Supplementary Material

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Table S1 The RegCM4 Model configuration used in this study.

Contents	Description
Domain	50 km horizontal resolution Central Lat. and Lon.: 35 °N, 115 °E 200 (Lon) × 130 (Lat)
Vertical layers (top)	18 vertical sigma levels (1 hPa)
PBL scheme	Holtslag
Cumulus parameterization scheme	Emanuel
Land surface model	NCAR CLM3.5
Short-/Longwave radiation scheme	NCAR CCM3
Boundary data	MPI-ESM-MR
Simulation period	Jan. 1970–Dec. 2000 ; Jan. 2020–Dec. 2050
Analysis period	Jan. 1971–Dec. 2000 ; Jan. 2021–Dec. 2050

Table S2. Transfer matrix of soil erosion rate before and after irrigation under RCP8.5 scenario (%)

		Y85							
		Very slight	Slight	Light	Moderate	Severe	Very severe	Extremely severe	Total
N85	Very slight	50.14	0.75						50.90
	Slight	0.73	9.78	0.78					11.29
	Light		0.68	12.65	0.70				14.04
	Moderate			0.44	7.35	0.57			8.36
	Severe				0.29	4.05	0.48		4.82
	Very severe					0.22	4.75	0.33	5.30
	Extremely severe						0.16	5.15	5.30
	Total	50.88	11.21	13.87	8.35	4.83	5.39	5.48	100.00

Table S3. Soil erosion area percentage (%) in different altitude zones

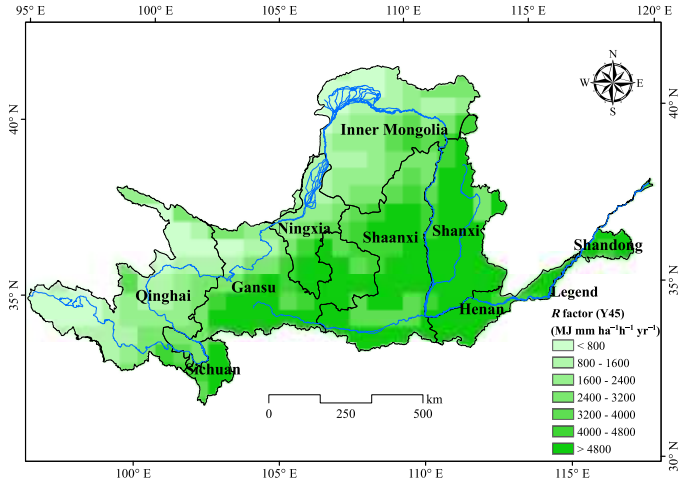
Altitude (m)		Very slight	Slight	Light	Moderate	Severe	Very severe	Extremely severe	Total
RCP4.5	0-500	5.69(-0.02)	0.33 (0.61)	0.33 (-1.75)	0.16 (-2.48)	0.08 (0.98)	0.07 (6.63)	0.07 (4.50)	6.73
	500-1000	3.89(-2.22)	0.99 (-0.05)	1.35 (0.75)	0.93 (1.17)	0.58 (1.60)	0.65 (1.58)	0.71 (6.51)	9.1
	1000-2000	26.26(-0.12)	5.80 (0.19)	6.95 (1.24)	4.50 (1.02)	2.84 (0.22)	3.31 (0.07)	3.54 (-3.42)	53.21
	2000-3000	2.62(0.18)	1.07 (2.21)	1.70 (0.52)	1.18 (0.77)	0.65 (0.12)	0.68 (-1.71)	0.66 (-5.43)	8.56
	3000-4000	6.83(-2.17)	1.81 (0.24)	2.11 (2.16)	0.82 (6.52)	0.29 (8.94)	0.23 (4.67)	0.14 (5.98)	12.23
	>4000	5.75(0.28)	1.19 (0.84)	1.51 (0.57)	0.75 (0.69)	0.35 (1.86)	0.36 (-1.61)	0.25 (0.76)	10.17
RCP8.5	0-500	5.66(0.62)	0.34 (-1.55)	0.33 (-2.36)	0.16 (-1.45)	0.08 (-5.92)	0.08(-10.48)	0.08 (-8.85)	6.73
	500-1000	3.75(4.03)	0.99 (-0.40)	1.36 (-2.39)	0.95 (-4.22)	0.60 (-2.83)	0.67 (-1.72)	0.78 (-5.85)	9.1
	1000-2000	26.09(0.90)	5.81 (-1.22)	7.05 (-3.00)	4.57 (-2.28)	2.87 (-0.52)	3.34 (1.50)	3.49 (3.38)	53.21
	2000-3000	2.71(-4.56)	1.11 (-1.49)	1.73 (-1.51)	1.16 (3.68)	0.64 (2.59)	0.64 (6.42)	0.59 (11.21)	8.56
	3000-4000	6.92(-3.31)	1.84 (0.20)	2.08 (4.06)	0.77 (9.35)	0.28 (10.73)	0.21 (10.39)	0.14 (12.17)	12.23
	>4000	5.77(-1.52)	1.20 (1.43)	1.50 (1.63)	0.75 (2.60)	0.36 (0.93)	0.36 (-0.39)	0.23 (10.51)	10.17

Notes: The parentheses represent the change percentage (%) in the soil erosion area in different altitude zones under the irrigation scenario.

Table S4. Statistical parameters of soil erosion change in typical years

Typical year	RCP4.5		RCP8.5	
	Standard Deviation	Mean	Standard Deviation	Mean
Normal	26.7	-1.3	28.5	2.5
Dry	14.3	-3.9	23.1	-4.2
Wet	38.2	-11.4	40.7	-14.2
Multi-year average	10.2	-3.2	12.6	-4.2

(a) *R* factor in RUSLE model under Y45



(b) *R* factor in RUSLE model under Y85

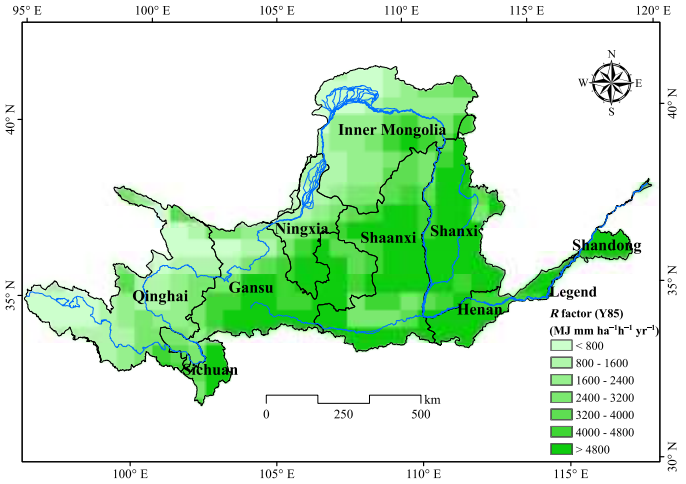


Figure S1 *R* factor (unit: MJ·mm·ha^{-2}·h^{-1}·yr^{-1}) of the RUSLE model under Y4.5 (a) and Y8.5 (b).

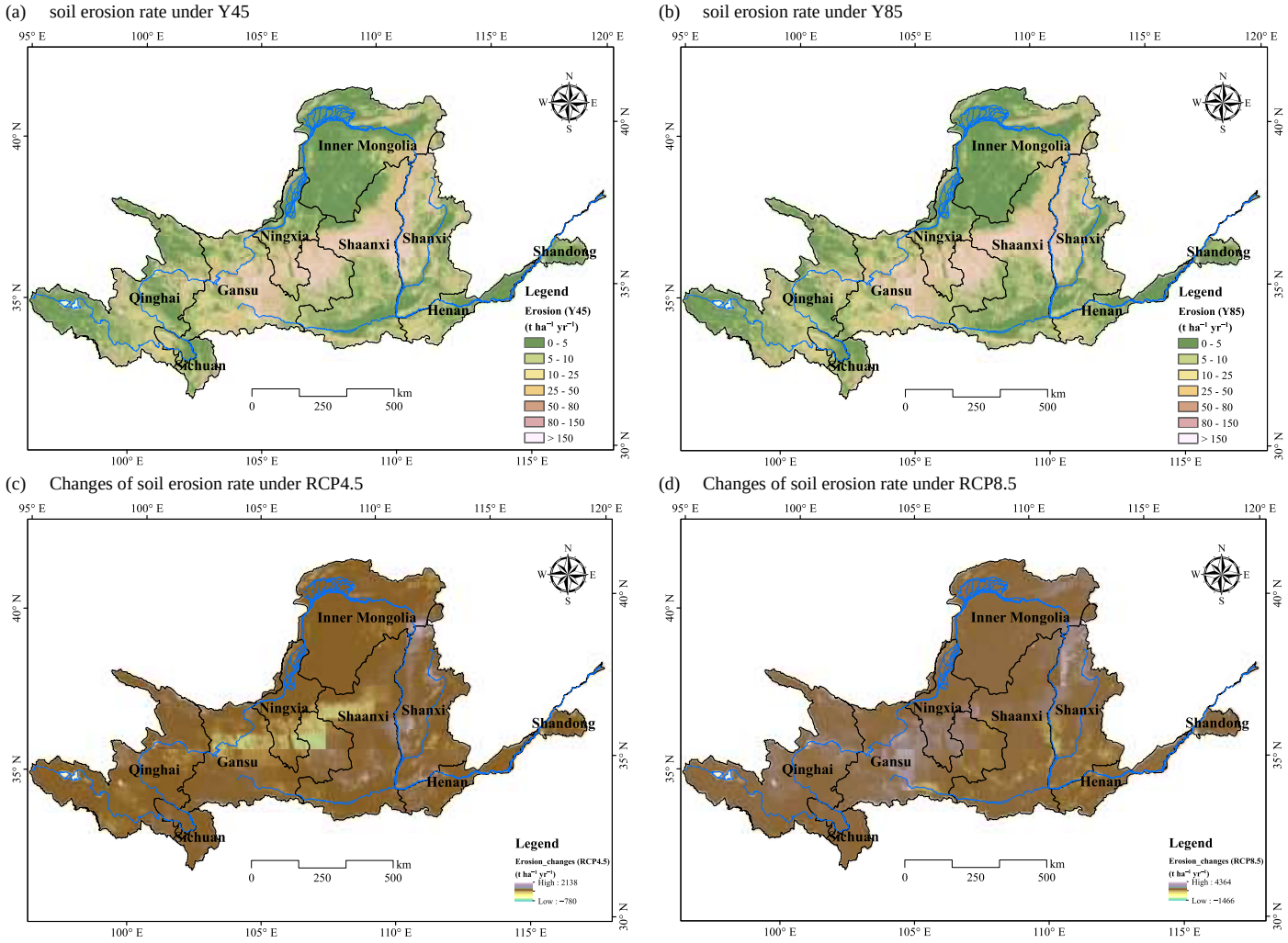


Figure S2 Spatial pattern of soil erosion rates in the YRB with and without irrigation. [(a) and (b) depict the soil erosion rate in YRB under Y45 and Y85 experiments, respectively; (c) and (d) show the corresponding change rate (defined as Y−N), unit: $t \cdot ha^{-1}yr^{-1}$) of soil erosion rate with irrigation (Y45, Y85) compared to without irrigation (N45, N85)].

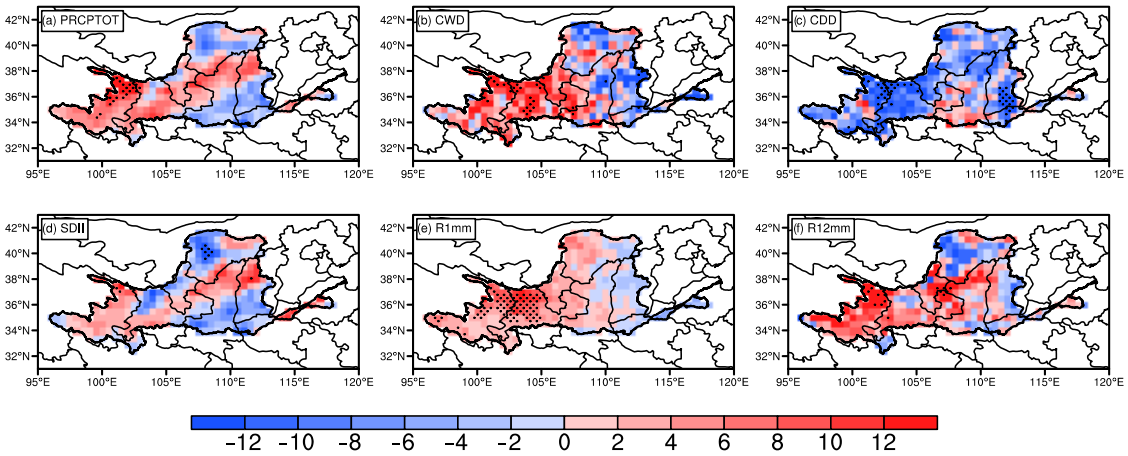


Figure S3 Spatial distribution of differences (defined as (Y−N)×100/N; unit: %) in summer precipitation indices under RCP8.5 over the YRB. [(a) PRCPTOT; (b) CWD; (c) CDD; (d) SDII; (e) R01mm; (f) R12mm]

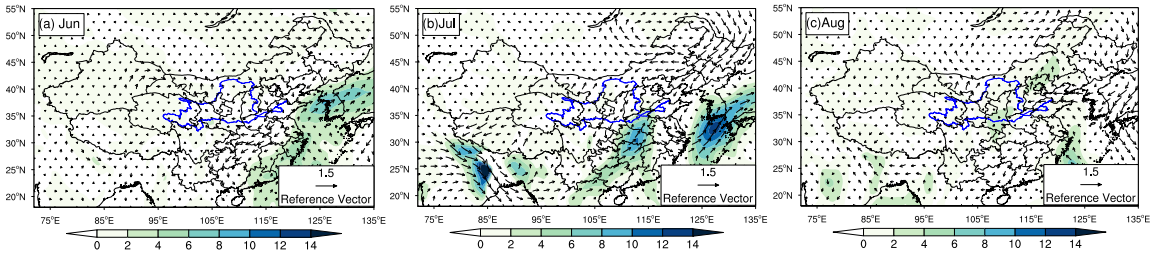


Figure S4 Differences (defined as Y minus N) in the integrated water vapor flux (shading, unit: $kg \cdot m^{-1} \cdot s^{-1}$) and wind field (vector, unit: $m \cdot s^{-1}$) at 850hPa under RCP4.5 from June to August. [(a) June; (b) July; (c) August]

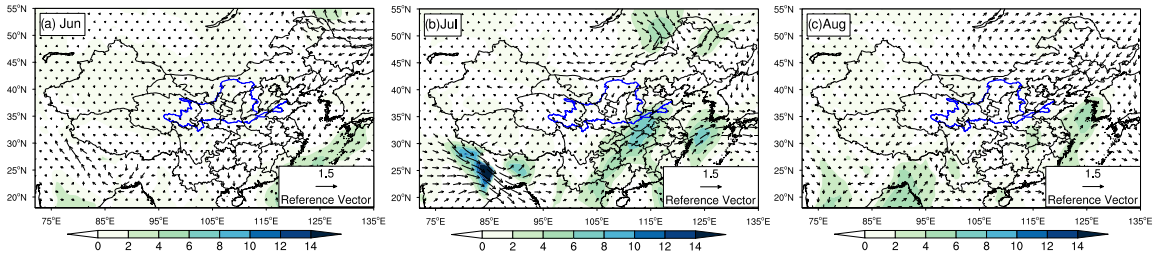


Figure S5 Differences (defined as RCP8.5 minus RCP4.5) in the integrated water vapor flux (shading, unit: $kg \cdot m^{-1} \cdot s^{-1}$) and wind field (vector, unit: $m \cdot s^{-1}$) at 850hPa from June to August. [(a) June; (b) July; (c) August]

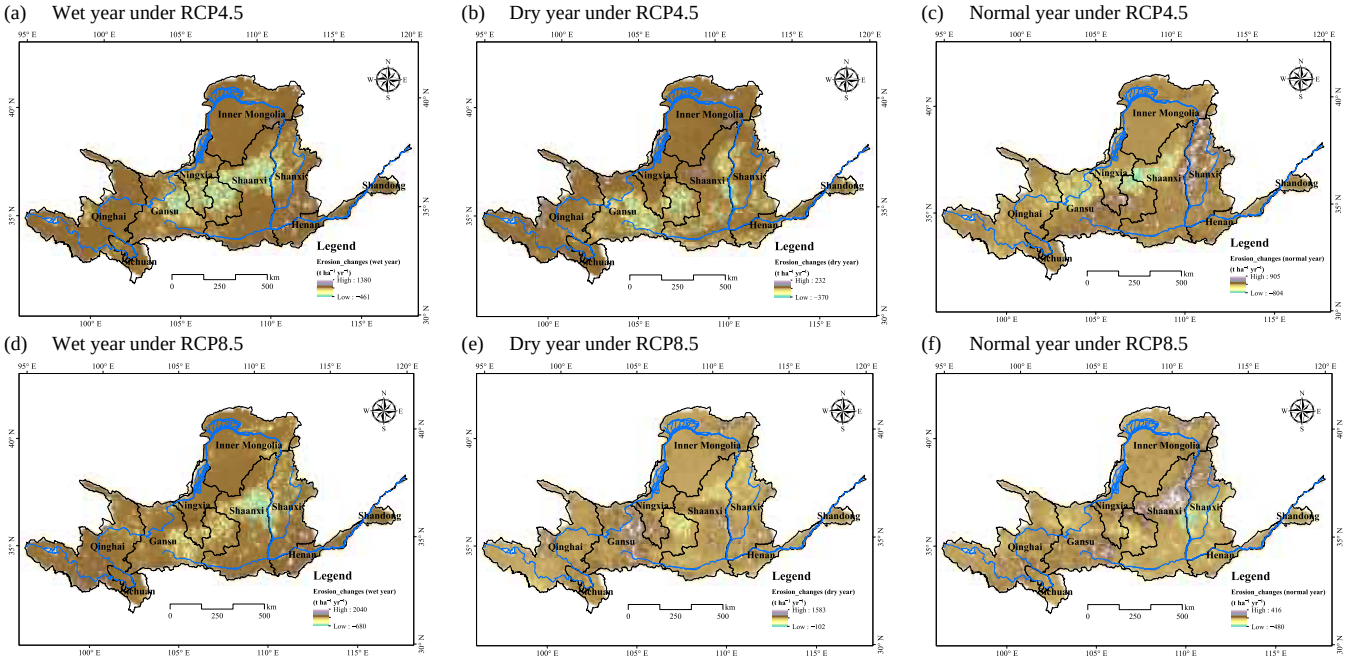


Figure S6 Spatial distribution of soil erosion rate changes (defined as Y minus N; unit: $t \cdot ha^{-1}yr^{-1}$) in typical years. [(a)~(c) represent wet, dry, normal years under the RCP4.5 scenario, respectively; (d)~(f) are similar to (a)~(c), but under the RCP8.5 scenario.]