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Research Article

Spatiotemporal Characteristics of Evapotranspiration Paradox and Impact Factors in China in the Period of 1960–2013

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Downward trend of potential evaporation accompanied with upward of air temperature which is denoted as evaporation paradox has been reported in many regions over the past several decades in the world. In this paper, evaporation paradox and key factors attributed to ET_0 changes are systematically analyzed based on data from 599 meteorological stations during 1960–2013. Results show that (1) Evaporation paradox exists in all regions in1960–2013 and 1960–1999 except SWRB in 1960–2013 but no evaporation paradox in 2000–2013. (2) Evaporation paradox exists in large areas in spring and summer, the extent and range fall in autumn, and there is no evaporation paradox in winter. (3) The evaporation paradox area accounts for 73.7% of China in 1960–2013 and 91.2% in 1969–1999. (4) Sunshine hours, humidity, wind speed, and maximum temperature appear to be the most important variables which contributed to ET_0 change in China.

1. Introduction

Climate change characterized by global warming has been the focus of diversified research fields such as water resource, agriculture, ecosystem, and human health. It is widely accepted that global air temperature had been increasing in recent decades, it has risen by about 0.85 (0.65–1.06)°C from 1951 to 2012, and the average rising rate was 0.12 (0.08–0.14)°C (IPCC [1]). In China, temperature has increased by about 0.5–0.8°C and precipitation has large regional fluctuation but no significant trend in the recent 100 years (Wang et al. [2]).

Potential evapotranspiration (ET_0) is one of the most important components of the hydrological system which refers to "the quantity of water evaporated per unit area, per unit time from an idealized, extensive free water surface under existing atmospheric conditions." It is an important indicator of atmospheric evaporative demand for estimating terrestrial evaporation and crop water requirements. There have been many discussions on methods of calculating ET_0 (Penman [3], Hargreaves and Samani [4], Pereira and Pruitt [5]), the spatial-temporal variations (Irmak et al. [6], Dinpashoh et al. [7], Liang et al. [8], Croitoru et al. [9]), and its influencing factors (Feng et al. [10], Liu and Yang [11], Harmsen et al. [12], Tang et al. [13]). Declining trends in both pan evaporation (McVicar et al. [14]) and potential evaporation (ET_0) have been reported to be occurring simultaneously in many regions with increasing trends of air temperature, which has been denoted as the evaporation paradox (Roderick and Farquhar [15]) and it has been one of the hot issues of hydrological system. Over the past several decades evaporation paradox had been verified in many regions of the world such as the former Soviet Union (Peterson et al. [16]), the United States (Golubev et al. [17]), China (Thomas [18], Ma et al. [19]), India (Chattopadhyay et al. [14]), Thailand (Tebakari et al. [20]), Italy (Moonen et al. [21]), Romania (Croitoru et al. [9]), Australia, New Zealand (Roderick and Farquhar [22]), Canada (Burn and Hesch [23]). But there existed exception to this rule (Cohen et al. [24]). In China both at national scale (Yin et al. [25], Han et al. [26]) and at regional scale such regions as the Northwest China (Liang et al. [8]), the YeRB (Wang et al. [27]), the HaRB (Xing et al. [28]), the YaRB (Xu et al. [29]), the Northwest

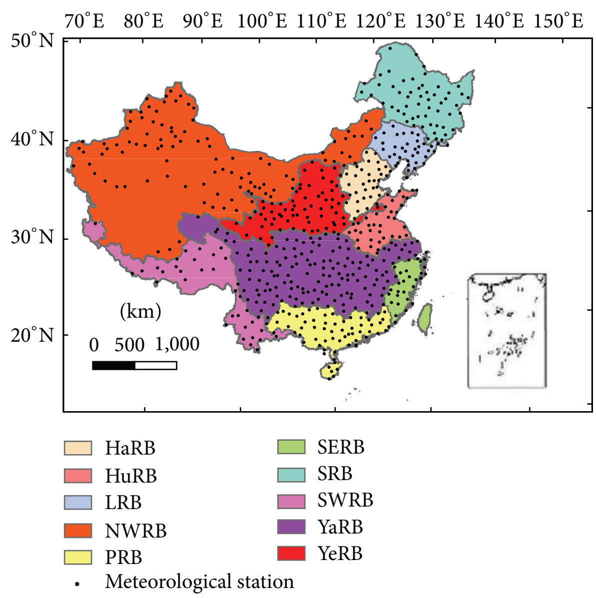


Figure 1: Spatial distribution of meteorological stations and first-order basin in China.

China (Yang et al. [30]), the Loess Plateau (Li et al. [31]), and the Tibet Plateau (Liu et al. [32]) evaporation paradox had been found.

In fact pan evaporation observations mostly ended in 2001 in China; evaporation paradox was concluded based on annual pan evaporation of 1960–2000 (H. Yang and D. Yang [33]) or potential evaporation from 1960–2010 without no data segment. However, change of temperature and potential evaporation transformed around 2000. In this paper observed meteorological variables are divided into two parts taking year 2000 as the boundary and the objectives of this study are (1) to investigate changes in ET_0 and temperature in China since 1960s; (2) to examine the existence of evaporation paradox in different periods and regions; (3) to determine potential key factors attributed to ET_0 changes in the whole country as well as different river basins.

2. Data and Methodology

2.1. Data. Daily meteorological data were obtained from 754 stations from the China Meteorological Administration (CMA) and National Meteorological Information Center of China (NMIC); 599 stations (Figure 1) of these had complete records of all climatic factors calculating ET_0 in time series of 1960–2013. The daily meteorological data included precipitation, relative humidity, sunshine hours, vapor pressure, wind speed, maximum, minimum, and mean air temperature. A few missing data (mainly in 1967, 1968, 1969) were estimated by averaging the value of the other years observed at the same station.

In the data set, the 10 river basins are the first-order basin in China (Figure 1). 56 stations are in the Songhua River basin (SRB), 36 are in the Liao River basin (LRB), 33 are in the Hai River basin (HaRB), 67 are in the Yellow River basin (YeRB), 38 are in the Huai River basin (HuRB), 143 are in the Yangtze River basin (YaRB), 28 are in the southeast rivers basin (SERB), 67 are in the Pearl River basin (PRB), 35 are in the southwest rivers basin (SWRB), and 97 are in the Northwest Rivers Basin (NWRB). In the 599 stations, the Taiwan Island is the one that we could not collect observation data from; therefore, it is excluded from the study region.

2.2. Methodology

2.2.1. Penman-Monteith Method. In this paper, potential evapotranspiration (ET_0) was estimated using the Penman-Monteith (PM) method (Allen et al. [34]); the formula is given as

$$ET_0 = \frac{0.408\Delta\left(R_n - G\right) + \gamma\left(900/\left(T+273\right)\right)U_2\left(e_s - e_a\right)}{\Delta + \gamma\left(1 + 0.34U_2\right)}, \quad (1)$$

where ET_0 is the daily potential evapotranspiration (mm d^{-1}), and the yearly and monthly value of ET_0 will be used in this paper; R_n is the net radiation at the top surface ($MJ{\cdot}m^{-2}{\cdot}d^{-1}$); G is the soil heat flux density ($MJ{\cdot}m^{-2}{\cdot}d^{-1}$); T is the mean daily air temperature at 2 m height (°C); U_2 is daily average wind speed at 2 m height ($m{\cdot}s^{-1}$); e_s is the saturation vapor pressure (kPa); e_a is the actual vapor pressure (kPa); Δ is the slope of the vapor pressure curve ($kPa^{\circ}C^{-1}$); γ is the psychrometric constant ($kPa^{\circ}C^{-1}$). In the model the radiation term was calculated by experience formula and its accuracy depends on the experience coefficients which were often only effective in particular regions. In this paper, ET_0 was calculated by corrected radiation. The correcting net radiation is as follows (Yin et al. [35]):

$$R_n = 0.77 \times \left(0.2 + 0.79\frac{n}{N}\right)R_{sa} - \delta\left[\frac{T_{x,k}^4 + T_{n,k}^4}{2}\right] \times \left(0.56 - 0.25\sqrt{e}\right)\left(0.1 + 0.9\frac{n}{N}\right), \quad (2)$$

where δ is constant of Stefan-Boltzmann ($4.903 \times 10^{-9} MJ{\cdot}K^{-4}{\cdot}m^{-2}{\cdot}d^{-1}$), $T_{x,k}$, $T_{n,k}$ is the absolute maximum and minimum temperature (K), n is the actual sunshine hours (h), N is the duration of possible sunshine (h), and R_{sa} is the Sunny radiation ($MJ{\cdot}m^{-2}$). Soil heat flux G is small compared with the relative net radiation and $G \approx 0$ in the day time scale.

2.2.2. Trend Analysis Method. The simple linear regression method was used to estimate the trend magnitudes (slope) in ET_0 and other climatic variables. The linear equation is

$$\widehat{X}_i = a + b \cdot t_i, \quad (3)$$

where $\widehat{X}_i$ is the simulated value of climatic variables; $b \times 10$ is the trend which denoted the change trend of climatic variables per decade; and t is the time series (Yang et al. [36]). Meanwhile, the nonparametric Mann-Kendall

Table 1: Change trends of temperature and potential evapotranspiration (ET_0) in China.

	ET_0						Temperature					
	1960–2013		1960–1999		2000–2013		1960–2013		1960–1999		2000–2013	
	a	*b*	*a*	*b*	*a*	*b*	*c*	*d* (%)	*c*	*d* (%)	*c*	*d* (%)
China	-3.9^{*}	59.1	-14.78^{**}	75.1	10.08	43.7	0.24^{**}	97.8	0.21^{**}	90	−0.08	41.4
YaRB	−2.51	58.7	-17.64^{**}	86	52.27	16.8	0.18^{**}	96.5	0.07	74.3	0.16	62.2
SERB	3.61	60.7	-20.93^{**}	89.3	19.37	21.4	0.21^{**}	100	0.1	92.9	−0.14	46.4
HaRB	-9.21^{**}	75.8	-18.08^{**}	84.8	−17.05	72.7	0.28^{**}	97	0.3^{**}	97	−0.41	39.4
HuRB	−5.95	60.5	−8.16	65.8	−17.24	60.5	0.2^{**}	97.4	0.17^{*}	97.4	−0.1	39.5
YeRB	1.02	61.2	−5.94	55.2	−6.22	53.7	0.27^{**}	97	0.23^{**}	98.5	−0.1	13.4
LRB	-10.68^{*}	52.8	−12.67	80.6	−78.2	86.1	0.23^{**}	100	0.31^{**}	100	−0.51	2.7
SRB	−4.04	70.9	−3.77	58.2	−74.26	90.9	0.33^{**}	100	0.44^{**}	98.2	−0.36	27.3
NWRB	-11.13^{**}	69.1	-27.65^{**}	81.4	26.69	39.2	0.34^{**}	99	0.31^{**}	94.8	0	45.4
SWRB	3.89	48.6	−3.26	60	102.4	5.7	0.28^{**}	100	0.22^{**}	88.6	0.4	97.1
PRB	−1.01	44.8	-14.65^{**}	76.1	5.74	43.3	0.14^{**}	98.5	0.11^{**}	88.1	−0.28	25.4

a slope of ET_0 (mm per decade); *b* percent of downward (%); *c* slope of temperature (°C per decade); *d* percent of upward; $^{*}\alpha = 0.05$, $^{**}\alpha = 0.01$, the significance in 2000–2013 was not calculated because of the short time.

(M-K) method (Mann [37], Kendall et al. [38]) is highly recommended by the World Meteorological Organization for analyzing hydrological series as it did not need any distributional assumption for the data and it was used to detect the significance of the trend.

2.2.3. Stepwise Regression. The basic idea is to introduce the influencing factors into regression equation one by one. Significant test is carried out when introducing one variable into the model, retaining the significant factors and rejecting the insignificant ones until there are no variables introduced into the model and no one rejected. This method can eliminate the variables which contribute little to principal component or those existing linear relations and can overcome the multicollinearity based on guaranteeing the regression effects.

2.2.4. Region Average of Variables. In previous researches, regional value was obtained by using an arithmetic mean method from meteorological station. However, meteorological stations are not distributed evenly but dense in the east and sparse in the west in China. Therefore, it is necessary to assign different weights for different stations when evaluating climate change accurately for different regions. When calculating the average value of an area, the weight of a station is determined by the percentage of the Thiessen polygon in the whole area. Thiessen polygon method was more accurate than simple mean method and less workload grid data set method.

3. Results

3.1. Observed Changes of Temperature and ET_0. In 1960–2013, 98.2% of the 599 stations show upward trend (91.2% of all stations are at 95% significance level). The average daily temperature in China as a whole (Figure 2) rises at the rate of 0.24°C per decade (95% significance level). Corresponding with significant warming trend, the mean national ET_0 declines at the rate of −3.9 mm per decade (95% significance level), so there exists evaporation paradox in China as a whole.

3.2. Temporal Trends of Evaporation Paradox. According to Figure 2, the mean annual temperature climaxed in around year 2000 and then decreased slowly, and ET_0 reached the lowest value around 1993 and then rose slowly. Taking the change into account comprehensively, this paper took the year 2000 as the dividing line. At the same time in order to compare with the proceeding results of other researchers, we analyzed the characteristics of evaporation paradox in the period of 1960–2013, 1960–1999, and 2000–2013 (Table 1). In 1960–2013 and 1960–1999, the annual temperature increased significantly, while ET_0 decreased significantly at the rate −3.9 mm per decade (58.4% of all stations) and −14.78 mm per decade (75.1% of all stations); in 2000–2013, temperature decreased (58.6% of all stations) with the rate being −0.08°C per decade while ET_0 increased (56.3%) with the rate being 10.08 mm per decade. In 1960–1999, ET_0 of 75.1% stations dropped and temperature of 90% stations rose and the opposite change of temperature and ET_0 between 1960–1999 and 2000–2013 made the range of temperature rise and ET_0 dropping moderate and evaporation paradox weaken in 1960–2013.

The mean annual temperature in the 10 river basins all rose at 95% significance level and ET_0 all showed downward trend except in SERB, YeRB, and SWRB in 1960–2013; all river basins indicated upward in temperature and downward in ET_0 in 1960–1999. The maximum downward in ET_0 and upward in temperature appeared in NWRB and SRB with values being −27.65 mm per decade and 0.44°C per decade, respectively, in 1960–1999. In 2000–2013, ET_0 in YaRB, SERB, SWRB, NWRB, and PRB increased while temperature in SWRB and PRB decreased. In other basins the trend in temperature and ET_0 was the same. In this period temperature only in YaRB and SWRB increased, whether the increase was a fluctuation in the whole upward process or the beginning of decrease needs further investigation.

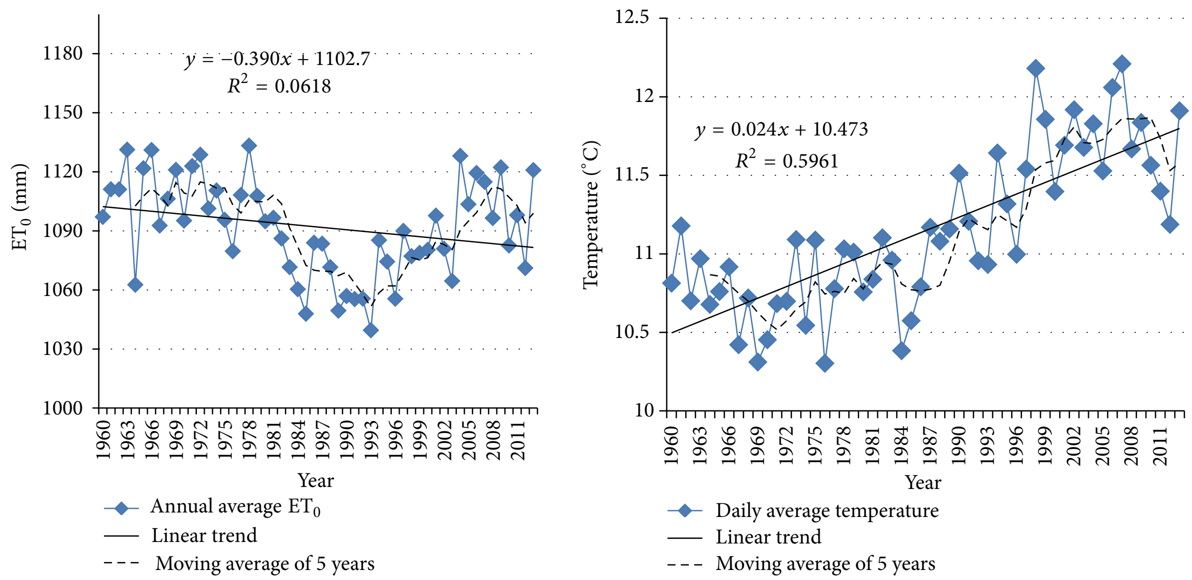


FIGURE 2: Interannual changes of temperature and ET_0 in 1960–2013.

3.3. Seasonal Change of Evaporation Paradox. Figure 3 showed trends of evaporation paradox in 4 seasons.

Spring (March to May): in 1960–2013, evaporation paradox existed in HaRB, LRB, SRB, NWRB, SWRB, PRB, and China as a whole. In 1960–1999, evaporation paradox existed in all regions except SRB; in 2000–2013, there was no evaporation paradox; change of temperature and ET_0 was the same in eight river basins and temperature in 5 river basins dropped. The opposite changes of temperature and ET_0 in 1960–1999 and 2000–2013 weakened the evaporation paradox of 1960–2013.

Summer (June to August): in 1960–2013, ET_0 and temperature were the highest values in a whole year; the slope of ET_0 and percent of downward stations were the highest values too. ET_0descended in YaRB, HaRB, HuRB, YeRB, LRB, NWRB, and China as a whole; temperature rose in all regions, except HuRB which was at 99% confidence level. In 1960–1999, evaporation paradox existed in all river basins except SWRB and HuRB; in China as a whole the percent of ET_0 downward climaxed 77% and 8 river basins were more than 70%, and so evaporation paradox was the most prominent in all statistical periods. In 2000–2013, the variation of ET_0 and temperature was the same except the HuRB.

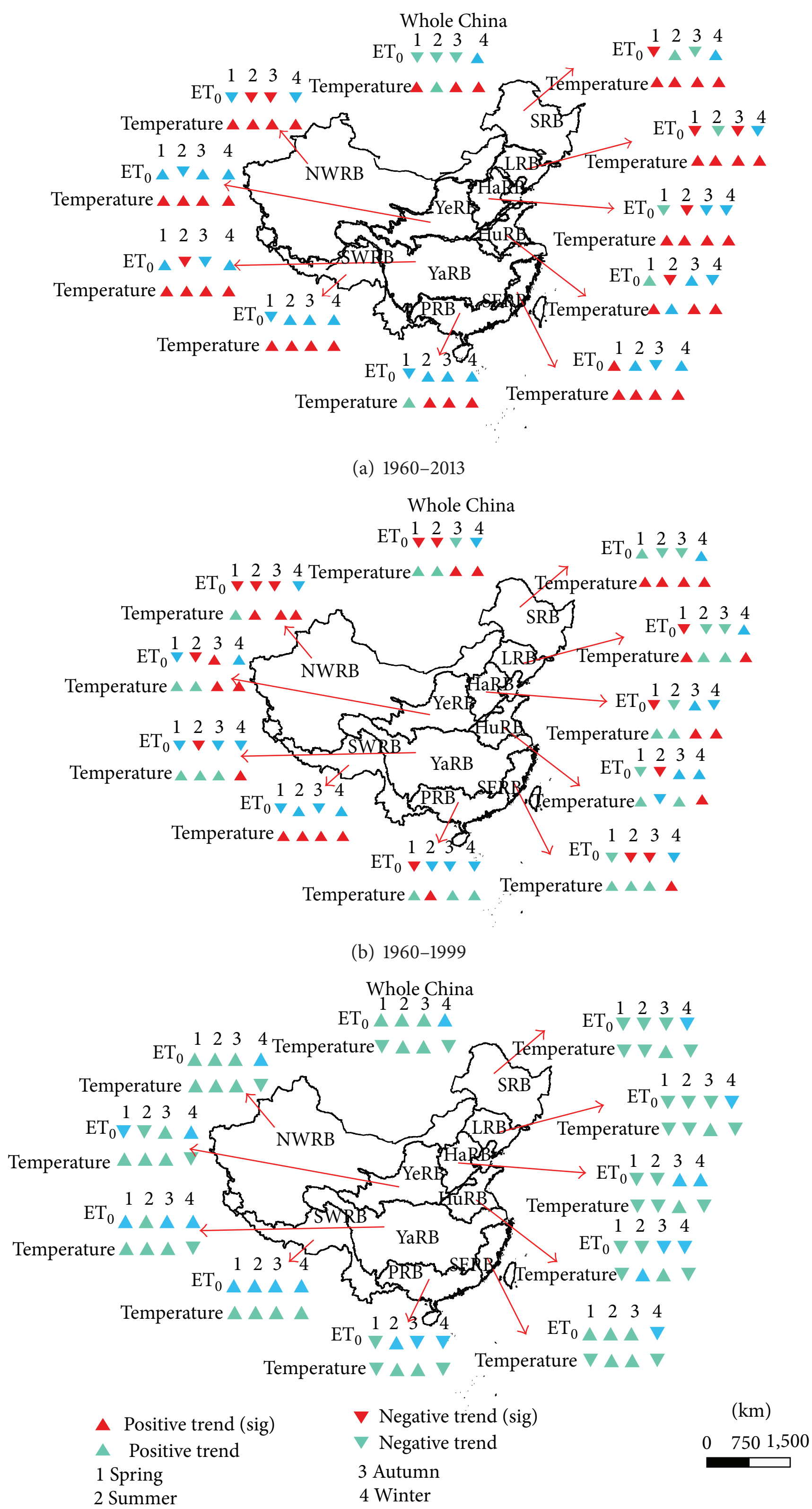
Autumn (September to November): the slope and range of ET_0 decline reduced in autumn comparing with that of spring and summer. In 1960–2013, ET_0 in HaRB, LRB, SERB, SRB, and NWRB decreased and temperature increased significantly. The phenomenon existed in the 5 river basins in 1960–1999 too. In 2000–2013, HuRB, LRB, SRB, and PRB showed evaporation paradox.

Winter (December to February next year): change in temperature was the most severe compared with the other seasons. Except in PRB in 1960–1999, temperature in 1960–2013 and 1960–1999 all rose significantly. Opposite to the severe increase in temperature, decrease of ET_0 in winter was moderate. In 1960–2013, ET_0 only in HuRB, HaRB, LRB, and NWRB declined slightly and other regions showed upward trend. In 1960–1999, ET_0 in HaRB, HuRB, PRB, YaRB, NWRB, and China as a whole insignificantly decreased. In 2000–2013, temperature showed biggest fall and only SWRB showed upward trend. In winter ET_0 changed the smallest in the four seasons and evaporation paradox was moderate.

3.4. Spatial Distribution of Evaporation Paradox. In 1960–2013 and 1960–1999, the percent of rising stations in temperature exceeded 90%, so stations in which ET_0 decreased can be judged as where evaporation paradox existed (Figure 4). The evaporation paradox distribution can be obtained from the interpolation of Z statistic of ET_0. In 1960–2013, 57.6% of the site of annual ET_0 decreased in China, the regions where ET_0 increased were mainly located in the northeast of the NWRB, northwest of SRB, three rivers sources regions, middle reach in YeRB, northeast and southeast of HuRB, SWRB, coastal area of PRB, middle of YaRB, and so on. Overall coastal areas in the south of 37°N, most of the regions between 30°N and 40°N, 90°E–110°E, northwestern of the northeast China, and southeastern of SWRB were the areas where evaporation paradox does not exist. The evaporation paradox area accounted for 73.7% of the 10 river basins. In 1960–1999, ET_0 of 75.1% stations showed downward trend; northwestern of SRB, Ningxia and middle Shaanxi section of the YeRB, three rivers sources regions and northeastern of HuRB, there is no evaporation paradox in such areas. The evaporation paradox area accounted for 91.2%. In 2000–2013, ET_0 and temperature of 223 stations change oppositely and 322 stations were the same; 54 stations of Z statistics of ET_0 or temperature were 0.

4. Discussion

4.1. Relationship between ET_0 and Precipitation. Precipitation and ET_0 were two important segments of the hydrologic



(a) 1960–2013

(b) 1960–1999

(c) 2000–2013

FIGURE 3: Seasonal change of temperature and ET_0 in different regions.

Table 2: Results of the stepwise regression.

China	YaRB	SERB	HaRB	HuRB	YeRB	LRB	SRB	NWRB	SWRB	PRB
V	H	V	T_{max}	H	V	H	RH	H	V	H
H	RH	RH	RH	RH	T_{max}	RH	H	V	RH	RH
RH	V	T_{max}	V	V	P	T_{max}	T_{max}	T_{mean}	T_{max}	T_{min}
T_{max}	T_{min}	H				V	V	P	H	V

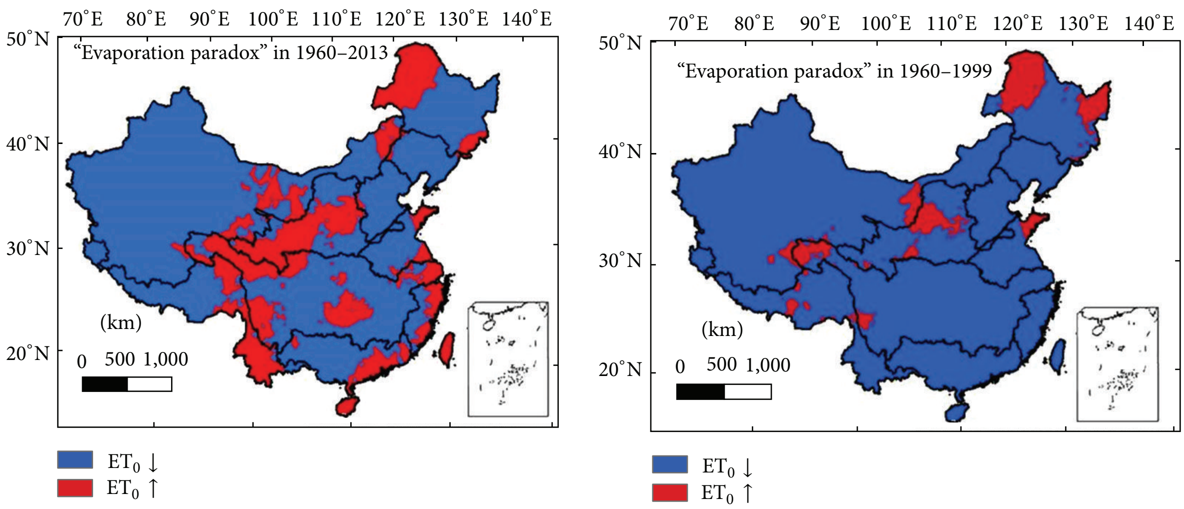


Figure 4: Distribution of evaporation paradox in different periods.

cycle; ET_0 will decline with the increase of precipitation according to the Bouchet assumption. The annual average precipitation is 808 mm in China during 1960–2013; it rose insignificantly and the rising percent was 48.4%. The annual average precipitation was 811 mm in 1960–1999 and the insignificant rising percent was 55.9%; in 2000–2013 the average value was 799.5 mm; change of ET_0 and precipitation in China were consistent with the Bouchet hypothesis and Figure 5 showed the relationship of them. In 1960–2013, reverse trend stations were 301 and were located in NWRB, SERB, three rivers sources regions, lower reaches of YaRB, northwestern of SRB, HuRB, and PRB where precipitation increased. Precipitation and ET_0 drop sites were mainly located in LRB, HaRB, YeRB, upper reaches of PRB, southeastern of SRB, and the middle reaches of the YaRB. Decreased stations of precipitation in 1960–1999 were more than that of 1960–2013, but its distribution was basically the same. The two factors both indicated upward trend in 2000–2013, whose precipitation rose in 330 stations, unchanged in 45 sites. 352 stations showed opposite change of them which accounted for 58.8% of the whole stations. Regions where precipitation decreased were mainly located in NWRB, SRB, LRB, HaiRB, and the middle reaches of the YeRB.

4.2. Impacts of Meteorological Factors on ET_0. Meteorological factors change had profound impacts on ET_0; in this paper stepwise regression was used to extract the influencing factors of ET_0. Yearly ET_0 and 7 meteorological factors such as mean temperature (T_{mean}), maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity (RH), sunshine hours (H), average wind speed (V), and average water pressure (P) were firstly normalized in order to remove the impacts of inconsistent units. The entering order of climate variability was showed in Table 2. V was the primary contributor which caused ET_0 change in China as a whole, SERB, YeRB, and SWRB and the standardized coefficients were 0.75, 0.54, 0.87, and 0.54, respectively. H contributed most to ET_0 change in YaRB, HuRB, LRB, and PRB with the standardized coefficients of 0.56, 0.66, 0.82, and 0.70. T_{max} had maximum impact on ET_0 in HaRB with standardized coefficients being 0.80. The largest contribution in SRB was RH which was negative with ET_0.

Table 2 indicated that H, T_{max}, V, and RH were the most important factors influencing ET_0. Table 3 showed slope of the listed meteorological elements and ET_0 in different statistical period. In 1960–2013, ET_0 decreased in all regions expect SERB, YeRB, and SWRB; in NWRB, LRB and HaRB ET_0 decreased at 99% level of confidence. In 1960–1999, ET_0 decreased in all regions and the decline rate was much more than that of 1960–2013; in 2000–2013, ET_0 in 5 river basins was downward trend. V which was in positive relationship with ET_0 decreased at the rate of $-0.11\,\mathrm{m\,s^{-1}}$ per decade significantly in China as a whole and it was found to be the primary contributor which caused ET_0 to decrease in the past 54 years; except PRB in 1960–2013, V decreased in all regions significantly. H which was in positive relationship with ET_0 too had decreased with a significant trend of −0.11 h per decade in 1960–2013 and −0.13 h per decade in 1960–1999 at 99% confidence level and the decline led ET_0 to decrease

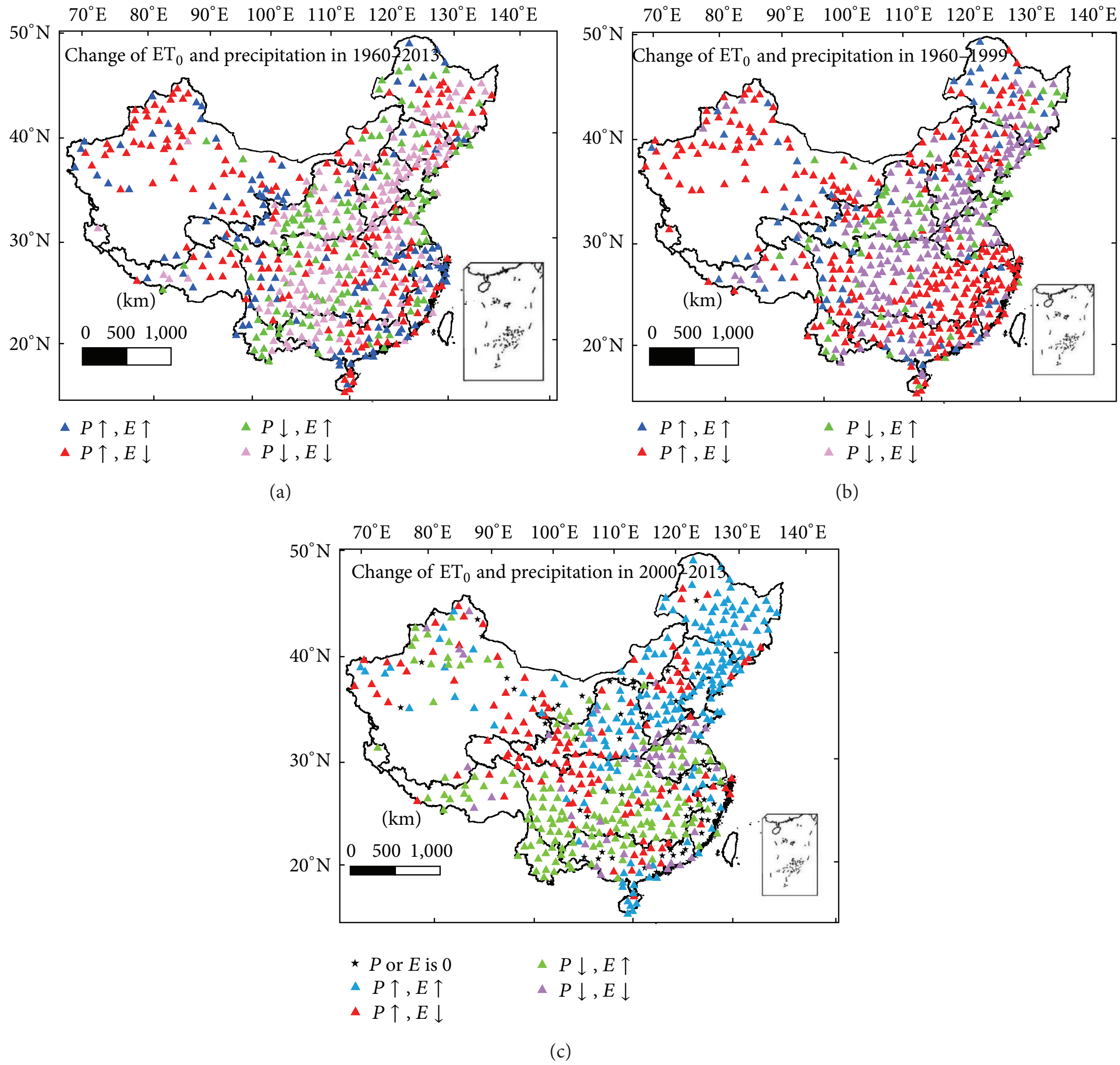


FIGURE 5: Change of precipitation and ET_0 in China.

in China as a whole; in the 10 river basins, H decreased significantly except SWRB. The range and scope of H, V decline both diminished in 2000–2013. T_{max} contributing positive impact on ET_0 growth increased in all regions in 1960–1999 and the increase was significant except HuRB in 1960–2013; the most dramatic change occurred in T_{max} in 2000–2013 among the 4 variables; it changed into decrease from increase in SERB, HaRB, HuRB, YeRB, LRB, SRB, PRB, and China as a whole. RH only increased in YaRB, NWRB, and SWRB in 1960–1999 and LRB and SRB in 2000–2013. The change of ET_0 was influenced comprehensively by all these factors; ET_0 was in a positive relationship with H, V, T_{max} and negative relationship with RH. In China, the decline of V, H made ET_0 reduce and decline RH and ascension of T_{max} made ET_0 ascend. The comprehensive effect of the four elements was the decline of ET_0. In 1960–1999, the decline rate of H, V strengthened corresponding to the weakness in T_{max} rising and RH decreasing strengthened the decline rate of ET_0 to −14.78 mm per decade. In 2000–2013, the trend of meteorological factors changed compared with that of 1960–1999, decline rate of H, V reduced greatly, T_{max} switched from increase into decrease, and decline rate of RH increased substantially. The combination caused ET_0 switch from decrease to increase.

5. Conclusions

(1) In 1960–2013, temperature in 98.2% stations of 599 stations increased in China. The decline rate of annual national ET_0 was −3.9 mm per decade so evaporation paradox existed. In 1960–1999, ET_0 of 75.1% stations was downward and temperature of

Table 3: Slope of climate variables and ET_0 in China.

		China	YaRB	SERB	HaRB	HuRB	YeRB	LRB	SRB	NWRB	SWRB	PRB
ET_0 (mm per decade)	1960–2013	-3.9^{*}	−2.51	3.61	-9.21^{**}	−5.95	1.02	-10.68^{*}	−4.04	-11.13^{**}	3.89	−1.01
	1960–1999	-14.78^{**}	-17.64^{**}	-20.93^{**}	-18.08^{**}	−8.16	−5.94	−12.67	−3.77	-27.65^{**}	−3.26	-14.65^{**}
	2000–2013	10.08	52.27	19.37	−17.05	−17.24	−6.22	−78.2	−74.26	26.69	102.4	5.74
H ($h\,d^{-1}$ per decade)	1960–2013	-0.11^{**}	-0.11^{**}	-0.16^{**}	-0.23^{**}	-0.18^{**}	-0.08^{*}	-0.08^{*}	-0.09^{**}	-0.04^{**}	0	-0.13^{**}
	1960–1999	-0.13^{**}	-0.16^{**}	-0.28^{**}	-0.2^{**}	-0.16^{**}	-0.1^{*}	-0.12^{**}	-0.11^{**}	-0.06^{*}	−0.01	-0.19^{**}
	2000–2013	−0.04	0.09	−0.05	−0.17	0.08	−0.13	−0.14	−0.43	0.07	0.23	−0.25
RH (% per decade)	1960–2013	-0.43^{**}	-0.53^{**}	-0.83^{**}	-0.6^{**}	-0.87^{**}	-0.5^{*}	−0.11	-0.46^{**}	−0.12	−0.34	-0.63^{**}
	1960–1999	−0.02	0.12	0	−0.33	−0.26	−0.17	−0.11	-0.42^{*}	0.21	0.21	-0.23^{*}
	2000–2013	−2.08	−3.18	−2.8	−2.41	−5.22	−1.93	2.14	1.35	−2.58	−5.9	−1.3
T_{max} (°C per decade)	1960–2013	0.18^{**}	0.16^{**}	0.18^{**}	0.19^{**}	0.08	0.25^{**}	0.16^{**}	0.19^{**}	0.25^{**}	0.24^{**}	0.09^{*}
	1960–1999	0.11	0	0.03	0.18^{*}	0.1	0.19	0.2^{*}	0.27^{**}	0.18^{*}	0.11	0.02
	2000–2013	−0.11	0.25	−0.21	−0.41	−0.46	−0.02	−0.72	−0.69	0.02	0.74	−0.41
V ($m\,s^{-1}$ per decade)	1960–2013	-0.11^{**}	-0.08^{**}	-0.13^{**}	-0.16^{**}	-0.1^{**}	-0.07^{**}	-0.18^{**}	-0.18^{**}	-0.14^{**}	-0.05^{**}	0.04
	1960–1999	-0.12^{**}	-0.09^{**}	-0.15^{**}	-0.19^{**}	-0.11^{**}	-0.07^{**}	-0.18^{**}	-0.17^{**}	-0.18^{**}	−0.02	-0.07^{**}
	2000–2013	−0.02	0.03	−0.13	0.01	−0.2	−0.06	−0.14	−0.21	−0.02	0.12	0.12

90% stations was upward which indicated the most prominent evaporation paradox. In 2000–2013 there was no evaporation paradox. The opposite change of temperature and ET_0 in 1960–1999 and 2000–2013 weaken the evaporation paradox in 1960–2013 compared with that of 1960–1999.

(2) In 1960–2013, evaporation paradox existed in spring, summer, and autumn in China as a whole; it existed in 6, 6, 5, and 4 river basins in spring, summer, autumn, and winter; the decline rate of ET_0 and percent of temperature downward climaxed in summer. In 1960–1999, except SRB in spring, SWRB in summer, HaRB, HuRB, and YeRB in autumn, HuRB, YeRB, LRB, and SRB in winter evaporation paradox exists in other times. In 2000–2013, there was no evaporation paradox.

(3) There was no evaporation paradox in the southeastern coastal areas south of 37°N, most of areas in 30°N–40°N, 90°E–110°E, northwestern in SRB, and southeastern of SWRB in China in 1960–2013; the area accounted for 26.3% of the 10 river basins. No evaporation paradox area was only in NWRB, northeastern of SRB, middle reach of YeRB, three river source regions, and northeastern of HuRB which accounted for 8.8% merely.

(4) Precipitation in NWRB, SERB, three river source regions, lower reaches of YaRB, northwestern of SRB, northwestern of HuRB, and lower reaches of PRB increased and in such regions ET_0 decreased in 1960–2013. Most of stations in which ET_0 and precipitation change inversely were located south of 27°N and north of 32°N; the number of the stations was 346 in 1960–1999. In 2000–2013, the stations which precipitation increased were located in north of 32°N and the number of stations in which ET_0 and precipitation change inversely was 352.

(5) H, T_{max}, V, RH were the most important variations affecting ET_0 change; H, V, T_{max} were positive and RH was negative relationship with ET_0; H, V, RH mainly decreased and T_{max} mainly increased in China and the comprehensive function of them made ET_0 decrease in 1960–2013 and 1960–1999 and increase in 2000–2013.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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