Hindawi
Mathematical Problems in Engineering
Volume 2022, Article ID 3673758, 9 pages
https://doi.org/10.1155/2022/3673758

Research Article

Impact of Land Cover Changes on the Wetland Ecosystem Water Environment Using Soft Computing Methods

Wenming Cai,[1] Xue Liu,[1] Dapeng Zhang ,[2] and Farzana Akter [3]

[1]*School of Urban Design, Wuhan University, Wuhan 430072, China*
[2]*School of Business Administration, Zhongnan University of Economics and Law, Wuhan 430073, China*
[3]*Bangabandhu Sheikh Mujibur Rahman Digital University, Kaliakair, Gazipur, Bangladesh*

Correspondence should be addressed to Dapeng Zhang; zzddpp01@163.com and Farzana Akter; farzana@ict.bdu.ac.bd

Received 13 February 2022; Revised 7 April 2022; Accepted 13 April 2022; Published 25 May 2022

Academic Editor: Parikshit Narendra Mahalle

Economic growth is accelerating in the entire world due to new inventions and advancements in the field of science and technology. The technology is progressing at a rapid pace and resulting in the infrastructure and technical progression of each nation. The utilization rate of land in the world has also increased substantially where the cultivated land is used for the development of industries and buildings. This land occupancy is alarming for the environment, and it is impacting the ecosystem of the earth in many adverse ways. In this study, the impact of land cover changes on the wetland ecosystem water environment has been studied in depth using soft computing techniques. The water environment data of the wetland ecosystem are obtained from real-world scenario and are mined using a particle swarm K-means clustering approach based on chaos search. The water environment assessment approach is used to analyze the influence of land cover changes on the water environment of the wetland ecosystem. The findings of this research work reveal that the cultivated land in the wetland is steadily decreasing, and the fertile forestland is steadily decreasing in the early stages and gradually increasing in the latter stages. The wetland water quality is gradually degrading over the period of time. The outcomes of the study demonstrate that a nonpoint source of pollution produced by land-use changes is the most important factor, which is affecting water quality. The analytical results' accuracy is as high as 0.98 when compared to the real-world circumstances.

1. Introduction

Wetlands are important ecosystems that provide many benefits and functions to preserve the ecosystem of the Earth [1]. Wetlands are areas of marshy, peatland, or water, natural or man-made, perennial, or transitory with water in the static or flowing state [2]. The water can be fresh, salty, or saline and includes regions of seawater with a depth of less than six meters at low tide [3]. Wetlands' destiny is determined by the human beings who are exploiting the water resources more than the required extent, and this may lead to future crisis [4]. The preservation of soil and wetlands is an important issue to address these days. Wetland degradation is a global and tough challenge in the context of the industrial revolution and global warming [5]. The global environment is touched and destroyed in unprecedented ways as a result of the industrial revolution, fast population increase, and urbanization [6]. Due to all these factors, the ecosystem is rapidly deteriorating [7, 8]. Climate change and rapid agricultural growth have substantially lowered the area of wetlands around the world in recent years [9]. This growth is severely affecting the ecosystem services of wetlands [10]. Changes in land usage and its spatial consequences on the wetland ecosystem are the major concern of the geographical experts and environment conservationists [11]. The main goal of this study was to move the focus of planning from cultivated land protection to natural resource protection. The natural resources are backbone of this earth's ecosystem and are very important for the survival of plants, animals, and human beings [12]. To make effective use of land and meet the requirements of land planning, it is necessary to comply with the requirements during the implementation. It is essential to take the efficient completion of land planning as the basic starting point and then to coordinate between the land requirements and ecosystem requirements to achieve the win-win situation. It is required to comply with the requirements during the implementation in order to make effective use of land and meet the objectives of land planning. The human agricultural activities are the dominant cause of changes in forest and other ecosystems over the last 50 years as observed by the conversion of wetland to non-wetland. A significant number of studies have been found in the literature where researchers have conducted surveys and studied the impact of land usage on the ecosystem, but there is a need to explore more versatile methods to protect this ecosystem with the aid of soft computing techniques. The main contributions of the proposed research are as follows:

(i) The data of the wetland systems have been collected from the authentic datasets available for research studies.
(ii) improved parallel K-means (IPK) algorithm is used to mine the data of the wetland ecosystem as a cluster center and to obtain the best clustering results of the Wetland ecosystem water environment data.
(iii) The clustering algorithm based on chaos search is used to cluster the data for finding out similarities to make the corrective decisions.
(iv) The soft computing-based method is utilized to analyze the impact of land cover changes on the wetland ecosystem water environment.
(v) The results of the study are in good agreement with the actual situation in the world, which needs in-depth study for the conservation of the natural resources.

The rest of the study is organized as follows: in Section 2, the current research works are discussed. In Section 3, the soft computing-based technique is discussed to analyze the impact of land usage on wetland ecosystems. In Section 4, the results are explained, and discussion on results is described in Section 5. The last section concludes the soft computing-based research work to analyze the land usage impact on wetland ecosystems.

2. Related Works

In [13], the authors analyzes the water level of Daihai Lake from 1960 to 2019 and found a continuous decline in water level from 2010 to 2019. They measured the average water scarcity in the lake as well. It can help in the sustainable development of lake. The authors in [14] calculated and observed changes in ecosystem services value (ESV) in terms of land-use land cover (LULC) in Khulna, Bangladesh, from 2014 to 2019, and found that water bodies and vegetation decreased continuously. This study demonstrates that the rapid rise of urbanization is posing a threat to natural ecosystems all across the world. The authors in [15] investigated how land use/cover change (LUCC) influences not only the surface structure but also biological processes such as the material cycle and energy flow. It has an impact on the ecosystem's structure and function, which in turn has an impact on ecosystem services and human well-being. In [16], the author research on the change in regional ecosystem services caused by LUCC has attracted much attention. Through ecosystem value assessment, the changes in atmosphere, soil, water, and other ecosystems in the region can be integrated to reflect the stress effect of LUCC on the ecological environment from the macro-perspective.

For a long time, the consequences of LULC changes on the water cycle, water balance, and flood have piqued people's interest, and the forest's hydrological influence has received even more attention. The results show that the influence of wetland vegetation change on hydrology is affected by wetland area, climate, and vegetation type [17]. The destruction of wetland vegetation, especially large area of forest, increases the flow in flood season, decreases the flow in the dry season, changes the extreme value of runoff, and causes severe soil erosion and water quality decline. However, people have not paid enough attention to the nonpoint source pollution of wetland water quality caused by LULC changes [18]. Dissolved or solid pollutants flow into receiving water bodies (such as rivers, lakes, reservoirs, and bays) from nonspecific places under the action of precipitation and runoff erosion and finally cause water pollution of surface water or groundwater. In China, after point source pollution, agricultural nonpoint source pollution has become the most critical environmental pollution source. Almost all nonpoint source pollution sources are closely related to the change if LULC [19]. It is predicted that after the point source pollution is effectively controlled, the nonpoint source pollution will rise to the first pollution source. The main characteristics of nonpoint source pollution are scattered layout, complex types, gradual, lagging, and challenging to control. Comprehensive and thorough comprehensive treatment is impossible [20]. It is of great significance to deeply understand and study the impact of LULC change on the wetland water environment, maintain wetland ecological balance, adopt reasonable land management methods, and protect environmental security [20]. There are many approaches discussed in [21, 22] that focus on the preservation of natural resources using soft computing and modern computational techniques.

The International Geosphere Biosphere Program (IGBP) pays more attention to the interaction among natural environment systems, biogeochemical systems, and human social systems in the process of organizing and implementing research on global change. It points out that the Dahe wetland system is the paramount object to studying these systems' interaction mechanisms [23]. In 1996, IGOP_PAGES put forward the research topic of the impact of land use and climate change on river systems to explore the response and mechanism of the river system to land-use change. LULC alters the natural landscape, affecting material circulation and energy distribution, and has a particularly significant impact on regional climate, soil, water quantity, and water quality [24]. For a long time, the impact of LUCC on ecosystem services has been mostly focused on a single element, according to [24], and there has been a paucity of research on the total ecosystem. Furthermore, the actual process and method of LUCC's impact on the ecosystem are still unknown in [25]. There are still many disagreements about how ecosystem services should be classified and evaluated around the world, and there is no systematic and defined approach for assessing the value of ecosystem services. In [26], the authors find ecosystem service value and the evaluation of ecosystem service value in China is mainly based on that research results. The average value of ecosystem service value per unit area is used to estimate directly, or the value of regional ecosystem service is indirectly estimated through biomass, biodiversity, and other correction methods. There is an intense subjectivity in this method. Even if the corrected value per unit area of an ecosystem is used in the calculation, it cannot fully reflect the structure and characteristics of a specific regional ecosystem. The definition of the ecosystem and ecosystem services is unclear, and the evaluation methods are not unified, which seriously restricts the development of ecosystem service value research.

3. Proposed Methodology

3.1. Data Source

3.1.1. The Particle Swarm K-Means Clustering Algorithm Based on Chaos Search Using Soft Computing Approach. First, the global searchability of the PSO algorithm is used to find a better particle swarm as the initial center of the K-means algorithm. Then, the searchability of the K-means algorithm is used to accurately search these initial centers to get the best clustering results of the Westland ecosystem water environment data [14].

The IPK-means algorithm is defined as follows:

(1) Particle Population Initialization: data of the wetland ecosystem are randomly selected as a cluster center, and then, the remaining cluster centers are selected according to the maximum distance principle. These operations are repeated n times to generate n particles (each particle is a $k \times \text{col}$ dimensional vector), where k is the number of clusters set in advance and col is the number of attributes in the dataset [13]. The distance is calculated as follows:

$$\text{dis}\left(x_j, C\right) = \sum_{i=1}^{|C|} \text{dis}\left(x_j, C_i\right), \tag{1}$$

where C is the cluster center set, x_j represents the j_{th} data in the ecosystem dataset, $|C|$ describes the current cluster number, and x is the chaotic variable.

(2) According to the principle of minimum distance, the clustering dataset of the wetland ecosystem water environment is divided, and the fitness value of each particle is obtained. The personal extremum pbest_i and global maximum gbest of each particle and their corresponding particle positions xbest_i and xbest are obtained. The fitness function adopts the formula of Davies–Bouldin index (DBI) index of clustering and is given as follows:

$$\text{fit} = \frac{1}{k} \sum_{i=1}^{k} \max_{j \neq i} \left(\frac{\overline{C}_i + \overline{C}_j}{\left\| w_i - w_j \right\|_2} \right), \tag{2}$$

where $\overline{C}_i$ represents the average distance of cluster i, $\|w_i - w_j\|_2$ represents Euclidean distance, and k is the number of clusters.

(3) Dynamic Adjustment Factor: particle velocity and position are updated [20].

(4) The updated particles are used as the clustering center of the wetland ecosystem water environment to re-cluster the dataset, and the fitness value of each particle is calculated.

(5) In particle swarm optimization, the particles whose extremum are invariable and are not the global optimum are deleted, and the equivalent particles are randomly generated at the optimum global position using a chaos search algorithm.

(6) Whether the current population fitness variance, var, is lower than the threshold ther (indicating that the population has converged) or reaches the maximum number of iterations is judged. If so, step 7 is proceeded; otherwise, the following equation is used:

$$\text{var} = \frac{1}{n} \sum_{i=1}^{n} \left(f_i - f_{\text{avg}} \right)^2. \tag{3}$$

(7) The best position obtained by the particle swarm optimization algorithm is the initial center, and the data category matrix $U_{n\times k}$ of the wetland ecosystem is established so that the current iteration number $t = 0$.

(8) According to the principle of nearest distance, the dataset of the wetland ecosystem is subdivided and clustered again, and $U_{n\times k}$ is updated according to the following equation:

$$u_{ij} = \begin{cases} 1, & x_j \in C_j, \\ 0, & x_j \notin C_j. \end{cases} \tag{4}$$

(9) If there is no change in the category matrix $U_{n\times k}$, the clustering center has converged, and then, the iteration process is ended; otherwise, step (10) is proceeded.

(10) According to the partition results, the average value of each cluster is obtained as a new cluster center point. If there is an empty cluster class, the cluster class is deleted, and the value of the number of clusters K is -1 [10].

(11) The number of iterations $t++$ is set, and if $t \geq t_{\max}$, the algorithm will end, and the clustering results of the water environment data of the wetland

ecosystem are output. The DBI index of clustering is calculated according to the following equation:

$$\mathrm{DBI} = \frac{1}{k}\sum_{i=1}^{k}\max_{j\neq i}\left(\frac{\overline{C}_i + \overline{C}_j}{\left\|w_i - w_j\right\|_2}\right), \tag{5}$$

where $\overline{C}_i$ is the average distance of cluster i, $\|w_i - w_j\|_2$ is the Euclidean distance, and k is the number of clusters.

3.1.2. Test Setting. Xitiaoxi wetland is located in Huzhou City, Zhejiang Province, with a population of 576000, an area of 2200, and has an average annual precipitation of 1385.9 mm. The wetland terrain is high in the southwest and low in the northeast, with a gradient distribution of mountains, hills, and plains, but mainly low and gentle hills [21]. The land-use types in the wetland are complete, mostly forest land, followed by cultivated land, grassland, industrial and mining land, residential land, garden land, and unused land [18].

In the data of the wetland ecosystem water environment, the main water quality indexes are as follows: $NH_3 - N$, $NO_3 - N$, $NO_2 - N$, BOD_5, DO, oil, pH value, TP, Tss, T, and turbidity. Other data in the study are from UVNC CCC topographic map, statistical yearbook of each county and district in Huzhou, soil records of Huzhou City, agricultural data, and field survey. This study's data on LULC changes are from TM data in 2017, 2018, and 2019 [7].

3.2. Water Environment Assessment Method. Due to the lack of research on the hydrological, hydraulic, and dynamic changes in Xitiaoxi wetland, it is not easy to use the model to simulate and analyze the water quality. It has been shown that WQI can effectively measure the overall water quality. It may be used to compare and contrast water quality trends, as well as quantitatively describe the role of water quality parameters.

The comprehensive pollution index (P_r) of a river refers to the average value of the comprehensive water pollution index of each measured section of the river. Among them, the calculation formula of water pollution comprehensive index of the section j is given in the following equation:

$$P_j = \frac{1}{n}\sum_{i=1}^{n}\frac{C_i}{C_{oi}}, \tag{6}$$

where C_i is the measured concentration of pollutant i and C_{oi} is the evaluation standard of pollutant i.

The calculation of the water quality index includes two steps: first, the measured index value is standardized; that is, according to the standard, the test value of each index is converted into a value between 0 and 100. 100 indicates the best water quality, while 0 means the worst. Then, according to the importance of indicators affecting water quality, each indicator is given a certain weight, and a weighted calculation is carried out. The water quality index (WQI) is calculated as follows:

$$\mathrm{WQI} = \frac{\sum_{i=i}^{n} C_i P_i}{\sum_{i=1}^{n} P_i}, \tag{7}$$

where C_i represents the evaluation score of the i_{-th} index; P_i represents the weight of the i_{-th} index, with the value range of 1–4.

The standardization of each index value shall refer to China's national surface water environment quality standard GHZB1-1999. According to surface water's use, Udine, and protection objectives, the standard divides surface water into five categories, with rough classification. Therefore, the water quality evaluation research cannot be carried out completely based on this, and necessary amendments are needed. In this study, the wetland water quality is divided into 11 grades, reducing the range of every index in each grade of water quality. The first-level water quality is assigned 100, the second level is 90, and so on. The eleventh-level water quality is 0. On this basis, the water quality level corresponding to the measured value of every single index is standardized to convert it into the response value between 0 and 100 (Table 1). In [22], the authors found an expert evaluation method, which obtains the relative weight of each index. Firstly, expert consultation is carried out, and the experts rank the impact degree of every single index on water quality. The water quality indicators are then split into four categories based on the degree of impact on water quality, and the relative weight is likewise separated into four levels, according to most experts. 4 corresponds to the index with the greatest impact on water quality, and 1 corresponds to the index with the least impact on water quality, to obtain the relative weight value of each index shown in Table 1 and description in Abbreviation.

4. Results

4.1. The Changes in Land Use. Due to the poor traffic conditions in the wetland, the traffic land, residential land, industrial land, and mining land are combined into construction land, so the land-use types in the wetland are divided into forest land, cultivated land, grassland, construction land, garden land, water body and unused land, etc. The simple transfer matrix of land use in 2004–2019 is shown in Tables 2–4.

Tables 2–4 show that the Xitiaoxi wetland's land use is largely agricultural and forestry land, followed by cultivated land. In 2004, 2014, and 2019, the proportion of agricultural and forestry land in the total wetland area showed a decreasing trend. However, the specific change process of the two is different: the cultivated land continues to decrease, but the decrease tends to be minor. The performance of forest land has been increasing and then declining, but the performance of construction land has been increasing continuously. Garden land, grassland, and water bodies all went through a process of reducing and then growing, but the overall change range was small. Therefore, the change in unused land has little effect on the land-use pattern of the whole wetland.

Table 1: Comparison of standard values of calculated water quality index.

Index	Weight	100	80	70	60	50	40	30	20	10	0
NH4-N	3.1	<0.02	<0.16	<0.21	<0.36	<0.51	<0.76	<1.01	<1.26	≤1.51	>1.51
NO3-N	2.1	<0.51	<2.1	<3.1	<5.1	<10.1	<15.1	<25.1	<25.1	≤50.1	>50.1
NO2-N	2.1	<0.06	<0.016	<0.03	<0.04	<0.06	<0.11	<0.16	<0.51	≤1.01	>1.01
BOD5	3.1	<0.51	<1.6	<2.1	<2.6	<3.1	<4.1	<6.1	<8.1	≤10.1	>10.1
DO	4.1	≥7.51	>6.6	>6.1	>5.1	>4.1	>3.6	>3.1	<2.1	≥1.1	>1.1
Hard	1.1	<25.1	<75.1	<100.1	<150.1	<200.1	<300.1	<400.1	<600.1	≤1000.1	>1000.1
Mg	1.1	<1.1	<3.1	<4.1	<6.1	<8.1	<9.1	<10.1	<12.1	≤15.1	>15.1
Oil	2.1	<0.006	<0.041	<0.081	<0.151	<0.301	<0.601	<1.001	<2.0001	3.0001	>3.0001
pH	1.1	7.1	7.6~8.1	8.1~8.6	8.6~9.1	9.1~9.6	9.51~10.1	10.1~11.1	11.1~12.1	12.1~13.1	13.1~14.1
			6.1~6.6	5.6~6.1	5.1~5.6	4.6~5.1	4.1~1.6	3.1~4.1	2.1~7.1	1.1~2.1	<1.1
TP	3.1	<0.02	<0.04	<0.05	<0.05	<0.07	<0.11	<0.21	<0.31	≤0.51	>0.51
TSS	4.1	<10.1	<30.1	<40.1	<60.1	<100.1	<200.1	<500.1	<800.1	≤1200.1	>1201
T	1.1	21.1~16.1	24.1~14.1	26.1~12.1	28.1~10.1	30.1~5.1	32.1~0	36.1~2.1	40.1~4.1	45.1~6.1	>45.1<-6.1
Turb	2.1	<10.1	<15.1	<20.1	<25.1	<31	<40.1	<60.1	<80.1	≤100.1	>100.1

Table 2: Land-use change in Xitiaoxi watershed from 2004 to 2014 (hm^2).

	2004	2014	Growth rate/%
Woodland	134755.7	137096.9	1.73
Garden plot	3418.8	3360.5	−1.73
Grassland	5528.7	4983.8	−9.01
Water body	4496.2	4430.3	−1.48
Residential industrial and mining area	3425.9	3743.6	9.27
Unused land	45.5	53.8	18.24
Cultivated land	68183.6	66185.7	−3

Table 3: 2014–2019 land-use change in Xitiaoxi watershed (hm^2).

	2014	2019	Growth rate/%
Woodland	137097.7	136683.1	−0.3
Garden plot	3360.6	3371.2	0.31
Grassland	4983.9	5139.6	3.12
Water body	4353.4	4510.8	3.61
Residential industrial and mining area	3820.5	4131.8	8.14
Unused land	53.8	67.8	26
Cultivated land	65340.8	65106.1	−0.36

Table 4: Land-use change in Xitiaoxi watershed in 2004–2019 (hm^2).

	2004	2019	Growth rate/%
Woodland	134755.9	136683.6	1.43
Garden plot	3418.8	3519.6	−9.71
Grassland	5528.7	5139.7	9.3
Water body	4496.3	4510.8	0.32
Residential industrial and mining area	3425.9	4131.8	20.6
Unused land	45.5	67.8	49
Cultivated land	68332.1	65950.6	3.6

4.2. Impact of Land Use on Water Quality

4.2.1. Single Indicator Analysis. By comparing the observation data, it is found that the difference in water quality indexes between the two stations of Fushikan and Laoshikan in Xitiaoxi is very small, which indicates that the water quality of the two stations is basically the same, so the indexes of any station can represent the upstream water quality. In this study, the indexes of the Fushikan Station are selected.

Many studies have shown that N and P in water environments are mainly from farmland fertilization, the BOD is mainly from domestic sewage, livestock, and aquaculture, and P content in domestic sewage is also very large. A similar result can be obtained by analyzing Figure 1.

From upstream to downstream, the concentration of DIN reached the maximum value of 1.3 mg/L at Chaitanbu of Xitiaoxi wetland and then decreased to 0.9 mg/L at Jingwan Station. This phenomenon shows that the water

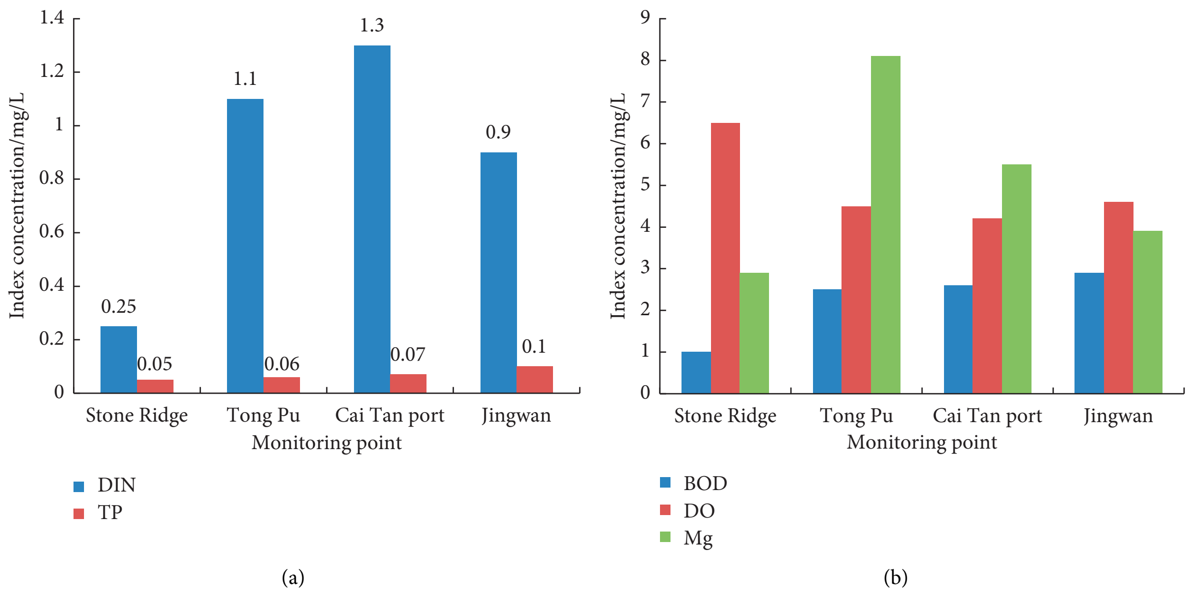

Figure 1: Spatial change in some monitoring indicators.

quality in the reach above Chaitanbu Station of Xitiaoxi wetland is gradually getting worse, while it has improved between Chaitanbu Station and Jingwan Station. This is consistent with the change in water quality reflected by dissolved oxygen and permanganate index. The concentration of DIN decreased in Jingwan Station, mainly due to the dilution of mud from the tributary. DIN reached the maximum value in Chaitanbu Station of Xitiaoxi wetland and then decreased, which may be caused by fertilization of farmland and bamboo forest in front of the Chaitanbu Station. However, the concentration of total phosphorus has been increasing from upstream to downstream, especially between Chaitanbu Station and Jingwan Station, which shows that domestic sewage and urban runoff (Anji County is located in this reach) are important sources of P. The variations in TP show that the river's water quality is consistently poor from upstream to downstream, which is consistent with the water quality as measured by biochemical oxygen demand.

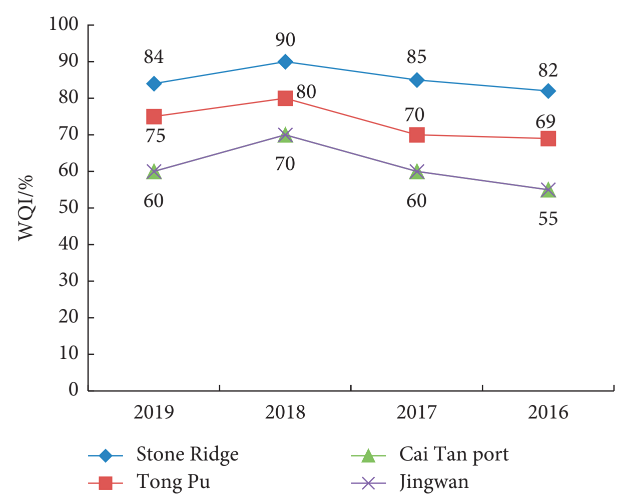

Figure 2: Water quality change.

4.2.2. The Analysis of WQI

(1) Water Quality Changes with Time. WQI results of each monitoring station in Xitiaoxi wetland are shown in Figure 2.

From 2016 to 2019, the water quality changes at each monitoring point of Xitiaoxi wetland are the same; that is, the water quality changed little from 2016 to 2019, improved in 2018, and slightly decreased in 2019. This trend of water quality is consistent with the previous research results. However, compared with 2016, the increase in water quality index is minimal, of which Tangpu Station has the most significant increase. According to the detection of the local environmental protection department, the industrial wastewater in Xitiaoxi wetland has been discharged up to the standard, which shows that the point pollution source is not the main factor of water pollution in Xitiaoxi wetland, and the difference in water quality index between the upstream and the downstream is mainly caused by the nonpoint source pollution caused by different land-use methods. In addition, the water quality in 2019 shows a downward trend (but still better than in 2016–2019), which may be due to the lax treatment of industrial pollution sources. This shows that the effect of point pollution source control is limited. To fundamentally improve the wetland water environment, nonpoint pollution needs to be vigorously controlled.

(2) Water Quality Changes with Space. It can be seen from Figure 3 that although the water quality of Xitiaoxi wetland in each year is different, it shows a trend of gradual deterioration from upstream to downstream.

As seen in Figure 3, WQI of Fushikan Station at the upstream of Xitiaoxi wetland is 83%, and it gradually

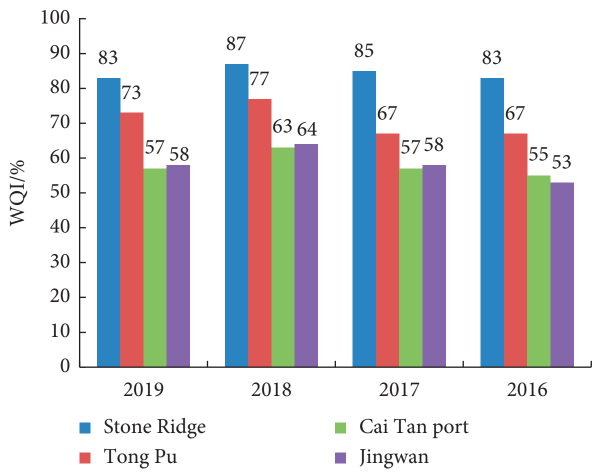

Figure 3: Spatial change in water quality index.

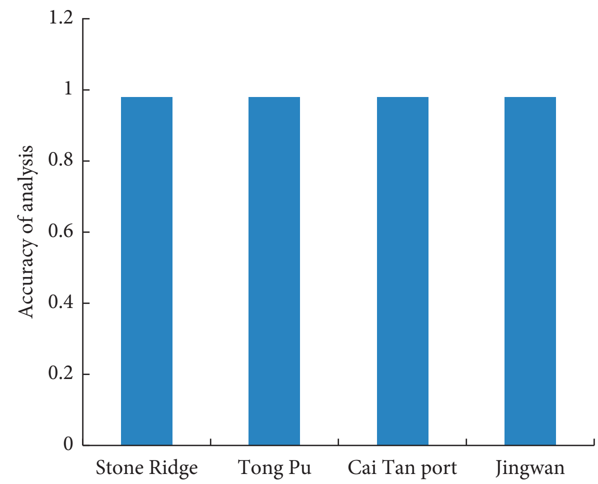

Figure 4: Accuracy test results of the method in this study.

decreases to the downstream and only 53% at Jingwan Station. The river from the Fushikan to Tangpu sections of Xitiaoxi wetland flows through the low mountain area, and the water quality index also decreased. Economic forests dominate this area, and cultivated land is mainly distributed in the river valley. The bamboo forest is the main part of the forest land, in which the bamboo forest in the low flat area is applied with both green fertilizer and chemical fertilizer. The bamboo forest in the hilly area is used with chemical fertilizer once a year. This kind of land-use mode is the main reason for declining river water quality in this section. The Tangpu and Chaitanbu sections of Xitiaoxi wetland are mostly low mountains and hills. In this area, Anji County is the section with the largest population density above Jingwan Station. Land use is still dominated by forest land, and construction land represented by residential land has increased significantly. The decline of the water quality index in this reach is mainly due to the role of domestic sewage and industrial wastewater.

In the section from Chaitanbu to Jingwan of Xitiaoxi wetland, hills and valley plains are arranged alternately, forest land and farmland are equally important, and water quality change is not apparent. The length of the river in this section is less than 10 km. Although the degree of agricultural nonpoint source pollution has not been reduced, at the upstream of Jingwan Station, the right bank of the river receives Hunni port, a tributary from the western mountainous, which plays a role of dilution. As a result, the water quality index increased.

The result analysis of this method is compared with the actual situation to test its accuracy, as shown in Figure 4.

Figure 4 demonstrates that the method's analysis results are extremely compatible with the actual scenario, and the analysis accuracy is as high as 0.98, indicating that the method's analysis results are reliable.

5. Discussion

Solutions to land usage are discussed as follows:

(i) The focus of planning should be changed from the protection of cultivated land to the protection of land and resources.

The dynamic balance and protection of cultivated land are the key content of the previous land planning. In future land planning, we should adhere to the principle that the existing natural resources will not be destroyed and pay attention to the value and role of the existing land resources for the future. In addition, all regions should develop fairly and protect the interests of the state and the people in an all-around way.

(ii) A dynamic monitoring mechanism of land planning should be established.

To establish and improve the dynamic monitoring mechanism of land planning and accurately report the detection information to the planning department, many measures have been taken by relevant departments and personnel in China. From the perspective of China's existing land planning system, there is still much room for improvement, but any fantasy is not in line with reality. It is necessary to find the most effective method based on the actual situation and do an excellent job in supervision, testing, management, and other work. Two rules should be strictly observed during the implementation: the relevant departments should do a good job in land planning and comply with various management regulations, especially in some key areas. Construction monitoring must be done well, and panoramic real-time monitoring of the construction area. The importance of land planning should be highlighted. When planning, the planning situation should be compared with the actual implementation situation to find out what cannot be completed in the plan, discuss with the planning department to find solutions, and strictly follow the direction of the plan.

(iii) The joint land decision-making mechanism should be established.

There will be many problems and contradictions in the process of land planning implementation. The root of these problems and contradictions is the problem of interests. To make effective use of land and meet the requirements of land planning, it is necessary to comply with the requirements during the implementation, take the efficient completion of land planning as the basic starting point, coordinate various relationships, and achieve win-win results. In the beginning, it is essential to formulate reasonable planning objectives, coordinate the interests of the masses and the government, construction personnel, and the government, and safeguard the country's interests. This can ensure smooth and efficient planning and seek joint development.

(iv) The land planning method should be improved.

The uncertainty of external factors leads to the dynamic land planning analysis methods. In addition to the dynamic analysis method, there are also qualitative analysis methods for land planning analysis. Qualitative analysis is based on the previous land planning experience and can make a correct judgment and reasonable planning for future land planning. Land planning is based on the premise of economic development, to achieve high quality of ecological resources, land use, and people's interests. The dynamic analysis must reflect the land status and construction situation in real time, and the construction department must be closely monitored to ensure that the planned objectives are met.

(v) The legal status of land-use planning needs to be improved.

To carry out land planning efficiently and reasonably, some policies and laws should be established to prove the importance of land planning. To improve the value of land use, we should encourage rural residents to concentrate in some large villages or towns and redistribute the land. In addition, the unreasonable policies in the past should be modified and adjusted. The adjustment should be justified, and the existence of any regulation should have its rationality. In addition, the rules and decisions made should be open and transparent to accept the masses' supervision and criticism. If there is a violation of the law, it should be dealt with strictly.

(vi) The planned price barrier shall be protected.

In recent years, the form of conservation planning is not optimistic. Some areas occupy and expand land under the banner of land planning. Random demolition and construction have caused significant damage to the land. The reason for these problems is that there is no price guarantee. If the actual land use of land planning considerably outnumbers the plan, the cost will rise. If the land is rectified out of the plan, it will exceed the original plan's cost. The relationship between economic development and land needs to be reasonably coordinated to achieve the rational utilization of resources and the maximization of interests. In addition, the price barrier of protection planning should be implemented. For illegal land occupation, it is necessary to impose fines and play an essential role in the price barrier.

6. Conclusion

Humans are determining the fate of wetlands by utilizing water supplies beyond the requirements, which may result in future crises. In this study, the impact of land cover changes on the wetland ecosystem water environment is studied. It is observed from the research study that land cover changes have a certain impact on the wetland ecosystem, and using soft computing methods, the optimal usage can be devised and the current usage can be analyzed. The particle swarm K-means clustering approach based on chaos search is utilized to accurately search the initial centers of data to get the best clustering results of the Westland ecosystem water resources. The analytical results reveal the outcomes to use the wetland optimally for protecting it for future use. The accuracy of the proposed method is 0.98 when compared to the real-world circumstances. The results show that the most important factor affecting water quality is a nonpoint source of pollution caused by land-use changes. The motive of the study is to shift the planning focus from the cultivated land protection to the natural resource protection. Therefore, land planning is a problem that needs attention in the current ecological environment protection. The problem of land planning is very important for the nations to preserve the ecosystem, and it is an effective way to improve the land usage rate. It can strengthen the management of land and ensures the efficient usage of wetland.

Abbreviations

NH_4-N: Ammonium nitrogen
NO_3-N: Nitrate
NO_2-N: Nitrite
BOD5: Biological oxygen demand
DO: Dojlido index
Mg: Magnesium
pH: Potential of hydrogen
TP: Total phosphorus
TSS: Total suspended solid
T: Toxicity
Turb: Turbidity.

Data Availability

All the data pertaining to this article are available in the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Acknowledgments

This work was supported by the Humanity and Social Science Youth Foundation of Ministry of Education of China for allowing to access the wetland areas for research study.

References

[1] B. Fu, *Ecosysetem Service and Ecological Security*, Higher Education Press, Beijing, China, 2013.

[2] L. F. Ricaurte, M. H. Olaya-Rodríguez, J. Cepeda-Valencia et al., "Future impacts of drivers of change on wetland ecosystem services in Colombia," *Global Environmental Change*, vol. 44, pp. 158–169, 2017.

[3] Y. Zheng, Z. Niu, P. Gong, and J. Wang, "A database of global wetland validation samples for wetland mapping," *Science Bulletin*, vol. 60, no. 4, pp. 428–434, 2015.

[4] N. J. Murray, R. S. Clemens, S. R. Phinn, H. P. Possingham, and R. A. Fuller, "Tracking the rapid loss of tidal wetlands in the Yellow Sea," *Frontiers in Ecology and the Environment*, vol. 12, no. 5, pp. 267–272, 2014.

[5] M. M. Patwary, S. Ashraf, and F. K. Shuvo, "Land Use Changes and their Effects on urban Ecosystem services value: a study of Khulna City, Bangladesh," in *Proceedings of the 2020 IEEE India Geoscience and Remote Sensing Symposium (InGARSS)*, pp. 62–65, Waikoloa, HI, USA, September 2020.

[6] B. Böhme, M. Becker, B. Diekkrüger, and G. Förch, "How is water availability related to the land use and morphology of an inland valley wetland in Kenya?" *Physics and Chemistry of the Earth, Parts A/B/C*, vol. 93, pp. 84–95, 2016.

[7] D. Zhang, Q. Huang, C. He, and J. Wu, "Impacts of urban expansion on ecosystem services in the Beijing-Tianjin-Hebei urban agglomeration, China: a scenario analysis based on the Shared Socioeconomic Pathways," *Resources, Conservation and Recycling*, vol. 125, pp. 115–130, 2017.

[8] K. L. Coetzer-Hanack, E. T. F. Witkowski, and B. F. N. Erasmus, "Thresholds of change in a multi-use conservation landscape of South Africa: historical land-cover, future transformation and consequences for environmental decision-making," *Environmental Conservation*, vol. 43, no. 3, pp. 253–262, 2016.

[9] Z. J. Liang, W. C. He, and H. T. Cao, "Research on computing resource scale estimating method for intensive meteorological resource pool," *Journal of China Academy of Electronics and Information Technology*, vol. 11, no. 4, pp. 429–436, 2016.

[10] X.-K. Chen, X.-B. Liu, B.-G. Li et al., "Study on water balance and variations in water level of Daihai Lake," in *Proceedings of the 2021 7th International Conference on Hydraulic and Civil Engineering & Smart Water Conservancy and Intelligent Disaster Reduction Forum (ICHCE & SWIDR)*, pp. 1493–1498, Nanjing, China, November 2021.

[11] G. Cui, X. Chen, L. Xiang, Q. Zhang, and Q. Xu, "Evaluation of water environment improvement by interconnected river network in plain area," *Shuili Xuebao/Journal of Hydraulic Engineering*, vol. 48, pp. 1429–1437, 2017.

[12] Q. Deng, Y. Li, X. Hua, D. Dong, and D. Liang, "Effect of tubificid bioturbation on migration of Cu and Cd from Overlying water to sediment," *Journal of Jilin University(Science Edition)*, pp. 1186–1192, 2016, http://xuebao.jlu.edu.cn/lxb/EN.

[13] E. L. Ferguson, R. Ramakrishnan, S. B. Williams, and C. T. Jin, "Deep learning approach to passive monitoring of the underwater acoustic environment," *Journal of the Acoustical Society of America*, vol. 140, no. 4, p. 3351, 2016.

[14] H. Q. Fang, H. F. Xue, and W. Yi, "Simulation study on predicting of water intake quantity of national control points," *Computer Simulation*, vol. 33, no. 10, pp. 437–440, 2016.

[15] X. Feng, "Application analysis of BIM technology in visual simulation of water conservancy and hydropower projects," *Automation & Instrumentation*, vol. 3, pp. 214-215, 2016.

[16] H. Wang, X. Huang, B. Li, and J. Gao, "Facile preparation of super-hydrophobic nanofibrous membrane for oil/water separation in a harsh environment," *Journal of Materials Science*, vol. 53, no. 14, pp. 10111–10121, 2018.

[17] H. M. Kiruki, E. H. Zanden, Ž. Malek, and P. H. Verburg, "Land cover change and woodland degradation in a charcoal producing semi-arid area in Kenya," *Land Degradation & Development*, vol. 28, no. 2, pp. 472–481, 2017.

[18] J. J. Stoorvogel, M. Bakkenes, B. J. E. Brink, and A. J. A. M. Temme, "To what extent did we change our soils? A global comparison of natural and current conditions," *Land Degradation & Development*, vol. 28, no. 7, pp. 1982–1991, 2017.

[19] L. Jiang, S. R. Sakhare, and M. Kaur, "Impact of industrial 4.0 on environment along with correlation between economic growth and carbon emissions," *International Journal of System Assurance Engineering and Management*, vol. 13, no. S1, pp. 415–423, 2021.

[20] A. O. Arowolo, X. Deng, O. A. Olatunji, and A. E. Obayelu, "Assessing changes in the value of ecosystem services in response to land-use/land-cover dynamics in Nigeria," *The Science of the Total Environment*, vol. 636, pp. 597–609, 2018.

[21] C. Li, P. Gong, J. Wang et al., "An all-season sample database for improving land-cover mapping of africa with two classification schemes," *International Journal of Remote Sensing*, vol. 37, no. 19, pp. 4623–4647, 2016.

[22] B. Mareschal, M. Kaur, V. Kharat, and S. Sakhare, "Convergence of Smart Technologies for Digital transformation," *Tehnički glasnik*, vol. 15, no. 1, pp. II–IV, 2021.

[23] P. Fu and Q. Weng, "A time series analysis of urbanization induced land use and land cover change and its impact on land surface temperature with Landsat imagery," *Remote Sensing of Environment*, vol. 175, pp. 205–214, 2016.

[24] I. Taal, M. Rohtla, L. Saks et al., "Evidence of Atlantic salmon Salmo salar fry movement between fresh water and a brackish environment," *Journal of Fish Biology*, vol. 91, no. 2, pp. 695–703, 2017.

[25] W. Zhang and M. Kaur, "A Novel QACS Automatic Extraction algorithm for Extracting information in Blockchain-based systems," *IETE Journal of Research*, pp. 1–13, 2022.

[26] W. Sheng, S. Chen, M. Sheng, G. Xiao, J. Mao, and Y. Zheng, "Adaptive multi-Subpopulation Competition and multi-Niche Crowding based Memetic algorithm for Automatic data Clustering," *IEEE Transactions on Evolutionary Computation*, vol. 20, no. 6, p. 1, 2016.