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Dataset Development of Reference Evapotranspiration in Guanzhong Region of China (2010–2019)

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Abstract: Reference evapotranspiration (ET_0) is a parameter that has important agricultural and environmental implications. This study used daily meteorological data (maximum/minimum atmospheric pressure, maximum/minimum air temperature, precipitation, solar radiation duration, and maximum wind speed) recorded at six national meteorological stations in the Guanzhong area (China) during 2010–2019, and the Penman–Monteith model (recommended by the Food and Agriculture Organization of the United Nations), to calculate daily ET_0 for the period 2010–2019. Additionally, the inverse distance weighting method was used to obtain the spatial distribution of ET_0 for the same period. Together, these data constitute a dataset (2010–2019) of ET_0 in the Guanzhong area. The dataset includes the following: (1) boundary data of the Guanzhong region, (2) site location vector data, (3) site location information and daily ET_0 (2010–2019), and (4) the spatial distribution of ET_0 (2010–2019). The dataset is archived in .shp, .tif, and .xlsx formats and comprises 27 data files with total data size of 65.4 MB.

Keywords: reference evapotranspiration (ET_0); Penman–Monteith model; Guanzhong area; Shaanxi

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Dataset Availability Statement:

The dataset supporting this paper is published and accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodp.2021.03.07.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2021.03.07.V1.

1 Introduction

Reference evapotranspiration (ET_0), which is an important factor in relation to irrigation requirement calculations and water resource evaluation, forms the basis of water law formulation and water environment assessment[1,2]. Typically, ET_0 is affected by climatic conditions and reflects the impact of atmospheric evapotranspiration in different periods and regions on crop water requirements, and has nothing to do with soil type or crop type[3]. More than 50 methods have been proposed for ET_0 calculation, e.g., the models of Makkink[4], Hargreaves[5], and Irmark[6], and the Food and Agriculture Organization of the

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United Nations Penman–Monteith (FAO 56 P–M) model[7–9]. The latter is the standard ET_0 calculation model and it is used widely in the field. It integrates radiation and aerodynamic terms, and reliable calculation results can be obtained in areas with large differences in climatic conditions. Moreover, no parameter adjustment is required during its application[10].

The Guanzhong area (China) refers to the administrative districts of five cities: Xi'an, Tongchuan, Baoji, Xianyang, and Weinan in central Shaanxi Province. The area (33°35'N–35°52'N, 106°18'E–110°38'E) is narrow from north to south and long from east to west. The Guanzhong area is recognized as the region in which agriculture originated, and it has been a rich agricultural area since ancient times. It has excellent irrigation conditions, fertile soil, and high agricultural production potential. This study used meteorological data recorded at six national meteorological stations located in the Guanzhong area: Yangling, Sanyuan, Bin county, Baoji city, Baoji county, and Changwu. The meteorological data (maximum/minimum atmospheric pressure, maximum/minimum air temperature, precipitation, solar radiation duration, and maximum wind speed) were obtained from the China Meteorological Data Network[1]. Using the obtained meteorological data, a 10-year ET_0 dataset (2010–2019) was constructed for the Guanzhong area. This dataset provides a solid foundation for both the planning and design of water conservancy projects in Guanzhong region and the study of agricultural water-saving measures.

2 Metadata of the Dataset

The metadata of the Dataset of reference crop evapotranspiration in Guanzhong area of China (2010–2019)[11] is summarized in Table 1.

Table 1 Metadata summary of the Dataset of reference crop evapotranspiration in Guanzhong area of China (2010–2019)

Items	Description
Dataset full name	Dataset of reference crop evapotranspiration in guanzhong area of china (2010–2019)
Dataset short name	ET0_Guanzhong_2010-2019
Authors	Wang, S. D., Shaanxi Jinghui Canal Irrigation Administration, 807860882@qq.com Sun, G. F., Shaanxi Jinghui Canal Irrigation Administration, 864964464@qq.com Wei, Z., China Institute of Water Resources and Hydropower Research, weizheng@iwhr.com Wang, J., Aerospace Information Research Institute, Chinese Academy of Sciences, wangjin@aircas.ac.cn Lin, R. C., China Institute of Water Resources and Hydropower Research, 190453501@qq.com Cui, L., China Institute of Water Resources and Hydropower Research, 20833192@qq.com
Geographical region	Guanzhong area Year 2010–2019 Temporal resolution 1 d
Data format	.xlsx; .tif; .shp Data size 6.68 MB after compression
Data files	The data of Guanzhong region; the data of site location; the information of site location and daily ET_0 from 2010 to 2019; the spatial distribution of ET_0 from 2010 to 2019
Foundation	Ministry of Science and Technology of P. R. China (2017YFC0403202)
Computing environment	Microsoft Excel 2019; ArcGIS10.4
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[12]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

[1] China Meteorological Data Network. http://data.cma.cn.

3 Methods

3.1 Calculation Principle

Six national meteorological stations (Yangling, Sanyuan, Bin county, Baoji city, Baoji county, and Changwu) located in the Guanzhong area were selected for this study. Based on the daily meteorological data (maximum/minimum atmospheric pressure, maximum/minimum air temperature, precipitation, solar radiation duration, and maximum wind speed) recorded at the stations during 2010–2019, daily ET_0 at each site was calculated using the method recommended by the FAO[13]:

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (1)$$

where ET_0 is the daily reference crop evapotranspiration (mm/d), R_n is net radiation at the crop surface (MJ/m^2/d), G refers to the heat stored in the soil (MJ/m^2/d), γ is the psychrometric coefficient (kPa/°C), u_2 is the wind speed at 2 m height (m/s), e_a is the partial pressure of water (kPa/°C), e_s is the water vapor saturation pressure (kPa/°C), and Δ is the slope of the water vapor saturation pressure curve (kPa/°C).

3.2 Inverse Distance Weighting

Inverse distance weighting is a weighted average interpolation method, which assumes that each observation has local influence, and this influence decreases with distances[14]. The calculation formula can be expressed as follows:

$$P = \sum_{i=1}^{n} \frac{P_i}{d_i^2} \Big/ \sum_{i=1}^{n} \frac{1}{d_i^2} \quad (2)$$

where P is the estimated value, P_i is the calculated value at point i, d_i is the distance between the point to be estimated and the point i, and n is the number of national meteorological stations used.

4 Data Results

4.1 Data products

Details regarding the files containing the Guanzhong region data, site location data, daily site ET_0 data (2010–2019), and annual ET_0 spatial distribution data (2010–2019) are listed in Table 2.

Table 2 Details regarding the files of the reference evapotranspiration (ET_0) dataset for the Guanzhong area

Data	Data format	Data content	Data size
The information of site location and daily ET_0 from 2010 to 2019	.xlsx	ET_0 data	373 KB
The spatial distribution of ET_0 from 2010 to 2019	.tif	ET_0 data	65 MB
The data of Guanzhong region	.shp	shape file	41.4 KB
The data of site location	.shp	Shape file	4.65 KB

4.2 Data Results

It can be seen from Figure 1 that ET_0 at each of the six sites in the Guanzhong area during 2010–2019 exhibits a highly consistent pattern with an annual trend of increase and then

decrease with a peak in July. During May–August, ET_0 is high because of the high surface temperatures, active plant transpiration, and enhanced soil evaporation capacity. The minimum ET_0 values are in January with a range of 0.48–1.85 mm/d. There is little difference in ET_0 among the six stations in the Guanzhong area, indicating that the climatic conditions are broadly similar throughout the Guanzhong area. Therefore, it is not necessary to consider the influence or deviation caused by climatic conditions when conducting various scientific research related to regional agriculture and water conservancy.

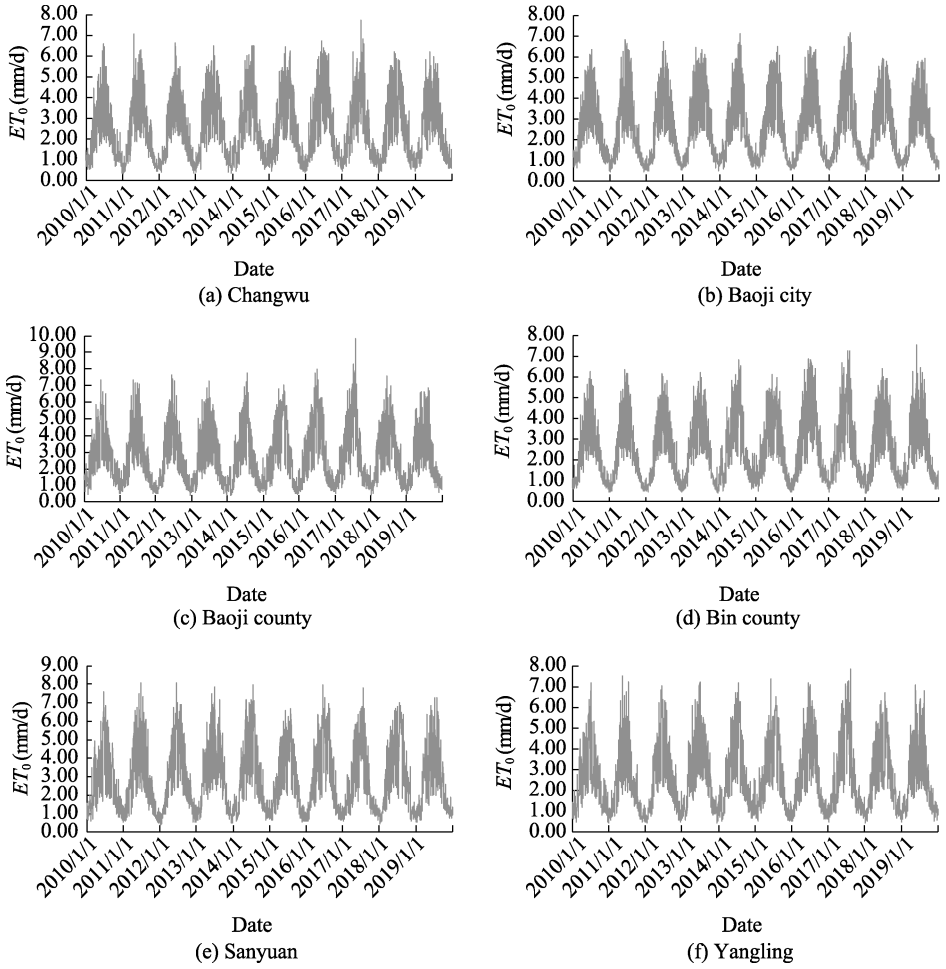

Figure 1 Variation of ET_0 at each of the six studied stations in the Guanzhong area during 2010–2019

Daily meteorological data recorded in the Guanzhong area were used in combination with the P–M model to calculate daily ET_0, and then the inverse distance weighting method in ArcGIS 10.4 was used to produce maps of the spatial distribution of annual ET_0 in the Guanzhong area. The spatial distribution of annual ET_0 in selected years (i.e., 2010, 2013, 2016, 2019) is illustrated in Figure 2. It can be seen that the characteristics of the distribution in different years show certain similarities, i.e., reduction from the northeast toward the southwest. This pattern is closely related to the topography of the Guanzhong area and the regional distribution of agriculture. The topography of the Guanzhong area generally presents the characteristics of being low in the middle, higher on all sides, and higher in the west than in the east. Regionally, agriculture is concentrated mainly in the

middle of the Guanzhong area. Furthermore, the spatial distribution of ET_0 has large variability with a range of 800–1,198 mm.

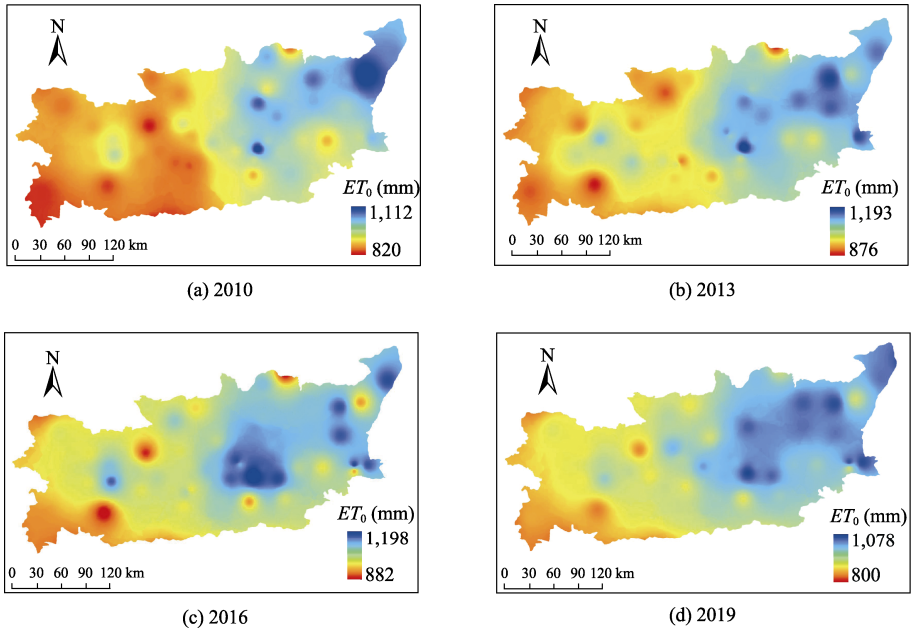

Figure 2 Spatial distribution of annual ET_0 in certain years in the Guanzhong area

5 Discussion and Conclusions

Six typical meteorological stations in the Guanzhong area were selected to calculate daily ET_0 for the period 2010–2019, in accordance with the FAO-recommended method. The results revealed that ET_0 at each of the studied sites had a highly consistent pattern, i.e., an annual trend of increase and then decrease with a peak in July. Evapotranspiration remained at 2.01–7.38 mm/d during May–August and evaporation capacity was strong. Evapotranspiration was reduced to its minimum (0.48–1.85 mm/d) in January. There was little difference in ET_0 among the six studied stations in the Guanzhong area, indicating that the climatic conditions are broadly similar across the region. The characteristics of the spatial distribution of annual ET_0 in the Guanzhong area showed certain similarities, i.e., a pattern of decrease from the northeast toward the southwest. Furthermore, the spatial distribution of ET_0 presented marked variability with a large variational range (minimum: 800 mm, maximum: 1,198 mm).

The Guanzhong area is a rich agricultural region in China, which has excellent irrigation conditions, fertile soil texture, and high agricultural production potential, and where ET_0 is closely related to crop water demand. The Guanzhong area extends over 5.58×10^4 km^2, and accounts for 27% of the total area of Shaanxi province[15]. Nevertheless, the dataset produced in this study reflects atmospheric evapotranspiration within the administrative divisions of the Guanzhong area, and represents a solid foundation for both the planning and design of regional water conservancy projects and the study of agricultural water-saving measures. The results could provide a reference for improving the understanding of the effects of climate change in the region in terms of regional water resources management, agricultural development, and ecological environment protection. In future research, the influence of climate change or of different climatic zones and human activities on the

spatiotemporal distribution of ET_0 could be considered.

Author Contributions

Wang, S. D. produced the overall design for the development of the dataset; Sun, G. F. and Zhao, X. T. collected and processed the meteorological data of the six stations in the Guanzhong area. Wei, Z. and Wang, J. designed the statistical algorithm of the model. Lin, R. C. and Cui, L. wrote the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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