Supplement of Causal effects of dams and land cover changes on flood changes in mainland China

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Table S1. Values, standard deviations, and p values about the regression coefficients in the effect testing process of Eq. (1).

k	Model	Variable	Coef.	Std.	P value
10	$\beta_1 Urban + \beta_2 Crop$	<i>Urban</i>	9.86E-03	5.47E-03	7.12E-02
10		<i>Crop</i>	-5.26E-03	2.71E-03	5.22E-02
10	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i>	6.90E-03	7.84E-03	3.79E-01
10		<i>Urban</i> ²	1.02E-04	1.46E-04	4.85E-01
10		<i>Crop</i>	-5.36E-03	2.71E-03	4.81E-02
10	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i>	2.40E-02	9.17E-03	9.02E-03
10		<i>Urban</i> ^{1/2}	-8.75E-02	4.77E-02	6.67E-02
10		<i>Crop</i>	-5.47E-03	2.71E-03	4.39E-02
10	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	<i>Urban</i>	9.72E-03	6.06E-03	1.09E-01
10		<i>Crop</i>	-4.96E-03	5.33E-03	3.52E-01
10		<i>Crop</i> ²	-3.44E-06	6.42E-05	9.57E-01
10	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	<i>Urban</i>	8.89E-03	5.63E-03	1.14E-01
10		<i>Crop</i>	-1.03E-02	7.95E-03	1.94E-01
10		<i>Crop</i> ^{1/2}	6.02E-02	8.09E-02	4.57E-01
10	$\gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i> ²	2.17E-04	9.91E-05	2.82E-02
10		<i>Crop</i>	-6.41E-03	2.63E-03	1.48E-02
10	$\theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i> ^{1/2}	6.75E-03	2.85E-02	8.13E-01
10		<i>Crop</i>	-7.54E-03	2.67E-03	4.69E-03
10	$\beta_1 Urban + \gamma_2 Crop^2$	<i>Urban</i>	8.87E-03	5.94E-03	1.35E-01
10		<i>Crop</i> ²	-4.74E-05	3.22E-05	1.41E-01
10	$\beta_1 Urban + \theta_2 Crop^{1/2}$	<i>Urban</i>	1.16E-02	5.28E-03	2.77E-02

10		$Crop^{1/2}$	-4.78E-02	2.75E-02	8.17E-02
20	$\beta_1 Urban + \beta_2 Crop$	$Urban$	1.59E-02	5.83E-03	6.26E-03
20		$Crop$	-3.50E-03	2.77E-03	2.07E-01
20	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	$Urban$	1.49E-02	8.43E-03	7.73E-02
20		$Urban^2$	3.42E-05	1.51E-04	8.21E-01
20		$Crop$	-3.52E-03	2.77E-03	2.04E-01
20	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban$	2.63E-02	9.21E-03	4.24E-03
20		$Urban^{1/2}$	-6.68E-02	4.87E-02	1.69E-01
20		$Crop$	-3.49E-03	2.77E-03	2.08E-01
20	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	$Urban$	1.68E-02	6.31E-03	7.68E-03
20		$Crop$	-5.52E-03	5.40E-03	3.07E-01
20		$Crop^2$	2.38E-05	6.61E-05	7.20E-01
20	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	$Urban$	1.60E-02	5.95E-03	7.26E-03
20		$Crop$	-3.20E-03	8.04E-03	6.91E-01
20		$Crop^{1/2}$	-3.55E-03	8.09E-02	9.65E-01
20	$\gamma_1 Urban^2 + \beta_2 Crop$	$Urban^2$	2.79E-04	1.02E-04	6.39E-03
20		$Crop$	-5.42E-03	2.73E-03	4.72E-02
20	$\theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban^{1/2}$	3.71E-02	3.08E-02	2.28E-01
20		$Crop$	-5.89E-03	2.72E-03	3.04E-02
20	$\beta_1 Urban + \gamma_2 Crop^2$	$Urban$	1.59E-02	6.21E-03	1.02E-02
20		$Crop^2$	-2.56E-05	3.35E-05	4.44E-01
20	$\beta_1 Urban + \theta_2 Crop^{1/2}$	$Urban$	1.68E-02	5.68E-03	3.17E-03
20		$Crop^{1/2}$	-3.67E-02	2.78E-02	1.87E-01
30	$\beta_1 Urban + \beta_2 Crop$	$Urban$	2.63E-02	6.07E-03	1.47E-05
30		$Crop$	-6.06E-03	2.78E-03	2.90E-02
30	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	$Urban$	3.39E-02	9.02E-03	1.71E-04
30		$Urban^2$	-2.39E-04	1.60E-04	1.34E-01
30		$Crop$	-5.95E-03	2.77E-03	3.19E-02
30	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban$	3.26E-02	9.41E-03	5.36E-04
30		$Urban^{1/2}$	-4.21E-02	5.15E-02	4.13E-01
30		$Crop$	-6.02E-03	2.78E-03	3.04E-02
30	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	$Urban$	2.23E-02	6.37E-03	4.69E-04

30		<i>Crop</i>	4.44E-03	5.84E-03	4.48E-01
30		<i>Crop</i> ²	-1.23E-04	7.08E-05	8.18E-02
30	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	<i>Urban</i>	2.42E-02	6.13E-03	8.20E-05
30		<i>Crop</i>	-1.96E-02	8.03E-03	1.45E-02
30		<i>Crop</i> ^{1/2}	1.61E-01	8.27E-02	5.12E-02
30	$\gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i> ²	3.19E-04	1.05E-04	2.47E-03
30		<i>Crop</i>	-9.96E-03	2.79E-03	3.55E-04
30	$\theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i> ^{1/2}	9.00E-02	3.32E-02	6.77E-03
30		<i>Crop</i>	-9.16E-03	2.74E-03	8.26E-04
30	$\beta_1 Urban + \gamma_2 Crop^2$	<i>Urban</i>	2.29E-02	6.30E-03	2.89E-04
30		<i>Crop</i> ²	-8.31E-05	3.37E-05	1.38E-02
30	$\beta_1 Urban + \theta_2 Crop^{1/2}$	<i>Urban</i>	2.86E-02	5.98E-03	1.67E-06
30		<i>Crop</i> ^{1/2}	-4.31E-02	2.84E-02	1.30E-01
40	$\beta_1 Urban + \beta_2 Crop$	<i>Urban</i>	2.65E-02	6.06E-03	1.19E-05
40		<i>Crop</i>	-6.43E-03	2.84E-03	2.35E-02
40	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i>	3.52E-02	8.94E-03	8.15E-05
40		<i>Urban</i> ²	-2.74E-04	1.58E-04	8.28E-02
40		<i>Crop</i>	-6.27E-03	2.84E-03	2.70E-02
40	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i>	2.98E-02	9.40E-03	1.55E-03
40		<i>Urban</i> ^{1/2}	-2.16E-02	5.10E-02	6.72E-01
40		<i>Crop</i>	-6.42E-03	2.84E-03	2.39E-02
40	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	<i>Urban</i>	2.16E-02	6.39E-03	7.33E-04
40		<i>Crop</i>	6.16E-03	5.80E-03	2.89E-01
40		<i>Crop</i> ²	-1.47E-04	7.03E-05	3.58E-02
40	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	<i>Urban</i>	2.41E-02	6.12E-03	8.46E-05
40		<i>Crop</i>	-2.18E-02	8.09E-03	7.07E-03
40		<i>Crop</i> ^{1/2}	1.83E-01	8.30E-02	2.78E-02
40	$\gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i> ²	3.01E-04	1.04E-04	3.77E-03
40		<i>Crop</i>	-1.07E-02	2.84E-03	1.62E-04
40	$\theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i> ^{1/2}	9.80E-02	3.28E-02	2.81E-03
40		<i>Crop</i>	-9.34E-03	2.80E-03	8.52E-04
40	$\beta_1 Urban + \gamma_2 Crop^2$	<i>Urban</i>	2.24E-02	6.33E-03	4.09E-04

40		$Crop^2$	-9.25E-05	3.44E-05	7.10E-03
40	$\beta_1 Urban + \theta_2 Crop^{1/2}$	$Urban$	2.92E-02	5.95E-03	9.67E-07
40		$Crop^{1/2}$	-4.33E-02	2.90E-02	1.35E-01
50	$\beta_1 Urban + \beta_2 Crop$	$Urban$	3.04E-02	6.39E-03	1.96E-06
50		$Crop$	-5.80E-03	2.89E-03	4.49E-02
50	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	$Urban$	4.29E-02	9.22E-03	3.34E-06
50		$Urban^2$	-3.89E-04	1.62E-04	1.61E-02
50		$Crop$	-5.60E-03	2.89E-03	5.27E-02
50	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban$	2.82E-02	9.63E-03	3.38E-03
50		$Urban^{1/2}$	1.47E-02	5.04E-02	7.71E-01
50		$Crop$	-5.82E-03	2.89E-03	4.44E-02
50	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	$Urban$	2.50E-02	6.85E-03	2.66E-04
50		$Crop$	7.14E-03	5.71E-03	2.11E-01
50		$Crop^2$	-1.54E-04	7.11E-05	3.05E-02
50	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	$Urban$	2.77E-02	6.50E-03	1.99E-05
50		$Crop$	-2.12E-02	8.20E-03	9.65E-03
50		$Crop^{1/2}$	1.82E-01	8.21E-02	2.66E-02
50	$\gamma_1 Urban^2 + \beta_2 Crop$	$Urban^2$	2.97E-04	1.08E-04	5.81E-03
50		$Crop$	-1.09E-02	2.89E-03	1.49E-04
50	$\theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban^{1/2}$	1.26E-01	3.33E-02	1.49E-04
50		$Crop$	-8.70E-03	2.84E-03	2.23E-03
50	$\beta_1 Urban + \gamma_2 Crop^2$	$Urban$	2.59E-02	6.76E-03	1.23E-04
50		$Crop^2$	-8.98E-05	3.58E-05	1.21E-02
50	$\beta_1 Urban + \theta_2 Crop^{1/2}$	$Urban$	3.30E-02	6.26E-03	1.40E-07
50		$Crop^{1/2}$	-3.64E-02	2.88E-02	2.07E-01
60	$\beta_1 Urban + \beta_2 Crop$	$Urban$	3.23E-02	6.54E-03	7.71E-07
60		$Crop$	-3.85E-03	2.97E-03	1.96E-01
60	$\beta_1 Urban + \gamma_1 Urban^2 + \beta_2 Crop$	$Urban$	4.50E-02	9.46E-03	2.01E-06
60		$Urban^2$	-3.90E-04	1.65E-04	1.77E-02
60		$Crop$	-3.63E-03	2.97E-03	2.22E-01
60	$\beta_1 Urban + \theta_1 Urban^{1/2} + \beta_2 Crop$	$Urban$	2.73E-02	9.66E-03	4.65E-03
60		$Urban^{1/2}$	3.36E-02	5.05E-02	5.05E-01

60		<i>Crop</i>	-3.89E-03	2.97E-03	1.91E-01
60	$\beta_1 Urban + \beta_2 Crop + \gamma_2 Crop^2$	<i>Urban</i>	2.68E-02	6.87E-03	9.58E-05
60		<i>Crop</i>	1.06E-02	5.92E-03	7.25E-02
60		<i>Crop</i> ²	-1.69E-04	7.24E-05	1.96E-02
60	$\beta_1 Urban + \beta_2 Crop + \theta_2 Crop^{1/2}$	<i>Urban</i>	2.98E-02	6.60E-03	6.22E-06
60		<i>Crop</i>	-1.96E-02	8.07E-03	1.54E-02
60		<i>Crop</i> ^{1/2}	1.88E-01	8.11E-02	2.05E-02
60	$\gamma_1 Urban^2 + \beta_2 Crop$	<i>Urban</i> ²	3.24E-04	1.10E-04	3.29E-03
60		<i>Crop</i>	-9.32E-03	2.96E-03	1.66E-03
60	$\theta_1 Urban^{1/2} + \beta_2 Crop$	<i>Urban</i> ^{1/2}	1.41E-01	3.40E-02	3.27E-05
60		<i>Crop</i>	-6.79E-03	2.91E-03	1.99E-02
60	$\beta_1 Urban + \gamma_2 Crop^2$	<i>Urban</i>	2.80E-02	6.82E-03	4.13E-05
60		<i>Crop</i> ²	-7.49E-05	3.61E-05	3.81E-02
60	$\beta_1 Urban + \theta_2 Crop^{1/2}$	<i>Urban</i>	3.44E-02	6.41E-03	7.79E-08
60		<i>Crop</i> ^{1/2}	-1.48E-02	2.99E-02	6.20E-01

Table S2. Values, standard deviations, and p values about the regression coefficients in the effect testing process of Eq. (2).

k	Model	Variable	Coef.	Std.	P value
10	$\beta_3 RI$	RI	-1.27E-01	1.31E-02	1.80E-22
10	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.43E-01	2.85E-02	1.51E-17
10		RI^2	2.46E-02	4.04E-03	1.18E-09
10	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	3.85E-02	2.12E-02	6.88E-02
10		$RI^{1/2}$	-3.01E-01	3.99E-02	4.59E-14
10	$\gamma_3 RI^2$	RI^2	-1.15E-02	1.47E-03	5.12E-15
10	$RI^{1/2}$	$RI^{1/2}$	-2.47E-01	2.22E-02	1.20E-28
20	$\beta_3 RI$	RI	-1.23E-01	1.27E-02	2.97E-22
20	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.32E-01	2.83E-02	3.04E-16
20		RI^2	2.29E-02	4.02E-03	1.17E-08
20	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	4.37E-02	2.05E-02	3.28E-02
20		$RI^{1/2}$	-3.03E-01	3.88E-02	5.25E-15
20	$\gamma_3 RI^2$	RI^2	-1.13E-02	1.42E-03	1.26E-15
20	$RI^{1/2}$	$RI^{1/2}$	-2.42E-01	2.18E-02	1.43E-28
30	$\beta_3 RI$	RI	-1.37E-01	1.30E-02	9.72E-26
30	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.58E-01	2.89E-02	4.50E-19
30		RI^2	2.54E-02	4.18E-03	1.29E-09
30	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	3.33E-02	2.04E-02	1.02E-01
30		$RI^{1/2}$	-3.10E-01	3.77E-02	1.70E-16
30	$\gamma_3 RI^2$	RI^2	-1.27E-02	1.51E-03	5.20E-17
30	$RI^{1/2}$	$RI^{1/2}$	-2.64E-01	2.16E-02	4.25E-34
40	$\beta_3 RI$	RI	-1.27E-01	1.29E-02	6.68E-23
40	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.59E-01	2.82E-02	4.75E-20
40		RI^2	2.76E-02	3.92E-03	1.94E-12
40	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	6.06E-02	1.98E-02	2.17E-03
40		$RI^{1/2}$	-3.42E-01	3.66E-02	9.26E-21
40	$\gamma_3 RI^2$	RI^2	-1.06E-02	1.37E-03	1.14E-14
40	$RI^{1/2}$	$RI^{1/2}$	-2.57E-01	2.15E-02	7.01E-33
50	$\beta_3 RI$	RI	-1.30E-01	1.23E-02	6.42E-26

50	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.73E-01	2.70E-02	6.84E-24
50		RI^2	2.99E-02	3.79E-03	3.06E-15
50	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	5.95E-02	1.90E-02	1.71E-03
50		$RI^{1/2}$	-3.46E-01	3.59E-02	5.55E-22
50	$\gamma_3 RI^2$	RI^2	-1.04E-02	1.33E-03	5.55E-15
50	$RI^{1/2}$	$RI^{1/2}$	-2.62E-01	2.07E-02	1.17E-36
60	$\beta_3 RI$	RI	-1.28E-01	1.23E-02	2.22E-25
60	$\beta_3 RI + \gamma_3 RI^2$	RI	-2.75E-01	2.72E-02	4.65E-24
60		RI^2	3.06E-02	3.79E-03	6.81E-16
60	$\beta_3 RI + \theta_3 RI^{1/2}$	RI	7.26E-02	1.88E-02	1.08E-04
60		$RI^{1/2}$	-3.69E-01	3.57E-02	4.17E-25
60	$\gamma_3 RI^2$	RI^2	-9.99E-03	1.30E-03	1.76E-14
60	$RI^{1/2}$	$RI^{1/2}$	-2.66E-01	2.08E-02	1.41E-37

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Figure S1. Catchment groups for all k values in Eq. (1). The points are the geometric centers of catchments

Figure S2. Catchment groups for all k values in Eq. (2). The points are the geometric centers of catchments