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Propagation characteristics from meteorological to hydrological drought and its influence factors in Huaihe River Basin

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CONTENTS

1. Introduction

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- Reveal under what circumstance meteorological drought does not propagate to hydrological drought and explore the cause of hydrological drought in the absence of meteorological drought.

- How dose drought propagate from meteorological drought and hydrological drought and investigate the causes of hydrological drought?

2. Study area

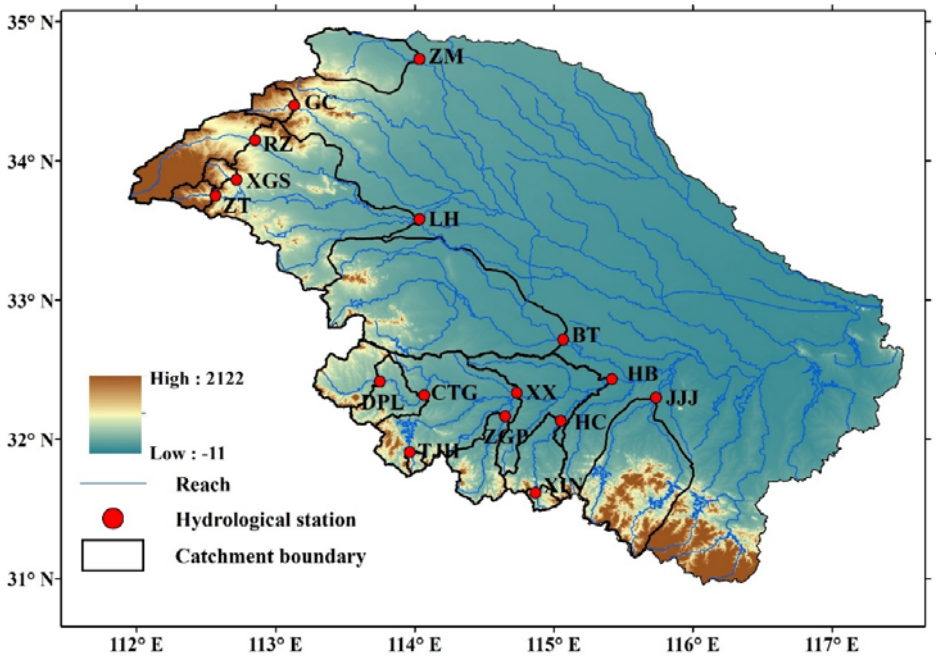

Figure 1 Study area

Table 1 Summary of catchments characteristics

Abbreviation of catchment	Hydrological station	Longitude	Latitude	Area (km^2)	Precipitation(mm)	
DPL	Dapoling	113.75	32.42	1640	997.3	UHRB
CTG	Changtaiguan	114.07	32.32	3090	1004.5	UHRB
XX	Xinxian	114.73	32.33	10230	1020.4	UHRB
HB	Huaibin	115.42	32.43	15780	1034.4	UHRB
TJH	Tanjiahe	113.88	31.90	173	1232.4	UHRB
ZGP	Zhuganpu	114.65	32.17	1639	1127.5	UHRB
XIN	Xinxian	114.87	31.62	274	1318.8	UHRB
HC	Huangchuan	115.05	32.13	2050	1201.9	UHRB
RZ	Ruzhou	112.85	34.15	2912	628.5	YHRB
XGS	Xiagushan	112.72	33.87	359	801.6	YHRB
ZT	Zhongtang	112.57	33.75	467	927.6	YHRB
LH	Luohe	114.03	33.58	12150	767	YHRB
GC	Gaocheng	113.13	34.40	631	669.6	YHRB
ZM	Zhongmou	114.03	34.73	2132	633.9	YHRB
BT	Bantai	115.07	32.72	11104	972.2	YHRB
JJJ	Jiangjiaji	115.73	32.30	5631	1246.1	MHRB

3. Data and methods

Data	Data source
Precipitation data	Daily precipitation data at 184 precipitation stations from1980 to 2014
Runoff data	Daily runoff data at 16 hydrologic stations from1980 to 2014
Digital Elevation Model	SRTM （https://lta.cr.usgs.gov/SRTM） 90m×90m
Normalized Difference Vegetation Index (NDVI)	MODI13C2（https://ladsweb.modaps.eosdis.nasa.gov/） 0.05° ×0.05° Data length: 2000.1～2014.12
Land cover data	GlobeLand30 （http://www.globallandcover.com/GLC30Download/index.aspx） 30m×30m
Reservoir	Stastical data

3. Data and methods

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Catchment properties	Definitions	Units
Drainage density	The total length of all the streams and rivers in a drainage basin divided by the total area of basin.	Km/Km^2
Baseflow index (BFI)	The ratio of baseflow and total runoff. Baseflow was separated from total streamflow using Digital filter method	-
Topographic index	ln (α/tanβ), α is the cumulative upslope area draining through per contour length to a pixel and tanβ is the local slope angle of the cell.	-
Normalized Difference Vegetation Index (NDVI)	An important parameters reflecting crop growth and nutritional information.	-
Ratio of reservoir capacity	The ratio of the storage capacity of the reservoir in the catchment to the annual average runoff in the catchment, reflecting the extent to which the river runoff is regulated by human activities (only the large- and medium-sized reservoirs in the catchment considered).	%
Ratio of cultivated land	The ratio of catchment covered by cultivated land counted from GlobeLand30-2010 and catchment area, reflecting the proportion of agricultural irrigation water consumption in total runoff.	%

3. Data and methods

- Standardized Precipitation Index (SPI)
- Standardized Runoff Index (SRI)
- Threshold level method： Identify drought events based on SPI/SRI values and calculate drought duration, severity and intensity.

$$D_P = D_1 + t_c + D_2$$

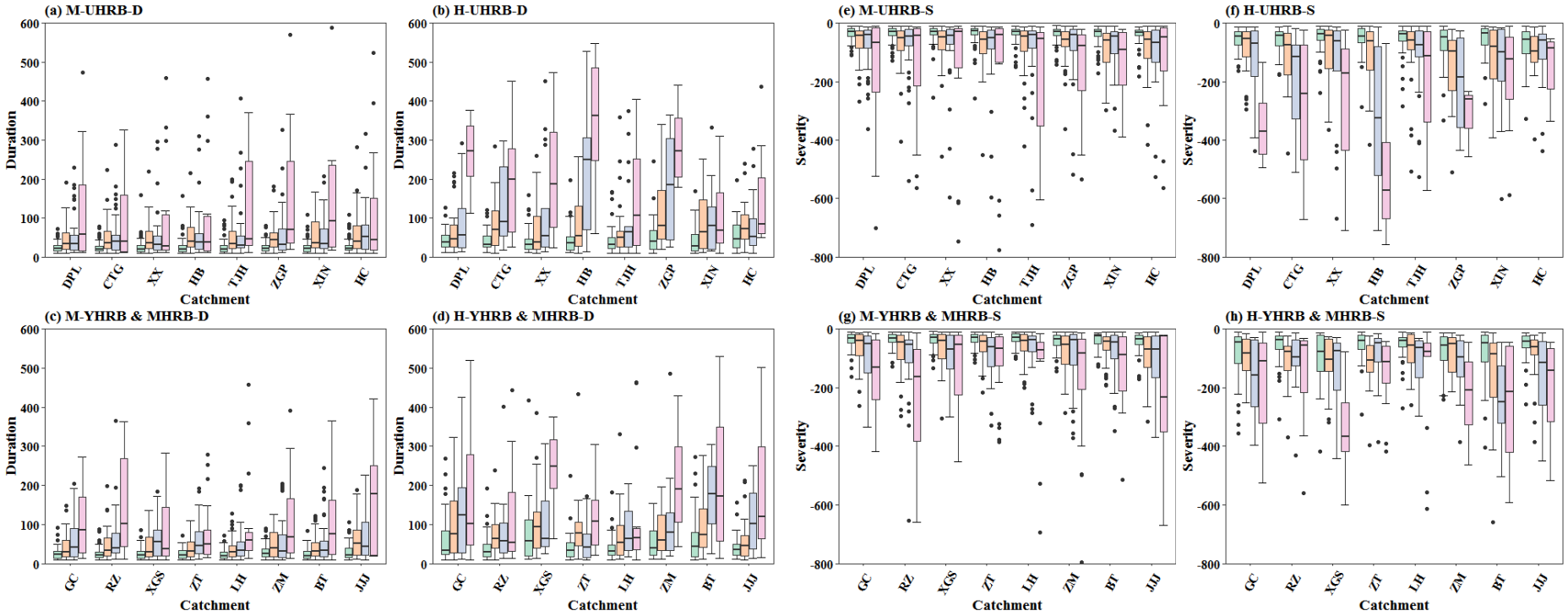
$$S = \sum_{t=1}^{D} SPI_t$$

$$I = \frac{1}{D}\sum_{t=1}^{D} SPI_t$$

- Paired-catchment approach: Quantify the influence of human activities.

4. Propagation characteristics

Drought characteristics calculated by threshold method based on SPI and SRI for different time scales in the upstream (UHRB), Ying river (YHRB) and midstream (MHRB) of Huai river Basin are shown.



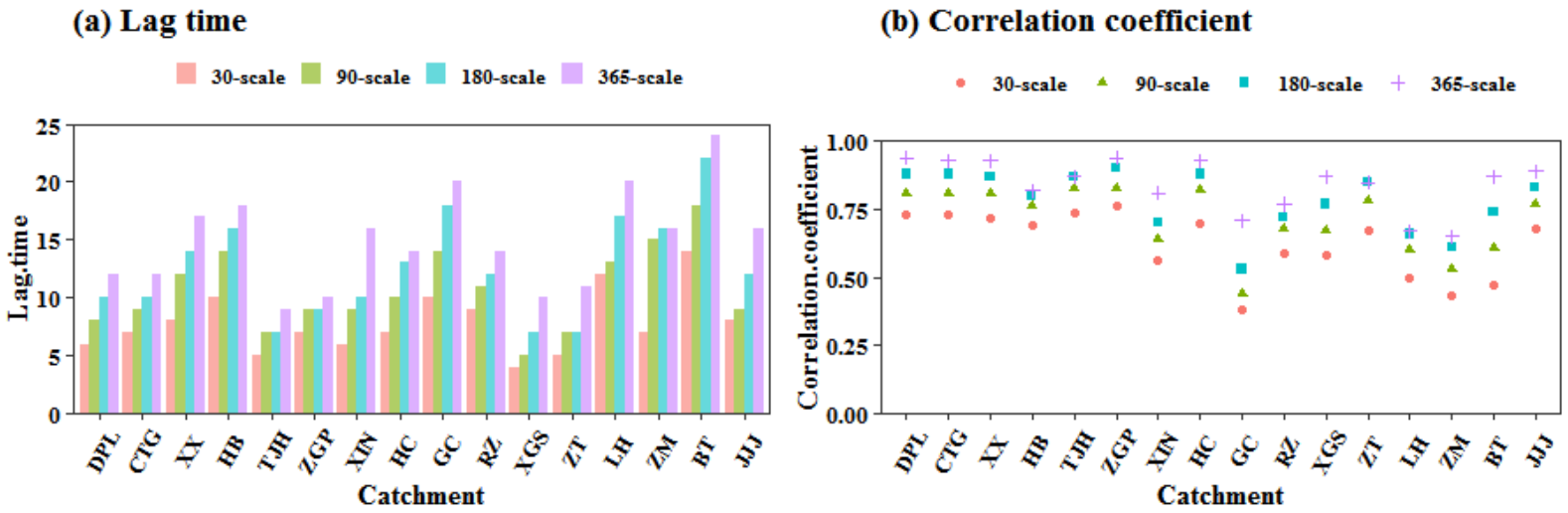
4. Propagation characteristics

The propagation from meteorological to hydrological drought is divided into three types:

I hydrological drought responds to meteorological drought;

II meteorological drought occurred but hydrologic drought did not occur;

III Hydrological drought occurred while meteorological drought did not occur.



5. Analysis of influencing factors

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Table 2 Correlation coefficients between hydrological drought characteristics and catchment

	Area	Annual average precipitation	Topographic index	NDVI	BFI	Drainage density	Ratio of cultivated land	Ratio of reservoir
Duration	-0.14	-0.83 (**)	0.013	-0.76 (**)	0.03	-0.57	0.13	-0.48
Severity	0.71 (*)	-0.25	0.8 (**)	-0.22	0.75 (**)	0.22	0.71 (**)	-0.07
Lag time	0.46	-0.55	0.72 (**)	-0.53	0.75 (**)	-0.23	0.68 (**)	-0.28
Matching rate	-0.51	0.38	-0.66 (**)	0.37	-0.74 (**)	0.1	-0.57	0.23

Note: * and ** indicate the correlation coefficient is significant at the significance level of 0.05 and 0.01, respectively.

5. Analysis of influencing factors

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- Using paired-catchment to investigate the reservoir influence on hydrological drought and propagation characteristics. The disturbed catchment with medium-sized reservoir (Xin) is paired with a catchment (Benchmark catchment, TJH) that is similar in all aspects except for the human activity under study to isolate the effect of reservoir.

Table X Summary of pair catchments characteristics

	Catchment	Area (km^2)	Precipitation (mm)	ET (mm)	Topographic index	Land use/Land cover	
						Cultivated land	Forests
Benchmark	TJH	173	1232.4	64.2	7.811	17.80%	82.10%
Reservoir	XIN	274	1318.8	64.0	7.538	13.80%	81.60%

Table X Comparison of drought characteristics for pair catchments (30-days scale)

	Duration (day)		Severity		Lag time (day)	March rates
	Average	Maximum	Average	Maximum		
Benchmark	43.2	169	-69.4	-277	5	0.83
Reservoir	43.9	160	-66.5	-255	6	0.8
Difference (%)	1.6	-5.6	-4.2	-7.9	20	3.6

6. Conclusions

- The propagation from meteorological to hydrological drought is divided into three types: I, hydrological drought responds to meteorological drought; II, meteorological drought occurred but hydrologic drought did not occur; and III, Hydrological drought occurred while meteorological drought did not occur. Type I is the main type of propagation, and occurred in the cases of one-to-one situation, which is a meteorological drought resulting in a hydrological drought. And the several-to-one situation that meteorological droughts combined into a prolonged hydrological drought accounts for 12% of the Type I relationship.
- Propagation characteristics are governed by different factors: The rate of type I propagation occurrence (matching rate) is strongly negatively correlated with BFI (Base Flow Index). Mean annual precipitation is strongly correlated with hydrological drought duration, whilst hydrological drought severity is governed by catchment properties associated with storage (such as BFI and topographic index).
- Reservoir has a role in reducing hydrological drought severity.

Thank you for listening

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