi	Yantai	1	118.34	35.07	121.38	37.54
108	Qingdao	Jinan	2	120.36	36.13	117.01	36.67
109	Rizhao	Jinan	1	119.45	35.43	117.01	36.67
110	Rizhao	Qingdao	1	119.45	35.43	120.36	36.13
111	Rizhao	Rizhao	2	119.45	35.43	119.45	35.43
112	Rizhao	Zaozhuang	1	119.45	35.43	117.56	34.87
113	Tai'an	Jinan	4	117.12	36.19	117.01	36.67
114	Tai'an	Tai'an	2	117.12	36.19	117.12	36.19

115	Weihai	Jinan	2	122.11	37.5	117.01	36.67
116	Weihai	Weihai	2	122.11	37.5	122.11	37.5
117	Weifang	Dongying	1	119.11	36.7	118.5	37.46
118	Weifang	Jinan	1	119.11	36.7	117.01	36.67
119	Weifang	Qingdao	1	119.11	36.7	120.36	36.13
120	Weifang	Weifang	2	119.11	36.7	119.11	36.7
121	Weifang	Zibo	1	119.11	36.7	118.06	36.79
122	Yantai	Jinan	1	121.38	37.54	117.01	36.67
123	Yantai	Qingdao	1	121.38	37.54	120.36	36.13
124	Yantai	Yantai	3	121.38	37.54	121.38	37.54
125	Zaozhuang	Jinan	1	117.56	34.87	117.01	36.67
126	Zaozhuang	Linyi	1	117.56	34.87	118.34	35.07
127	Zaozhuang	Zaozhuang	2	117.56	34.87	117.56	34.87
128	Zibo	Jinan	1	118.06	36.79	117.01	36.67
129	Zibo	Liaocheng	1	118.06	36.79	115.99	36.45
130	Zibo	Yantai	1	118.06	36.79	121.38	37.54
131	Datong	Taiyuan	1	113.3	40.1	112.57	37.87
132	Datong	Xinzhou	1	113.3	40.1	112.73	38.4
133	Jincheng	Datong	1	112.84	35.51	113.3	40.1
134	Jincheng	Shuozhou	1	112.84	35.51	112.42	39.31
135	Jincheng	Taiyuan	3	112.84	35.51	112.57	37.87
136	Jincheng	Yuncheng	1	112.84	35.51	110.99	35.01
137	Jinzhong	Jinzhong	3	112.75	37.68	112.75	37.68
138	Jinzhong	Taiyuan	3	112.75	37.68	112.57	37.87
139	Linfen	Linfen	2	111.51	36.08	111.51	36.08
140	Linfen	Taiyuan	2	111.51	36.08	112.57	37.87
141	Lvliang	Jincheng	1	111.13	37.52	112.84	35.51
142	Lvliang	Taiyuan	4	111.13	37.52	112.57	37.87
143	Shuozhou	Shuozhou	1	112.42	39.31	112.42	39.31
144	Shuozhou	Taiyuan	4	112.42	39.31	112.57	37.87
145	Shuozhou	Yuncheng	2	112.42	39.31	110.99	35.01
146	Shuozhou	Changzhi	1	112.42	39.31	113.11	36.18
147	Taiyuan	Taiyuan	2	112.57	37.87	112.57	37.87
148	Xinzhou	Taiyuan	1	112.73	38.4	112.57	37.87
149	Yangquan	Linfen	1	113.57	37.86	111.51	36.08
150	Yangquan	Taiyuan	1	113.57	37.86	112.57	37.87
151	Yangquan	Yangquan	1	113.57	37.86	113.57	37.86
152	Yangquan	Yuncheng	1	113.57	37.86	110.99	35.01
153	Yuncheng	Lvliang	2	110.99	35.01	111.13	37.52
154	Yuncheng	Shuozhou	2	110.99	35.01	112.42	39.31
155	Yuncheng	Taiyuan	1	110.99	35.01	112.57	37.87
156	Yuncheng	Xining	1	110.99	35.01	101.79	36.61
157	Changzhi	Lvliang	1	113.11	36.18	111.13	37.52
158	Changzhi	Taiyuan	4	113.11	36.18	112.57	37.87
159	Changzhi	Changzhi	1	113.11	36.18	113.11	36.18
160	Ankang	Ankang	2	109.03	32.69	109.03	32.69
161	Ankang	Baoji	1	109.03	32.69	107.14	34.38
162	Ankang	Xi'An	2	109.03	32.69	108.95	34.26
163	Baoji	Baoji	2	107.14	34.38	107.14	34.38
164	Baoji	Xi'An	3	107.14	34.38	108.95	34.26
165	Hanzhong	Hanzhong	3	107.03	33.08	107.03	33.08
166	Hanzhong	Shangluo	1	107.03	33.08	109.93	33.87
167	Hanzhong	Xi'An	2	107.03	33.08	108.95	34.26
168	Shangluo	Hanzhong	1	109.93	33.87	107.03	33.08
169	Shangluo	Shangluo	1	109.93	33.87	109.93	33.87
170	Shangluo	Xi'An	2	109.93	33.87	108.95	34.26
171	Tongchuan	Tongchuan	3	109.06	35.08	109.06	35.08
172	Tongchuan	Xi'An	4	109.06	35.08	108.95	34.26

173	Weinan	Weinan	2	109.5	34.5	109.5	34.5
174	Weinan	Xi'An	3	109.5	34.5	108.95	34.26
175	Weinan	Yan'An	1	109.5	34.5	109.47	36.59
176	Xi'An	Xi'An	3	108.95	34.26	108.95	34.26
177	Xianyang	Weinan	1	108.71	34.34	109.5	34.5
178	Xianyang	Xi'An	2	108.71	34.34	108.95	34.26
179	Xianyang	Xianyang	1	108.71	34.34	108.71	34.34
180	Yan'An	Xi'An	3	109.47	36.59	108.95	34.26
181	Yulin	Weinan	1	109.76	38.3	109.5	34.5
182	Yulin	Xi'An	3	109.76	38.3	108.95	34.26

Supplemental Files (5): Results of cities' Degree centrality, Closeness centrality, and Betweenness centrality in the city networks of Yellow River basin

	Out-degree centrality	In-degree centrality	Out-Closeness centrality	In-Closeness centrality	Betweenness centrality
Taiyuan	0.0519	0.2208	0.3130	0.4162	0.2738
Datong	0.1688	0.0649	0.4118	0.2790	0.2419
Yangquan	0.1818	0.1039	0.4096	0.3453	0.5425
Changzhi	0.3377	0.0649	0.4400	0.3565	0.8351
Jincheng	0.2468	0.0260	0.3738	0.3092	0.1204
Shuozhou	0.1818	0.0779	0.4254	0.2906	0.3799
Jinzhong	0.0519	0.1558	0.3130	0.3720	0.0255
Yuncheng	0.1299	0.2597	0.3598	0.4451	0.5197
Xinzhou	0.0909	0.1299	0.3422	0.3581	0.4958
Linfen	0.1039	0.2338	0.3581	0.4278	0.3925
Lvliang	0.1688	0.1039	0.4326	0.3249	0.7292
Hohhot	0.1039	0.1039	0.3667	0.2492	0.1793
Baotou	0.0909	0.1039	0.3684	0.2492	0.2351
Wuhai	0.0909	0.0519	0.3056	0.2348	0.0515
Erdos	0.1039	0.1169	0.3615	0.2821	0.3045
Bayannur	0.1039	0.0519	0.3362	0.2299	0.0514
Ulanqab	0.0779	0.0519	0.3348	0.2348	0.0041
Jinan	0.0909	0.2597	0.2399	0.4639	0.3049
Qingdao	0.1169	0.1558	0.2702	0.3453	0.0736
Zibo	0.1039	0.1818	0.2702	0.3775	0.1325
Zaozhuang	0.1688	0.0909	0.2895	0.3756	0.1657
Dongying	0.1169	0.0390	0.2721	0.2984	0.0018
Yantai	0.1039	0.1169	0.3249	0.3105	0.6589
Weifang	0.1299	0.1948	0.2711	0.3793	0.2311
Jining	0.2338	0.1169	0.3249	0.3738	0.3108
Tai'an	0.0909	0.2078	0.2558	0.4096	0.0702
Weihai	0.0519	0.0390	0.2533	0.2780	0.0000
Rizhao	0.0909	0.0649	0.2655	0.3056	0.0003
Linyi	0.1429	0.1429	0.2939	0.3438	0.1847
Dezhou	0.1039	0.2078	0.2593	0.4010	0.2208
Liaocheng	0.2078	0.0779	0.3182	0.3598	0.1436
Binzhou	0.1558	0.0519	0.2950	0.3468	0.1496
Heze	0.1948	0.0909	0.3143	0.3598	0.0371
Zhengzhou	0.1818	0.4416	0.2821	0.5620	0.4995
Kaifeng	0.0909	0.2727	0.2973	0.4556	0.1807
Luoyang	0.1948	0.4026	0.3222	0.5540	1.0118
Pingdingshan	0.1558	0.1299	0.2780	0.4162	0.0198
Anyang	0.1039	0.2468	0.2950	0.4529	0.2155
Hebi	0.0649	0.1948	0.2575	0.4375	0.0058
Xinxiang	0.1299	0.2857	0.2637	0.4695	0.0569
Jiaozuo	0.1169	0.1169	0.3031	0.3929	0.1513
Puyang	0.2468	0.0779	0.3598	0.3565	0.4667
Xuchang	0.1558	0.2338	0.2800	0.4350	0.0475
Luohe	0.1169	0.1688	0.2541	0.4375	0.0589
Sanmenxia	0.1688	0.1558	0.3615	0.4400	0.4585
Nanyang	0.1429	0.1299	0.2770	0.3969	0.0364
Shangqiu	0.2727	0.2468	0.3422	0.4503	1.0012
Xinyang	0.1169	0.1039	0.2750	0.4031	0.0101
Zhoukou	0.1169	0.1688	0.2646	0.4375	0.0804
Zhumadian	0.1299	0.1948	0.2760	0.4231	0.0300
Xi'an	0.0909	0.3506	0.3291	0.5461	0.7274
Tongchuan	0.1299	0.0649	0.3929	0.2628	0.1036
Baoji	0.1299	0.2338	0.3649	0.4231	1.2446
Xianyang	0.0390	0.2338	0.2810	0.4639	0.0861
Weinan	0.1039	0.2468	0.3377	0.4873	0.2928
Yan'an	0.1688	0.0909	0.3929	0.2928	0.4926
Hanzhong	0.1948	0.0779	0.4010	0.4031	1.0460
Yulin	0.1688	0.1299	0.4185	0.2962	0.5318
Ankang	0.1948	0.0519	0.4031	0.3056	0.5050
Shangluo	0.1948	0.0519	0.4031	0.2444	0.0153
Lanzhou	0.1429	0.1558	0.4053	0.3407	0.8401
Jiayuguan	0.0260	0.0260	0.2550	0.2098	0.0000
Jinchang	0.0519	0.0390	0.3043	0.2278	0.0317
Baiyin	0.1558	0.0649	0.3969	0.2692	0.5720
Tianshui	0.1429	0.1039	0.3869	0.3208	0.2751
Wuwei	0.1039	0.0649	0.3392	0.2312	0.1362
Zhangye	0.1169	0.0649	0.3377	0.2194	0.2781
Pingliang	0.2078	0.0130	0.4451	0.1864	0.0053
Jiuquan	0.0260	0.0649	0.2550	0.2194	0.0117
Qingyang	0.2727	0.0390	0.4753	0.2285	0.2762
Dingxi	0.1039	0.1169	0.3889	0.3222	0.5043
Longnan	0.1688	0.0260	0.3909	0.2558	0.0820
Xining	0.1818	0.0779	0.3831	0.2610	0.4273
Yinchuan	0.0519	0.1039	0.2973	0.2533	0.0996
Shizuishan	0.0649	0.0649	0.2984	0.2110	0.0390
Wuzhong	0.0390	0.1039	0.2884	0.2525	0.0525

Guyuan	0.0130	0.0390	0.2421	0.2188	0.0006
Zhongwei	0.1429	0.0909	0.3949	0.2452	0.6771