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Analysis of the Changes and Influencing Factors of Evapotranspiration in Fuping County based on Meteorological Data

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Abstract: Using meteorological station data, this paper analyzes the annual evapotranspiration and influencing factors in Fuping County from 1998 to 2017, and explores the dominant meteorological factors that affect the changes in evapotranspiration. The results show that from 1998 to 2017, the annual evapotranspiration in Fuping County showed a significant upward trend, with a growth rate of 9.9mm/a; The correlation between evapotranspiration and meteorological factors on a daily scale shows temperature>pressure>relative humidity>wind speed. There is a positive correlation between NDVI and evapotranspiration, with a correlation coefficient of 0.6693, indicating that surface evapotranspiration in the region is significantly influenced by underlying surface characteristics. Overall, temperature and vegetation are the main factors affecting evapotranspiration changes in Fuping County.

Keywords: Fuping County; Evapotranspiration; Meteorological Factors; NDVI; Relativity.

1. Introduction

Evapotranspiration is an important component of the surface water cycle and an important process for maintaining surface energy and water balance. Research has shown that about 60% of the precipitation that reaches the Earth's surface through condensation evaporates into the atmosphere through evaporation, with a proportion as high as 90% in arid regions. At the same time, surface evapotranspiration directly or indirectly affects crop production, vegetation growth, and economic development in the study area. The study of surface evapotranspiration has important guiding significance for ecological environment protection, agricultural development, and water resource utilization in the region [3,4]. At present, the acquisition of surface evapotranspiration is still in the development stage. With the rapid development of remote sensing quantitative inversion of surface evaporation, a large number of measured evapotranspiration are needed to verify the inversion results, but the measured evapotranspiration data are very scarce, which seriously affects the development of surface evapotranspiration research. Meteorological factors are the main factors affecting surface evapotranspiration, and their acquisition is simple. This study takes Fuping County as the research object and uses the monitoring data from the Fuping County Meteorological Station from 1998 to 2017 to calculate the annual evapotranspiration in the study area. The correlation analysis between evapotranspiration and meteorological factors are conducted to explore the changes and main influencing factors of evapotranspiration in Fuping County, providing a basis for the agricultural and economic development of Fuping County.

2. Data Sources and Processing Methods

2.1. Data Sources

The meteorological data for this study is provided by the China Meteorological Data Sharing Service Network (http: // data.cma.cn/) The daily data provided (China Surface Climate Data Daily Dataset V3.0) is from Fuping Station, with station number 53938 and a time span of 1998-2017. Meteorological data mainly includes daily evapotranspiration, average temperature, average wind speed, relative humidity, average atmospheric pressure, etc. The measurement method for daily evapotranspiration includes small evaporative dishes and E-601 evaporative dishes. To ensure data consistency, this article adopts Liu Xiaoning's research results, selects a conversion coefficient of 0.58 for the two, and converts them into small evaporative dish data uniformly. Using Excel to sum the daily evapotranspiration of Fuping County from 1998 to 2017, the annual evapotranspiration of Fuping County was obtained

2.2. Research Methods

This study used trend line analysis to study the trend of annual evapotranspiration in Fuping County from 1998 to 2017. The slope of the trend line between annual evapotranspiration and time series was calculated. If Slope>0, it indicates an upward trend of annual evapotranspiration over time, while Slope<0 indicates a downward trend of annual evapotranspiration over time. The larger the absolute value of the slope, the more significant the change in annual evapotranspiration. The calculation formula is:

$$Slope=\frac{n*\sum_{i=1}^{n} i*ET_i-\sum_{i=1}^{n} i\sum_{i=1}^{n} ET_i}{n*\sum_{i=1}^{n} i^2-(\sum_{i=1}^{n} i)^2} \quad (1)$$

In the equation, Slope represents the slope of change in annual evapotranspiration; N is the number of years during the monitoring period, and in this study, the value is 20; ETi represents the evapotranspiration in the i-th year.

3. Result Analysis

3.1. Change Pattern of Annual Evapotranspiration in Fuping County

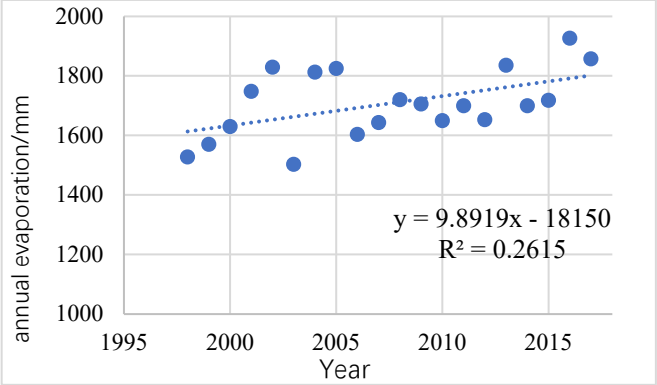

Fig 1. Change Curve of Evapotranspiration in Fuping County from 1998 to 2017

From Fig 1, it can be seen that the annual evapotranspiration of Fuping County ranges from 1500-2000mm, with the lowest evapotranspiration of 1502mm in 2003 and the highest evapotranspiration of 1926mm in 2016. The average evapotranspiration for 20 years is 1715mm. To further study the trend of annual evapotranspiration in Fuping County, this article calculates the annual evapotranspiration change rates from 1998 to 2005 and from 2006 to 2017 using trend line analysis method (Table 1). From the table, it can be seen that between 1998 and 2005, its annual evapotranspiration fluctuated greatly, with a fast growth rate, with an average growth rate of 35.7 mm/a; In 2006, its annual evapotranspiration significantly decreased, and from 2006 to 2017, the annual evapotranspiration of Fuping County increased year by year, with a growth rate of 20.3 mm/a. The average 20-year growth rate of annual evapotranspiration in Fuping County is 9.9mm/a. The above data indicates that in the past 20 years, except for the low annual evapotranspiration in 2006, the annual evapotranspiration in Fuping County has shown a gradual upward trend.

Table 1. Change rate of annual evapotranspiration in Fuping County

Year	1998-2005	2006-2017	1998-2017
Annual change rate of evaporation	35.7 mm/a	20.3 mm/a	9.9mm/a

3.2. Analysis of Factors Affecting Evapotranspiration

Surface evapotranspiration is a complex physical process closely related to air temperature, humidity, wind speed, and atmospheric pressure. To further explore the factors that affect evapotranspiration, this article collects daily data from Pucheng Meteorological Station for the entire year of 2017, with a total of 347 sets of data, except for some missing data. Conduct correlation analysis between evapotranspiration and meteorological factors using meteorological data (Fig. 2). As shown in the figure, on a daily scale, there is a significant correlation between evapotranspiration and temperature and pressure, with correlation coefficients of 0.6786 and 0.5578, respectively; The correlation with wind speed and humidity is not significant, and the correlation coefficient is less than 0.1. The overall correlation between evapotranspiration and various meteorological factors is temperature> pressure> humidity> wind speed.

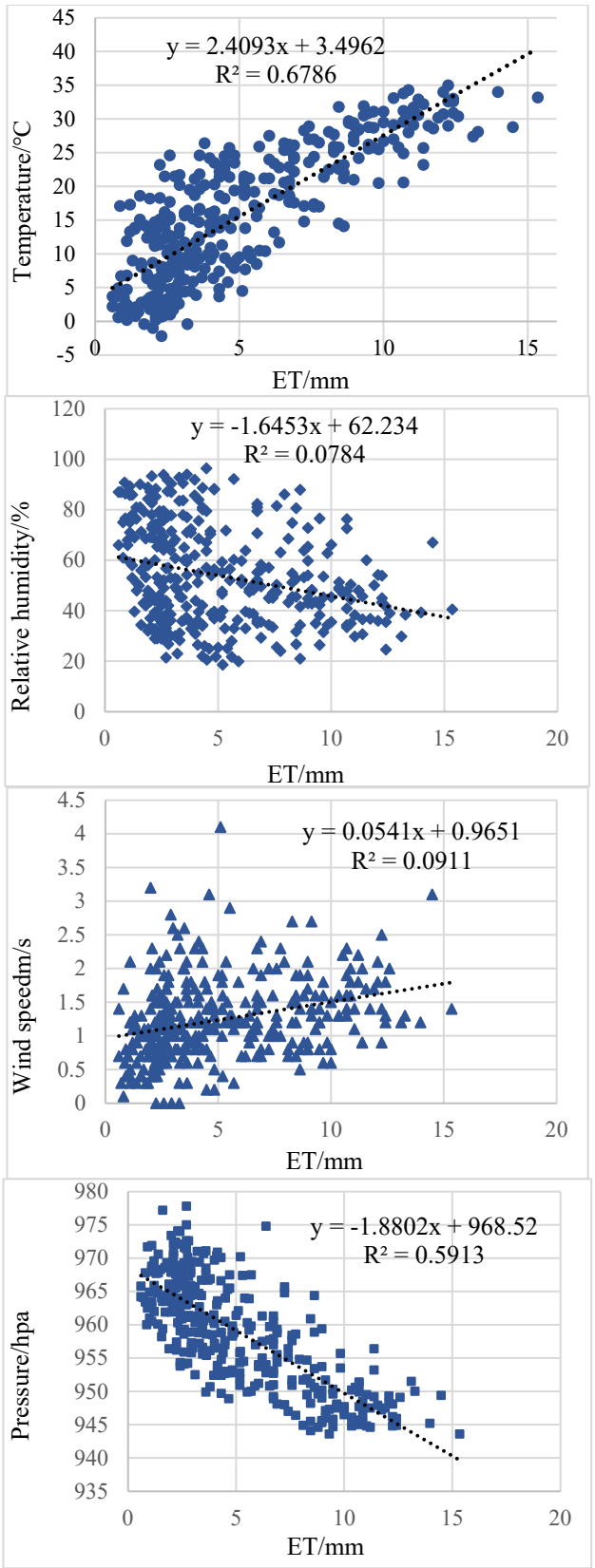

Fig 2. The correlation between evapotranspiration and meteorological factors

3.3. Relationship between Daily Evapotranspiration and NDVI

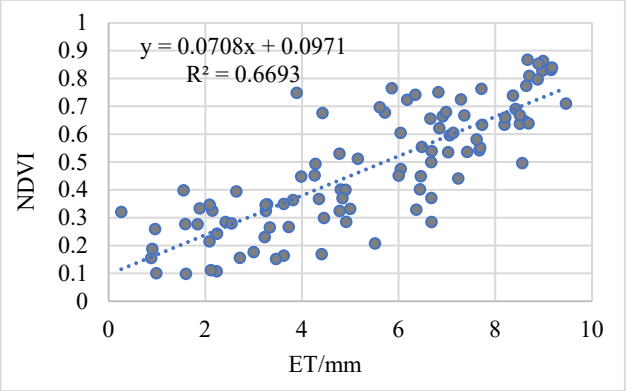

Fig 3. Correlation between daily evapotranspiration and NDVI

In order to further quantify the relationship between surface feature parameters and evapotranspiration, this study found through point regression that there is a positive correlation between NDVI and evapotranspiration, with a correlation coefficient of 0.6693. This indicates that surface evapotranspiration in the region is significantly affected by underlying surface features, and vegetation transpiration accounts for a large proportion of evapotranspiration.

4. Summary

Using meteorological station data, the annual evapotranspiration and influencing factors in Fuping County from 1998 to 2017 were analyzed, and the dominant meteorological factors affecting the changes in evapotranspiration were explored. The results show that the average annual evapotranspiration of Fuping County from 1998 to 2017 was 1715mm, and the annual evapotranspiration showed a gradual upward trend over the past 20 years, with an overall growth rate of 9.9mm/a; There is a significant correlation between evapotranspiration and temperature and air pressure, with correlation coefficients of 0.6786 and 0.5578, respectively. The correlation with wind speed and humidity is not significant. The correlation between evapotranspiration and meteorological factors on a daily scale shows temperature>pressure>relative humidity>wind speed. Overall, temperature is the main meteorological factor affecting the changes in evapotranspiration in Fuping County.

Acknowledgments

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