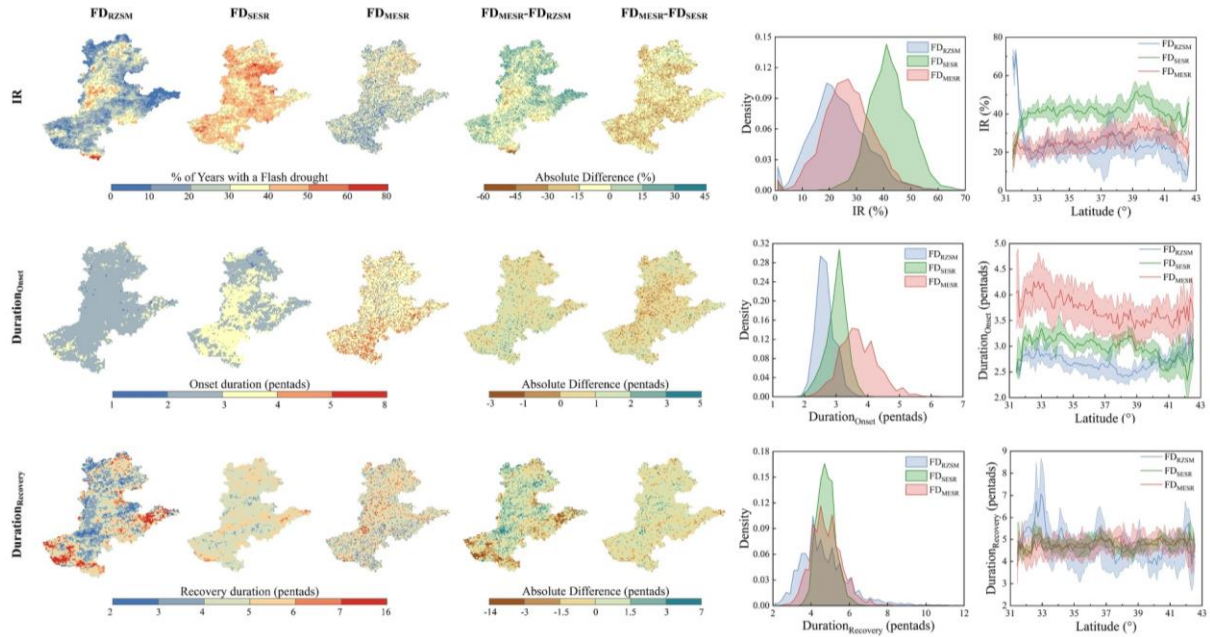
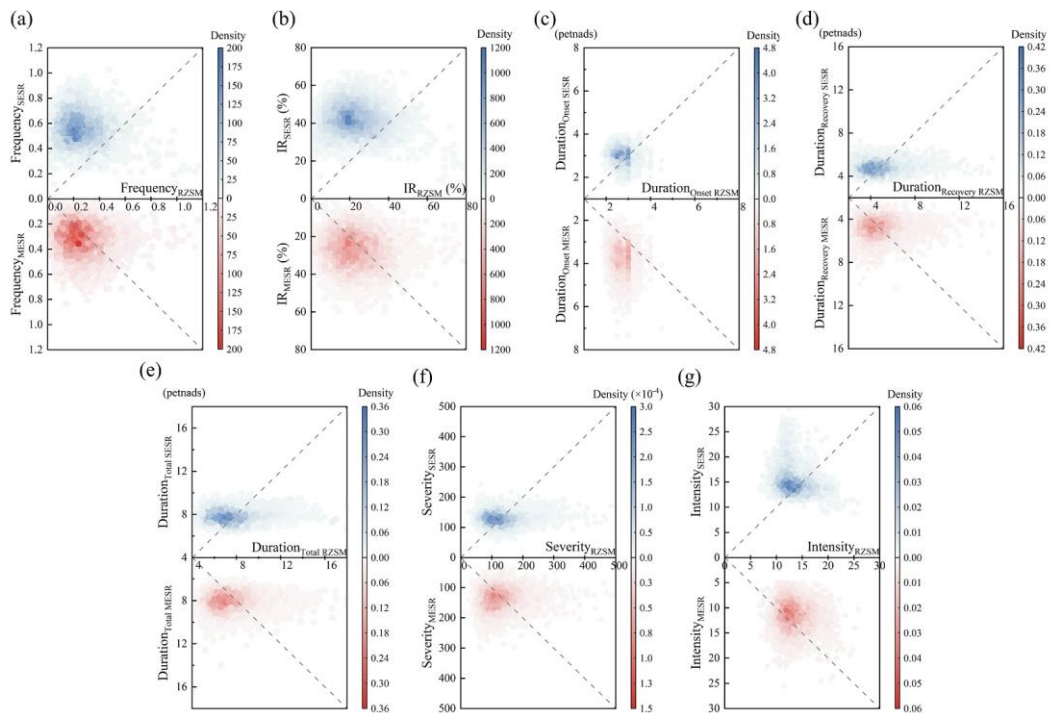
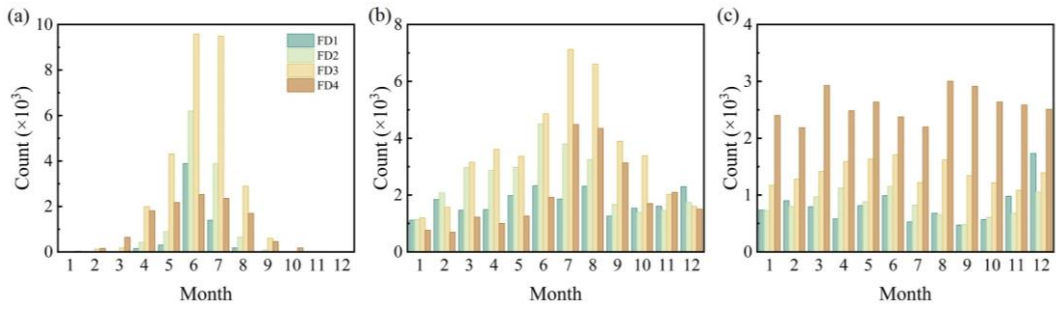
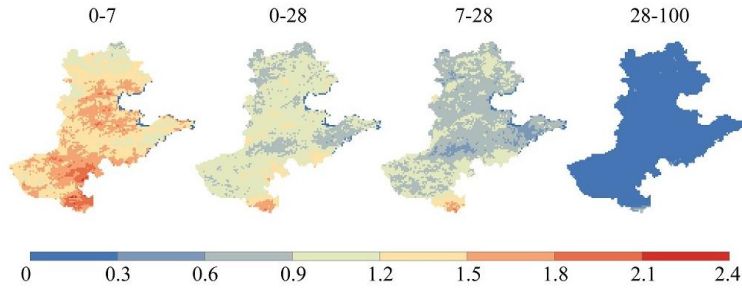
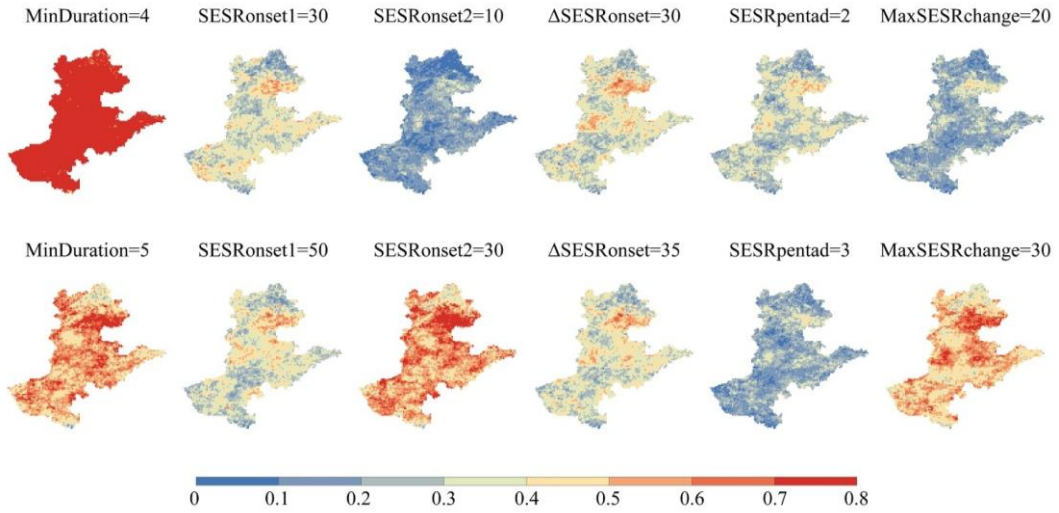
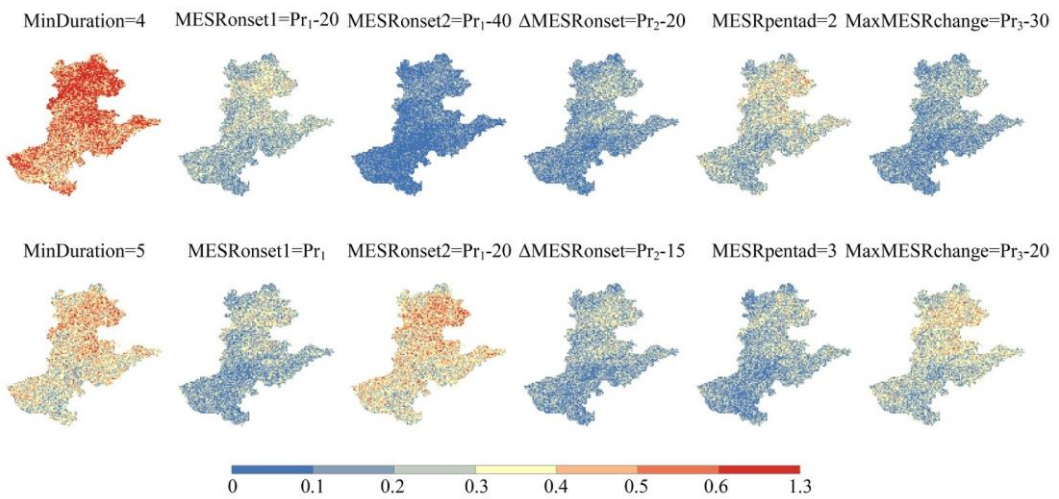
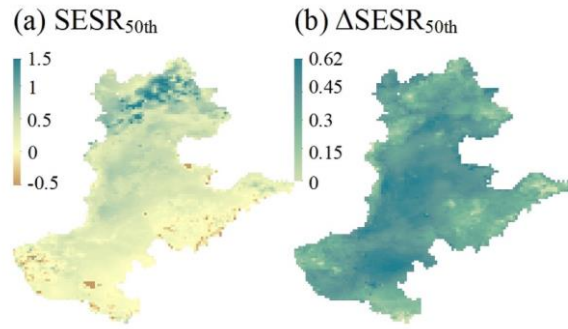
Table S1 The main ranges of FD characteristics under different FD grades.

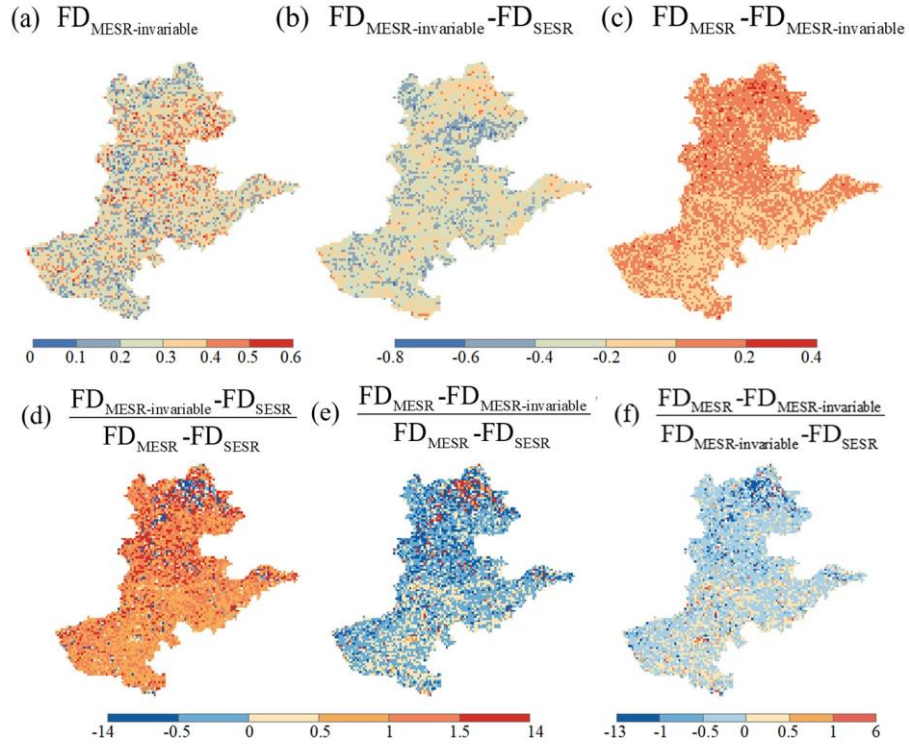
Characteristics	Method	FD1	FD2	FD3	FD4
Duration$_{Onset}$	FD$_{RZSM}$	2~3.5	2~3.5	2~3.5	3~3.5
	FD$_{SESR}$	2~4	2~5	3~6	3~6
	FD$_{MESR}$	2~3	2~4	3~4	3~5
Duration$_{Recovery}$	FD$_{RZSM}$	3~11	1~5	1~3	1~3
	FD$_{SESR}$	4~7	2~5	1~4	1~4
	FD$_{MESR}$	4~6	2~6	2~6	2~6
Duration$_{Total}$	FD$_{RZSM}$	6~12	4~8	4~6	4~6
	FD$_{SESR}$	7~10	6~8	6~8	6~8
	FD$_{MESR}$	6~10	6~10	6~10	6~10
Severity	FD$_{RZSM}$	150~350	50~150	0~100	0~50
	FD$_{SESR}$	100~150	150~300	50~100	50~100
	FD$_{MESR}$	50~200	50~200	50~200	50~200

 Figure S1 Same as Figure 4, but for IR, duration$_{Onset}$ and duration$_{Recovery}$.

 Figure S2 Scatter densities of FD characteristics identified by RZSM, SESR, and MESR.

6

7 **Figure S3 The amount of FD grids under different (a) FD$_{RZSM}$, (b) FD$_{SESR}$ and (c) FD$_{MESR}$ grades from 1981 to 2022.**

8

9 **Figure S4 Frequency for FD$_{RZSM}$ with RZSM from different soil layers.**

10

11 **Figure S5 Same as Figure 11, but for FD$_{SESR}$.**

12

13 **Figure S6 Same as Figure 11, but for FD$_{MESR}$.**

14

15   **Figure S7 Distribution of the mean (a) SESR$_{50th}$ and (b) ΔSESR$_{50th}$.**

16

17   **Figure S8 Frequency of FD$_{MESR-invariable}$ and its difference with FD$_{MESR}$ and FD$_{SESR}$.**