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LETTER TO THE EDITOR

Comprehensive Evaluation Method of Agro-Ecological Water Environment Based on Mathematical Filtering Algorithm

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In this paper, the agro-ecological water environment in Shanghai is systematically evaluated by mathematical filtering algorithm. Based on the basic theory of agricultural water resource utilization efficiency, this paper defines the agricultural water resource, its characteristics and utilization efficiency and other related concepts. In view of the existing problems and causes, countermeasures and Suggestions are put forward, such as improving the comprehensive utilization efficiency of water resources, controlling the over-exploitation of groundwater resources, improving the ecological environment of agricultural water resources and perfecting the management system of agricultural water resources.
Investigation and analysis; Comprehensive evaluation; Optimal allocation of water resources

I INTRODUCTION

Water is a necessary condition for all life on earth to survive. Water resources in a broad sense refer to the total amount of water in the hydrosphere. In a narrow sense, it refers to the amount of fresh water that can be recovered and updated every year (Li et al. 2017a). Rivers, rivers, lakes and seas are all water resources. Nowadays, water is indispensable for both production and life. Water resources are getting more and more stressed and attached with more and more meanings. When these fresh water resources are used for agricultural production, then the water resources become agricultural water resources. Both groundwater and surface water need to become soil water to nourish crops. Therefore, we can know that only soil water can directly affect crops, and it is the only way for water resources to be absorbed (Li et al. 2017b). As we all know, water can exist in three forms: solid, liquid and gaseous. But among these three forms, only liquid water is the water resource needed for agriculture. Water in gaseous and solid forms can only be converted into liquid for agricultural production. Rainwater falling on the surface of plants is also a kind of water resource, but the amount of this water resource is very small and often ignored by people. This water resource accounts for about 2% of the precipitation resources, so it can be ignored in the analysis of agricultural water resource (Huang et al. 2017). Although rivers and lakes can store a lot of fresh water resources, they cannot be fully exploited. Now many water conservancy facilities with water storage function cannot store too much water after they are full of water, resulting in a part of water resources waste. The fresh water resource without storage flows into the sea through the river, which turns the fresh water resource into sea water and directly leads to the reduction of the fresh water resource. However, the fresh water resource which can be used as domestic water or agricultural water is very rare, so it can be seen that the fresh water resource is very precious. Water for agriculture is mainly supplied by rainfall, so rainfall resources are very important for agriculture. If drought occurs, crop growth will be affected.

In 2010, Mehmet Akbulut et al. published an article in the journal Ekoloji's Issue 74: "Assessment of Surface Water Quality in the Atikhisar Reservoir and Sarıçay Creek (Çanakkale, Turkey)". This paper is conducting a cluster analysis of the water quality of the surface water, using principal component analysis and univariate statistical techniques to conduct specific research to understand the water quality composition (Akbulut et al. 2010). Multivariate statistical techniques such as cluster analysis, principal component analysis, multidimensional scaling and univariate statistical techniques were used to analyze the data. Three different groups are formed based on cluster analysis. Two-way ANOVA test results show that the interaction of any variable in the reservoir is not significant, but the interaction of the pH value of the creek is significant. Temperature, conductivity, oxygen saturation, biological oxygen demand, chemical oxygen demand, total phosphate, total nitrate, salinity, pH, reservoir Chl-a and total suspended solids are significantly different between seasons. Multidimensional scale analysis showed that variables such as EC, Sal, OS, T and TN affected the difference between the sites, while other variables showed similarity with COD, BOD, TSS, AD and TP. Inspired by this article, the mathematical morphological filtering technique is applied, and the statistical analysis method is applied to comprehensively evaluate the agro-ecological water environment.

2. IDEA DESCRIPTION

2.1 Characteristics of agricultural water resources

(1) Natural features. Agricultural water resources are liquid. It is a dynamic resource that is not easy to collect and store. However, in the process of growing crops, it is necessary to control water resources. Therefore, people often use various water conservancy projects to do water storage work. (González-Hidalgo et al. 2017, Tricase et al. 2018). Water resources will also dissolve fertilizers, organic matter, etc. in the process of recycling and collection. When watering the farmland, nutrients will be brought to the soil to moisten the soil and crops (Kundu 2017). Water resources also have two sides. If there is too much water, it will cause flood disasters, affect the growth of crops, and even cause crops to be drowned. However, if water resources are too small, it will affect the normal development of crops and cause food production to decrease. Because water resources have two sides, water conservancy projects also have the role of regulating water resources.

(2) Economic characteristics. Agricultural water resources are irreplaceable. All crops require water resources for growth. Although water resources cannot be replaced, they can be regenerated. Since water resources can be used as a commodity, it has economic attributes and is subject to market rules (Jiang et al. 2017). It is only an indispensable resource in agricultural production, and water resources are more special as commodities. Agricultural water resources can be continuously recycled, forming a cycle of watering, infiltration, flow, and collection, which can be continuously reused. However, if the management of water resources is not good, it will affect the use of water resources, which will result in waste of resources, thus affecting agricultural development. Therefore, to some extent, water resources are scarce.

2.2 Agricultural water use efficiency

Agricultural water resources, like other resources, are essential production materials for human beings in production, but because of their special use, they have certain specialities. According to its unique particularity, academically divide water resources into two aspects. The first aspect is the process of water supply and water use. It refers to people taking water from existing rivers, rivers and lakes for agricultural production. The second aspect is the water consumption process of agricultural production, which refers to the process of using water resources in the production process of crops. There are certain links between the two utilization processes of water resources. These two processes are indispensable. Agricultural production is inseparable from the allocation of water resources. The use of water resources has a positive effect on agricultural development. Therefore, the utilization efficiency of agricultural water resources is crucial for agricultural production. From the utilization process of water resources, it can be seen how the value of agricultural water resources is realized. To increase its value, it is necessary to improve its utilization efficiency. The utilization efficiency of agricultural water resources is also realized through two aspects.

2.3 Mathematical filtering technique

The main advantage of mathematical shape filtering is that it does not need to consider the type of noise. It only needs to select the structural elements that match the target signal. Designing a suitable filter can restore the original features of the target signal well, and the operation speed is fast. The time series of the ecological water environment in the mining and agricultural areas are analyzed. Although we are not sure which are the "pure" ecological water environment signals, we can basically determine which are not the ecological water environment signals. Therefore, as long as a suitable mathematical morphological filter can be designed, these signals that are determined to be inconsistent with the characteristics of the earth's ecological water environment are extracted in the time domain. And from the original signal, it can separate the basic "pure" ecological water environment signal, and then comprehensively evaluate the water environment, thus suppressing and separating the influence of various strong noise interference on the measured data. Based on the theory of mathematical morphology, this paper conducts denoising research based on the shape of ecological water environment signals. Analyze a large amount of ecological water environment data and obtain its characteristic information (Dai et al. 2017). By designing appropriate morphological filters, noise disturbances that do not conform to the characteristics of the ecological water environment are identified. This paper mainly discusses the application of traditional morphological filtering and generalized morphological filtering in the separation of strong electromagnetic interference. On the basis of mathematical shape filtering, combined with transform, median filtering and signal subspace enhancement, the noise contour or reconstructed signal extracted by morphological filtering is subjected to secondary signal-to-noise separation research to continuously approach the original shape of the ecological water environment signal. Through theoretical analysis, simulation and actual data processing, a comprehensive evaluation of agro-ecological water environment based on mathematical morphology is realized.

Mathematical morphology is a mathematical method based on set theory and integral geometry that is different from time domain and frequency domain. Mathematical morphology is a nonlinear analysis method compared to integral transformations such as Fourier and wavelet. The extraction of signal features is completely carried out in the time domain, mainly including addition and subtraction and the operation of taking the extreme value, which does not involve multiplication and division, and has a small amount of computation and is easy to realize. The mathematical filtering algorithm is adopted to process the agricultural ecological water environment, and the collected information is removed in the form of signals. In the calculation of agricultural water resource utilization efficiency, more accurate calculation results are obtained.

3 RESULTS

From the perspective of the dynamic characteristics of the socio-economy-water environment system in the basin, the conceptual framework describes that the water environment effect of the socio-economy in the basin should include two characteristics: positive effect and negative feedback. Positive effect: the scale, structure and layout of the development of "three industries" (agriculture, industry and service industry) positively determine the two types of pressure, leading to changes in the state of water environment. It is manifested as deterioration of water quality and degradation of water ecosystem. Firstly, it directly leads to the enrichment and discharge of water pollutants; secondly, it changes the land use mode (such as wetland, cultivated land area, etc.) and intensity (such as the intensity of fertilizer application, etc.), thus indirectly affecting the closure and degradation capacity of pollutants in the river basin. Reverse feedback: in the face of the deteriorating water environment, social and economic activities also show the reverse feedback, adopting control measures such as source control, land use mode and intensity adjustment, and terminal water pollution control to alleviate and improve the water environment in a certain period in the future.

In this paper, AWAE is used to measure the utilization efficiency of agricultural water resources in Shanghai. AWAE also represents the utilization efficiency of agricultural water resources in Shanghai, and GAWA represents the allocation capacity of each district (city, county) government of Shanghai for water resources. APMR represents the water consumption satisfaction rate of each district (city, county), WS represents the water resources supply of Shanghai, and TWR represents the total water resources of ShanghaiELA represents the effective farmland irrigation area of Shanghai, CL represents the total farmland area of Shanghai, and the calculation formula of AWAE is as follows:

$$AWAE_{it} = GAWA_{it} \times APMR_{it} \tag{1}$$

Among them,

$$GAWA_{it} = \frac{WS}{TWR}, APMR_{it} = \frac{EIA}{CL} \tag{2}$$

In the above formula, the value range of GAWA is 0, of course, the greater the value of GAWA is, the higher the allocation capacity of Shanghai municipal government is. When GAWA=1, the allocation capacity of Shanghai municipal government to water resources reaches the optimal level. But this is an ideal state, and reality is hard to achieve. The range of APMR is also $0 < APMR \leq 1$, indicating the satisfaction of agricultural production in Shanghai. Of course, the larger the value of APMR, the higher the satisfaction of agricultural production water in Shanghai. When APMR=1, Shanghai's agricultural production water satisfaction is optimal. That is to say, the supply of agricultural water resources in Shanghai can meet its demand, but this is only an ideal state, and the reality is difficult to meet. Through this result, a comprehensive assessment of the agro-ecological water environment in Shanghai is carried out. The results are as follows:

Table 1 Results of comprehensive assessment of agro-ecological water environment in Shanghai

Level1indicator	Level 2 indicator	Level 2 weight	Level 3 indicator	Level 3 weight	Evaluation results
Comprehensiveassessment results of agro-ecological water environment	Agricultural ecological water environment function index	0.163	Farming land storage capacity	0.071	B
			Farmland purification capacity	0.035	B
			Farmland adjustment capacity	0.011	A
			Ecological water environment	0.047	B
	Agro-ecological water environment indicator	0.540	Landscape pattern of farmland	0.118	C
			Regional micro-geomorphic conditions	0.037	A
			Regional climate of	0.036	B

		farmland		
		Agricultural land use structure	0.068	C
		Agricultural ecological water quality	0.143	B
		Drought and flood disaster coefficient	0.137	C
Human influence	0.297	The population density	0.029	A
		Scale of regional economic development	0.031	A
		Urbanization level	0.055	A
		Policy decree	0.182	C

According to Table 1, the water quality of agro-ecological water environment in Shanghai is general, and the cultivated land has certain adjustment, purification and storage capacity. Seriously affected by humans, there are many ecological and aquatic environments, serious eutrophication of water bodies, poor utilization efficiency, and need to improve water quality and improve the efficiency of agricultural water resources utilization.

4. CONCLUSION

The paper systematically studies the utilization efficiency of agricultural water resources in Shanghai. Firstly, the basic theory of agricultural water use efficiency is analyzed, and the basic status, problems and causes of agricultural water use efficiency in Shanghai are analyzed. Elimination of redundant information of agro-ecological water environment by mathematical filtering algorithm, calculation of utilization efficiency of agricultural water resources in Shanghai, Shanghai. Suggestions for improving the utilization efficiency of agricultural water resources in Shanghai were put forward.

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