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1-km Resolution Dataset of Water Yield in the National Ecological Barrier Zone (2000–2015)

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Abstract: The relationship between water and ecosystem is an important scientific issue that is widely concerned by the society. As a significant part of the national ecological security strategic pattern, water yield service in the National Ecological Barrier Zone closely links the integrity of China's ecological system with the sustainable development of the society from the perspective of hydrology and water resources. Meanwhile, its specialization and quantification are of great significance to the management and optimal allocation of Chinese water resources. Aiming at the production of water yield dataset, based on the principle of water balance, the modeling of barrier area water yield service that is driven by remote sensing data is carried out. The basic data of water yield dataset of the National Ecological Barrier Zone includes meteorology (Daily dataset of China surface climate data (V3.0)), land use, NDVI and other data. The water yield module of InVEST model is adopted. At the same time, the grid is applied as the unit to realize the estimation of water yield service of national ecological barrier area from 2000 to 2015. The spatial resolution of the data is 1 km, and the time period is 2000–2015. The projection coordinate system is WGS_1984_Albers, and the unit is mm. The data is archived in .tif format with a data size is 169 MB.

Keywords: National Ecological Barrier Zone; water yield services; InVEST model

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2020.03.18.V1.

1 Introduction

Ecosystem services are all kinds of benefits that human beings get directly or indirectly from

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[2] Yin, L. C., Wang, X. F., Wang, Y. Water yield product 1-km grid yearly dataset in National Barrier Zone of China (2000–2015) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2020. https://doi.org/10.3974/geodb.2020.03.18.V1.

the ecosystem[1]. United Nations Millennium Ecosystem Services Assessment (MEA) classifies them into four categories, namely supply, regulation, support and cultural services[2]. Water yield service of an ecosystem is roughly subordinate to regulation and supply services. Specifically, they represent the phenomenon and process of water changes in terms of time, space and quantity after water utilization and filtration by an ecosystem[3]. As an important regulation and supply service, the water yield services of an ecosystem are the basis of various ecological processes and ecological service functions[4]. Therefore, it plays an important role in arresting precipitation, regulating runoff, purifying water quality, improving hydrological conditions and regulating regional water cycle[5]. Quantitative evaluation of water yield services is the basis of rational utilization of water resources and guarantee of regional sustainable development[6]. Therefore, current studies on water yield services have become a research hotspot in the field of hydrology and watershed management[7–8].

The developing purpose is aimed at building the time series products of water yield services in the National Ecological Barrier Zone, carrying out researches on the tradeoff and collaboration of ecosystem services in the barrier area, and further consolidating and optimizing the regional ecological service function, so as to ensure the national ecological security and sustainable development. The hydrological regulation capacity is measured by deducting the maximum potential available surface water on the grid scale, and the water yield services in the National Ecological Barrier Zone is obtained by subtracting the precipitation from the evapotranspiration. The water yield module of InVEST model that is based on the principle of water balance was adopted to calculate the water yield dataset with 1-km spatial resolution for the National Ecological Barrier Zone, and the results were directly expressed in the form of raster map.

2 Metadata of the Dataset

The metadata summary of the dataset is shown in Table 1. It includes the dataset full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, etc[9].

3 Methods

3.1 Data Sources and Preprocessing

(1) Meteorological data is the daily dataset of China surface climatic data (V3.0), and is from China Meteorological Data Network. ANUSPLIN[12] was applied to interpolate national meteorological elements in batches, with a spatial and temporal resolution of 1 $km \cdot d^{-1}$.

(2) China's land use data (2000, 2005, 2010 and 2015) are obtained from China's land use status remote sensing monitoring database, with a spatial resolution of 1 km.

(3) NDVI data (2000–2015) is a MOD13A2 1 km vegetation index composite product for 16 days, and is downloaded from the geospatial data cloud. Through batch format conversion, annual maximum value synthesis, batch cropping and projection conversion, the annual NDVI raster dataset with the resolution of 1 km in the study area was obtained.

Table 1 Metadata summary of the "Water yield product 1km grid yearly dataset in National Barrier Zone of China (2000–2015)"

Items	Description
Dataset full name	Water yield product 1km grid yearly dataset in National Barrier Zone of China (2000–2015)
Dataset short name	NBZ_water_1km_2000-2015
Authors	Yin, L. C., Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, yinlichang3064@163.com Wang, X. F., School of Land Engineering, Chang'an University; Shaanxi Key Laboratory of Land Engineering, wangxf@chd.edu.cn Wang, Y., School of Earth Science and Resources, Chang'an University, wangyichangan134@163.com
Geographical region	The area[10] involves provinces: Heilongjiang, Jilin, Qinghai, Gansu, Sichuan, Xinjiang, Inner Mongolia, Hebei, Liaoning, Xizang, Ningxia, Yunnan, Guangxi, Guangdong, Guizhou, Hunan, Jiangxi, Shanxi The northern sand belt (36°45′N–45°06′N, 75°50′E–124°18′E) The ecological barrier of Qinghai-Tibet Plateau (29°40′N–38°10′N, 82°50′E–105°5′E) The ecological barrier of Sichuan-Yunnan Loess Plateau (24°10′N–38°50′N, 99°05′E–114°25′E) The south hilly mountain belt (22°45′N–27°10′N, 103°10′E–119°15′E) The northeast Forest belt (40°52′N–53°34′N, 118°48′E–134°22′E)
Year	2000–2015
Temporal resolution	1 year
Spatial resolution	1 km
Data format	.tif
Data size	169 MB (After compression)
Data files	There are 16 .tif data and the naming rules are 'NBZ_water_' + spatial resolution + year, such as 'NBz_water_1km_2000.tif', indicating that the 1-km resolution dataset of water yield in the National Ecological Barrier Zone is in 2000, the years are in order from 2000 to 2015
The projection coordinate	WGS_1984_Albers
Foundations	Ministry of Science and Technology of P. R. China (2019QZKK0405); Chinese Academy of Sciences (XDA2002040201)
Data publisher	Global Change Scientific Research Data Publishing System http://www.geodoi.ac.cn
Address	No. 11 A 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[11]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref

3.2 InVEST model

Based on the principle of water balance, this dataset adopts the water yield module of InVEST model to calculate the water yield of the National Ecological Barrier Zone from 2000 to 2015, so as to represent the regional water supply. By interpolating the input precipitation and output evapotranspiration of regional water, and combining climate, terrain, vegetation, soil and other factors as well[13], the water yield capacity of different landscape components

is quantitatively evaluated based on grid units. The specific calculation formulas are as follows:

$$WY(x) = \left(1 - \frac{AET(x)}{P(x)}\right) \times P(x) \tag{1}$$

$$\frac{AET(x)}{P(x)} = 1 + \frac{PET(x)}{P(x)} - \left[1 + \left(\frac{PET(x)}{P(x)}\right)^{w}\right]^{1/w} \tag{2}$$

$$w(x) = \frac{AWC(x) \times Z}{P(x)} + 1.25 \tag{3}$$

where $WY(x)$ refers to the annual water volume (mm) of a certain landscape type x in the grid unit, $AET(x)$ marks the annual actual evaporation capacity (mm) of unit x, and $P(x)$ means the annual rainfall (mm) of unit x. $PET(x)$ stands for the potential evapotranspiration (mm) of unit x that is calculated by Penman equation[14]. $AWC(x)$ represents the available water content of plants. $W(x)$ refers to an empirical parameter, and Z is Zhang coefficient[15].

4 Data Results and Validation

4.1 Data Composition

The water yield product 1-km grid yearly dataset in National Barrier Zone of China (2000–2015) is the annual water dataset on the National Ecological Barrier Zone from 2000 to 2015 in ArcGIS TIFF format. The spatial resolution is 1 km, the unit is mm, and the projection coordinate system is WGS_1984_Albers. After compression, the data size is 169 MB.

4.2 Data Results

The spatial distribution of water yield with a resolution of 1 km in the National Ecological Barrier Zone from 2000 to 2015 is illustrated in Figure 1. From 2000 to 2015, the average water yield in the study area was 206.63 mm, generally suggesting a pattern of high in the southeast and low in the northwest. The high values were concentrated in the Ecological barrier of the Sichuan-Yunnan to Loess Plateau and then to the southern hilly and mountainous belt, the middle values were in the northeast forest belt and the southeast of the ecological barrier of Qinghai-Tibet Plateau, and the low values were located in the northwest and northern sand control belt of the ecological barrier of Qinghai-Tibet Plateau. Between 2000 and 2015, 86.3% of the regional water yield services in the National Ecological Barrier Zone was increased, there was a large increasing in the northwest of the northeast forest belt and the central part of the hilly and mountainous belt in the south, while the areas with lower water yield were concentrated in the southeast of Sichuan-Yunnan Plateau.

4.3 Data Validation

Verification results at 30 stations revealed that the average water yield from 2000 to 2015 in this paper was highly correlated with the multi-year average water yield that was calculated based on the comprehensive storage capacity method[16], and the determination coefficient R^2 reached 0.81, indicating that the water yield in this paper could better represent the spatial distribution of water yield in the National Ecological Barrier Zone.

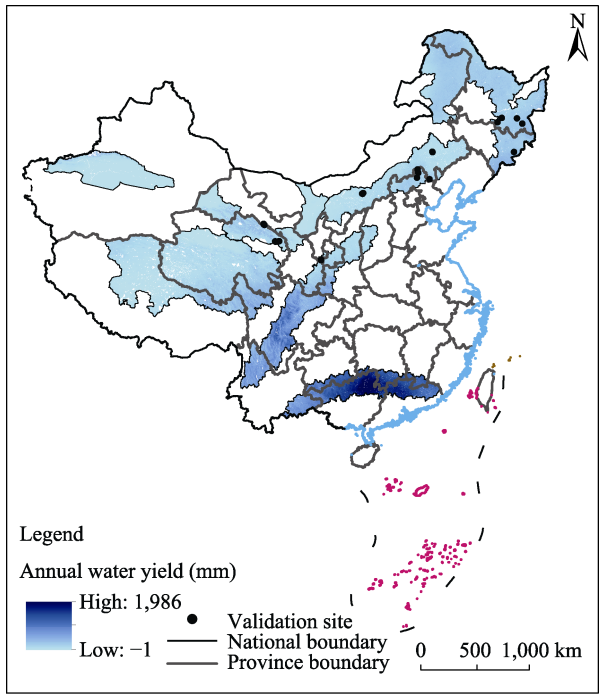

Figure 1 Map of the 1-km resolution water yield in the National Ecological Barrier Area (2015)

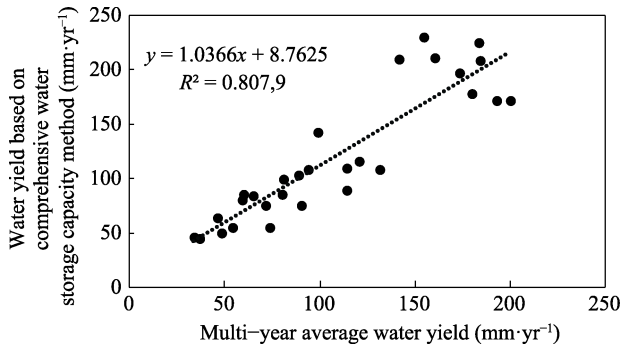

Figure 2 Comparative assessment of multi-year average water yield.
(Note: All site data are observation data)

5 Conclusion

In order to construct the time series product of the National Ecological Barrier Zone water yield service, the modeling research was carried out on the basis of the InVEST model water yield module with remote sensing, meteorology, land use and other data. The results showed that the average water yield in the study area was 206.63 mm that was generally high in the southeast and low in the northwest. Compared with the results calculated by the integrated storage capacity method based on site observation data, the results prove that the water yield in this paper can better represent the spatial distribution of water yield in the National Ecological Barrier Zone.

The water yield dataset with a spatial resolution of 1 km from 2000 to 2015 displays the

temporal and spatial distribution of water yield, and is an important input factor, so as to reveal the spatial-temporal evolution of ecosystem services and tradeoffs in the barrier area in recent years. It can provide reliable basic data and information for the exploration of the ecosystem service function of the National Ecological Barrier Zone under the background of global change, thus comprehensively and deeply understanding and grasping the security situation of the National Ecological Barrier Zone and providing the sustainable development of ecosystem.

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