**Supplementary material:**

**Spatio-temporal changes and their relationship in water resources and agricultural disasters across China**

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**Table S1.** Province-based results of trend detection in effective irrigated areas using the MMK method (corresponding to Fig. 7).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Province | ID | MK *Z* value | Sen’s slope |
| 1 | Beijing | A | -1.152815 | -2 |
| 2 | Tianjin | B | -1.692739 | -6.875 |
| 3 | Hebei | C | -0.709484 | -18 |
| 4 | Shanxi | D | -1.757549 | -13.55556 |
| 5 | Inner Mongolia | E | 4.1570103 | 37.777778 |
| 6 | Liaoning | F | 0.6418715 | 3.1428571 |
| 7 | Jilin | G | -0.017767 | -1.666667 |
| 8 | Heilongjiang | H | 5.2415262 | 28.875 |
| 9 | Shanghai | I | -3.856337 | -7.5 |
| 10 | Jiangsu | J | -0.664738 | -24.09524 |
| 11 | Zhejiang | K | -2.155433 | -16.66667 |
| 12 | Anhui | L | -1.414482 | -19.5 |
| 13 | Fujian | M | -3.327579 | -19.3 |
| 14 | Jiangxi | N | -1.124162 | -28.56 |
| 15 | Shandong | O | -0.393218 | -20.13043 |
| 16 | Henan | P | -1.92979 | -38.13043 |
| 17 | Hubei | Q | -2.534315 | -45.3 |
| 18 | Hunan | R | -1.411105 | -34.48 |
| 19 | Guangdong | S | -4.018046 | -79.25 |
| 20 | Guangxi | T | -2.838973 | -28 |
| 21 | Sichuan | U | -1.698331 | -54 |
| 22 | Guizhou | V | 0.0132705 | -0.666667 |
| 23 | Yunan | W | 1.0951936 | 8 |
| 24 | Tibet | X | -4.487917 | -3.333333 |
| 25 | Shaanxi | Y | -1.127884 | -12.55556 |
| 26 | Gansu | Z | -2.482905 | -14.04167 |
| 27 | Qinghai | AA | -0.151575 | -0.444444 |
| 28 | Ningxia | AB | 1.5396207 | 1.1923077 |
| 29 | Xinjiang | AC | -0.513982 | -13.66667 |

**Table S2.** Percentiles of rice, wheat, corn and beans cultivated areas to total crop-cultivated area in each province (corresponding to Fig. 8).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Province | ID | Rice | Wheat | Corn | Beans |
| 1 | Beijing | A | 0.0558289 | 0.2937511 | 0.3294221 | 0.0306417 |
| 2 | Tianjin | B | 0.067137 | 0.256331 | 0.2673852 | 0.0951155 |
| 3 | Hebei | C | 0.0138612 | 0.2871846 | 0.2360881 | 0.0762738 |
| 4 | Shanxi | D | 0.0021535 | 0.245824 | 0.1678865 | 0.1154841 |
| 5 | Inner Mongolia | E | 0.00903 | 0.2236648 | 0.127567 | 0.1750222 |
| 6 | Liaoning | F | 0.1166706 | 0.0248372 | 0.3498711 | 0.0840749 |
| 7 | Jilin | G | 0.0832587 | 0.0247544 | 0.4697431 | 0.1162333 |
| 8 | Heilongjiang | H | 0.0674257 | 0.1885992 | 0.231661 | 0.3033709 |
| 9 | Shanghai | I | 0.4019435 | 0.09468 | 0.0131527 | 0.0178713 |
| 10 | Jiangsu | J | 0.3037214 | 0.2323028 | 0.0527419 | 0.0470831 |
| 11 | Zhejiang | K | 0.5393033 | 0.061806 | 0.0146386 | 0.0429381 |
| 12 | Anhui | L | 0.2729905 | 0.2370774 | 0.0394931 | 0.0712697 |
| 13 | Fujian | M | 0.5761205 | 0.0421377 | 0.0049252 | 0.0462118 |
| 14 | Jiangxi | N | 0.56524 | 0.0170101 | 0.0027409 | 0.0407519 |
| 15 | Shandong | O | 0.0134233 | 0.3572715 | 0.2067307 | 0.050407 |
| 16 | Henan | P | 0.0386816 | 0.3778448 | 0.1548587 | 0.0582258 |
| 17 | Hubei | Q | 0.3477629 | 0.1617462 | 0.0525205 | 0.0444114 |
| 18 | Hunan | R | 0.5413994 | 0.0262157 | 0.0178392 | 0.0360887 |
| 19 | Guangdong | S | 0.5664442 | 0.0215225 | 0.0113613 | 0.0235818 |
| 20 | Guangxi | T | 0.5064828 | 0.0082716 | 0.1074716 | 0.0555478 |
| 21 | Sichuan | U | 0.260181 | 0.1751416 | 0.1336602 | 0.0423615 |
| 22 | Guizhou | V | 0.2260761 | 0.1233705 | 0.194633 | 0.0659493 |
| 23 | Yunan | W | 0.236132 | 0.1306578 | 0.2298713 | 0.0925034 |
| 24 | Tibet | X | 0.0037447 | 0.2154485 | 0.0084138 | 0.0668125 |
| 25 | Shaanxi | Y | 0.0328943 | 0.3347313 | 0.2041063 | 0.0940185 |
| 26 | Gansu | Z | 0.0014139 | 0.3893946 | 0.0883016 | 0.0680554 |
| 27 | Qinghai | AA | 0 | 0.3888744 | 0.0004071 | 0.1052967 |
| 28 | Ningxia | AB | 0.0609764 | 0.3258153 | 0.0628267 | 0.0984552 |
| 29 | Xinjiang | AC | 0.0283347 | 0.3995106 | 0.1618503 | 0.0230281 |

**Table S3.** Province-based results of trend detections in all crop, rice, wheat, corn and beans cultivated areas using the MMK method (corresponding to Fig. 9).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Province | ID | All Crops | Rice | Wheat | Corn | Beans |
| 1 | Beijing | A | -4.664622 | -1.975909 | -1.361661 | 1.6332523 | 0.2493515 |
| 2 | Tianjin | B | -2.733518 | 3.5213133 | -2.171087 | -1.710543 | -2.845512 |
| 3 | Hebei | C | -1.018542 | 2.6947486 | 0.4957786 | 2.0241061 | -2.598076 |
| 4 | Shanxi | D | -3.190126 | -7.034098 | -2.526878 | 1.204594 | -0.371154 |
| 5 | Inner Mongolia | E | 2.7569482 | 4.3457165 | 2.9960141 | 4.4686818 | 2.5980762 |
| 6 | Liaoning | F | -2.595886 | 3.3177266 | 1.2288772 | 2.2263152 | -1.608333 |
| 7 | Jilin | G | -1.416806 | 4.9187855 | -2.340655 | 2.8329904 | -1.113461 |
| 8 | Heilongjiang | H | 2.6079151 | 3.9296642 | -2.216638 | 1.5291125 | -1.113461 |
| 9 | Shanghai | I | -4.567186 | -7.689863 | 2.8733375 | -2.041665 | -2.533202 |
| 10 | Jiangsu | J | -3.968372 | -4.074228 | 2.9241227 | 1.8296625 | -1.113461 |
| 11 | Zhejiang | K | -3.06424 | -3.317557 | 0.2412353 | -2.474758 | 3.3403837 |
| 12 | Anhui | L | 2.824322 | -1.461586 | 3.6663922 | 2.9334025 | 0.1237179 |
| 13 | Fujian | M | 1.4638188 | -5.685835 | -4.347349 | 2.7102559 | 2.5980762 |
| 14 | Jiangxi | N | 0.6107309 | -5.215659 | -4.431318 | 1.7091036 | 0.3851644 |
| 15 | Shandong | O | 0.4540062 | -0.694357 | 1.8313139 | 4.5658517 | -2.598076 |
| 16 | Henan | P | 6.1496657 | 0.9066152 | 4.2362302 | 5.4610495 | -1.360897 |
| 17 | Hubei | Q | -1.369695 | -3.886638 | 0.4012498 | 1.2106133 | 1.3608971 |
| 18 | Hunan | R | -1.347399 | -4.653264 | -4.103585 | 1.4257533 | 2.7428664 |
| 19 | Guangdong | S | -3.332166 | -4.014744 | -3.07957 | 1.5989697 | 2.6387796 |
| 20 | Guangxi | T | 1.5703542 | -4.001427 | -1.381326 | -0.300199 | 3.3403837 |
| 21 | Sichuan | U | 1.4277894 | -3.148963 | 1.5053846 | 1.1356833 | -1.360897 |
| 22 | Guizhou | V | 3.1828825 | -2.513457 | 1.7142451 | -0.815751 | 3.0929479 |
| 23 | Yunan | W | 3.4336038 | -2.375868 | 1.4222201 | 1.0980593 | 0.3711537 |
| 24 | Tibet | X | -0.282156 | 3.1118739 | 0.6711199 | 3.4826058 | -2.992218 |
| 25 | Shaanxi | Y | -2.627157 | -3.019762 | 0.5306094 | 2.7694124 | -0.123718 |
| 26 | Gansu | Z | 2.2006636 | 2.1902313 | -1.295458 | 2.3608238 | -1.113461 |
| 27 | Qinghai | AA | 2.9973532 | 0 | 1.0965545 | 1.5615524 | -3.340384 |
| 28 | Ningxia | AB | 1.5512362 | 4.7480901 | 0.8630747 | 3.8415544 | -2.103205 |
| 29 | Xinjiang | AC | 2.3624235 | -2.842335 | -3.747484 | -2.830784 | -0.371154 |

**Table S4.** Average ratio of flood-affected and drought-affected crop areas and flood-destroyed and drought-destroyed crop areas to total affected and destroyed crop areas in each province (corresponding to Fig. 10).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Province | ID | Flood-affected | Flood-destroyed | Drought-affected | Drought-destroyed |
| 1 | Beijing | A | 0.120 | 0.142 | 0.627 | 0.551 |
| 2 | Tianjin | B | 0.234 | 0.310 | 0.554 | 0.490 |
| 3 | Hebei | C | 0.112 | 0.149 | 0.709 | 0.625 |
| 4 | Shanxi | D | 0.105 | 0.126 | 0.724 | 0.684 |
| 5 | Inner Mongolia | E | 0.127 | 0.184 | 0.630 | 0.595 |
| 6 | Liaoning | F | 0.204 | 0.262 | 0.628 | 0.577 |
| 7 | Jilin | G | 0.230 | 0.281 | 0.534 | 0.502 |
| 8 | Heilongjiang | H | 0.309 | 0.352 | 0.521 | 0.458 |
| 9 | Shanghai | I | 0.479 | 0.271 | 0.034 | 0.034 |
| 10 | Jiangsu | J | 0.350 | 0.414 | 0.375 | 0.345 |
| 11 | Zhejiang | K | 0.485 | 0.557 | 0.229 | 0.173 |
| 12 | Anhui | L | 0.350 | 0.459 | 0.513 | 0.401 |
| 13 | Fujian | M | 0.400 | 0.486 | 0.329 | 0.237 |
| 14 | Jiangxi | N | 0.461 | 0.532 | 0.401 | 0.334 |
| 15 | Shandong | O | 0.159 | 0.221 | 0.690 | 0.648 |
| 16 | Henan | P | 0.356 | 0.431 | 0.495 | 0.419 |
| 17 | Hubei | Q | 0.159 | 0.193 | 0.682 | 0.649 |
| 18 | Hunan | R | 0.365 | 0.434 | 0.516 | 0.455 |
| 19 | Guangdong | S | 0.402 | 0.521 | 0.321 | 0.209 |
| 20 | Guangxi | T | 0.249 | 0.277 | 0.575 | 0.502 |
| 21 | Sichuan | U | 0.273 | 0.305 | 0.556 | 0.512 |
| 22 | Guizhou | V | 0.260 | 0.316 | 0.460 | 0.446 |
| 23 | Yunan | W | 0.218 | 0.306 | 0.490 | 0.402 |
| 24 | Tibet | X | 0.159 | 0.154 | 0.502 | 0.329 |
| 25 | Shaanxi | Y | 0.159 | 0.193 | 0.682 | 0.649 |
| 26 | Gansu | Z | 0.130 | 0.167 | 0.627 | 0.546 |
| 27 | Qinghai | AA | 0.099 | 0.103 | 0.479 | 0.419 |
| 28 | Ningxia | AB | 0.095 | 0.116 | 0.633 | 0.610 |
| 29 | Xinjiang | AC | 0.112 | 0.111 | 0.466 | 0.439 |

**Table S5.** Province-based results of trend detection in the percentile of flood-affected and drought-affected crop areas and flood-destroyed and drought-destroyed crop areas to total affected and destroyed crop areas using the MMK method (corresponding to Fig. 11).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Province | ID | Flood-affected | Flood-destroyed | Drought-affected | Drought-destroyed |
| 1 | Beijing | A | -0.512391 | 0.2302165 | 0.5419687 | 1.3383431 |
| 2 | Tianjin | B | -2.262652 | -1.800234 | 1.3714312 | 0.9870058 |
| 3 | Hebei | C | 2.0646693 | 0.5064677 | -1.481887 | -0.468952 |
| 4 | Shanxi | D | 0.0967509 | -0.994177 | 2.747141 | 3.006345 |
| 5 | Inner Mongolia | E | 1.5384318 | 0.9005454 | 1.2567901 | 0.9380681 |
| 6 | Liaoning | F | 1.6316985 | 0.5959553 | 0.1688226 | 0.5129203 |
| 7 | Jilin | G | 2.5323383 | 1.7260454 | -0.5815 | 0.1255768 |
| 8 | Heilongjiang | H | 0.8450615 | 0.3921772 | -0.195568 | 1.0886701 |
| 9 | Shanghai | I | 0.698326 | 1.5751604 | 0.437551 | 0.437551 |
| 10 | Jiangsu | J | -1.219274 | -2.773597 | 0.4320948 | 0.8515435 |
| 11 | Zhejiang | K | -1.88452 | -1.801937 | -0.322617 | 1.5573243 |
| 12 | Anhui | L | 0.2063387 | -1.222936 | -0.393919 | 1.1099851 |
| 13 | Fujian | M | 0.5064677 | -0.997105 | -5.402677 | -0.094887 |
| 14 | Jiangxi | N | 1.5569191 | 0.8258877 | -1.819532 | -0.732682 |
| 15 | Shandong | O | 0.6565322 | 0.3188871 | -0.919336 | -0.09379 |
| 16 | Henan | P | 1.8874147 | 0.4502727 | -2.269725 | -0.519663 |
| 17 | Hubei | Q | 1.8945642 | 0.7690805 | 0.3188871 | 1.3822637 |
| 18 | Hunan | R | 2.7949512 | 1.8945642 | -3.879944 | -1.763568 |
| 19 | Guangdong | S | -0.056274 | -1.088159 | -0.393919 | 2.4884998 |
| 20 | Guangxi | T | 3.2784819 | 3.0565268 | -2.347612 | -0.373333 |
| 21 | Sichuan | U | 2.6448867 | 2.132668 | -2.194693 | -1.481887 |
| 22 | Guizhou | V | 2.9450157 | 1.6885227 | -0.994177 | -0.976049 |
| 23 | Yunan | W | 2.9825318 | 1.0316934 | -1.869751 | 0.695109 |
| 24 | Tibet | X | 3.6422271 | 2.4400216 | -1.914219 | -0.319766 |
| 25 | Shaanxi | Y | 1.8945642 | 0.7690805 | 0.3188871 | 1.3822637 |
| 26 | Gansu | Z | 0.7690805 | 0.3377045 | 1.519403 | 2.0477534 |
| 27 | Qinghai | AA | 2.7766817 | 2.1214034 | 0.6575355 | 1.1721784 |
| 28 | Ningxia | AB | 3.7876988 | 1.7847392 | -0.6907 | -0.225242 |
| 29 | Xinjiang | AC | 3.0246633 | 3.0249765 | -0.450484 | -0.675726 |

**Figure S1.** Utilization of water resources in Songhuajiang River Basin (2012–2016; unit: 108 m3).

**Figure S2.** Utilization of water resources in Liao River Basin (2012–2016; unit: 108 m3).

**Figure S3.** Utilization of water resources in Hai River Basin (2012–2016; unit: 108 m3).

**Figure S4.** Utilization of water resources in Huai River Basin (2012–2016; unit: 108 m3).

**Figure S5.** Utilization of water resources in Yellow River Basin (2012–2016; unit: 108 m3).