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## Increasing occurrence of sudden turns from drought to flood over China

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This study focuses on a new compounding concern, the sudden turn from drought to flood (STDF), that is becoming increasingly prominent. Droughts usually end due to increased precipitation, but if excessive rainfall occurs, it can lead to secondary impacts on already barren land, increasing the likelihood of landslides and making farmland flooding significantly costlier than it would have been if only flooding had occurred. Therefore, we must pay more attention to compound disasters that increase the vulnerability of populations and ecosystems. Most studies on rapid drought-to-flood transitions have analyzed individual cases, whereas few have studied the STDF characteristics in China or even globally or the long-term changes in the STDF trend. In this study, we selected an STDF screening method that is accurate on a daily scale.

In this study we calculated the SPEI on a 1-month scale, sliding a 30-day window in order to obtain the SPEI values for each day. Second, we used a relative threshold rather than an absolute threshold to define a flood in consideration of regional precipitation differences. A definition of STDF as follows:

 $\begin{cases} SPEI \le -0.5 \\ t_d - t_o \ge 40 \end{cases} \cap \begin{cases} PRE_t \ge 99.5th \ percentile, \ t = 3d \\ t_p - t_d \le 10 \end{cases}$ 

where t<sub>o</sub> is the drought start time, t<sub>d</sub> is the drought end time, and t<sub>p</sub> is the time when flooding starts. Here, a drought is said to have occurred when the SPEI ≤-0.5 for more than 40 consecutive days. Our reference method considers drought duration to be more than 20 days, which is based on the persistence of the drought. And the main reason for our choice of 40 days is mainly to exclude the effect of flash droughts, although that type of event proved not to have a significant impact on our results in the subsequent discussion. PREt represents the t-d precipitation (for example, t=3, PRE3 is the 3d cumulative precipitation), when PREt is greater than the 99.5th (for PRE3)/99.3th (for PRE5)/98.7th (for PRE10) percentile precipitation for each reference period (1961-2020) as the flood threshold. (Based on the natural disasters released by the Emergency Management Department and the China's Yearbook of Meteorological Disasters , 234 floods events were obtained for the period of 2010-2020, and so a threshold of 99.5th, 99.3th, and 98.7th percentile (corresponding to 3d/5d/10d continuous precipitation) was determined for their

ranking in the rainfall series from 1961 to 2020.)

The results show that STDFs have been increasing more frequently in China at a rate of average 2.8 events per decade. The most significant increases occurred in May and June, resulting in an advance of one month for the STDF peak. The STDF hotspots are concentrated in north and northeast China and YRD. Nearly 35% of droughts in northern and northeast China have been immediately followed by a flood rather than a gradual drought mitigation or a drought alone. STDFs have become more prevalent in northern China as a result of increased flood frequency and precipitation volatility, while in southern China, the increase in STDF frequency is primarily due to an increase in drought frequency.