

Contemporary condition and conservation of wetland resource in Pingshan, Hebei Province

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Abstract. The current work envisages the use of Remote sensing, Geography information systems and Global positioning systems. literature analysis of precipitation, field investigation and laboratory analysis to perform a comprehensive investigation on the present situation of wetland resources of Pingshan Wetland in Hebei Province. The results showed that there were 5 types of wetlands, including the riverine wetland, flood plain, reservoir and pond, water-conveyance canal, and paddy field, with a total area of 162.61 km². There were 311 species of wetland higher plants in Pingshan County, including 10 species of bryophytes, 296 angiosperm species, 5 species of ferns, and 81 phytoplankton species. There were 186 wetland birds, 35 species of fish, 5 species of amphibians, 14 species of reptiles, and 19 species of mammals in Pingshan County. In view of the present situation and the threat of wetland in Pingshan County, certain suggestions have been proposed to strengthen the protection and utilization of the wetland.

1. Introduction

Wetlands are the most unique ecosystems with the highest biodiversity and ecological function resulting from the interaction of the earth's surface water and land [1-3]. They not only provide a variety of resources for the survival of mankind, but also play an important role in the conservation of biodiversity, regulation of the regional climate, water conservation, reserve for migrating birds, and maintaining the food chain and the carbon cycle. Wetlands, forests and oceans are known to be the world's three big ecosystems, and also known as the "kidney of the earth" [1, 4-11]. For a long time, due to the lack of understanding of the importance of wetlands, wetlands have suffered from invasion and damage, resulting in the shrinkage of the wetland area, the decrease of biodiversity, and the decline of wetland function and benefit [12-15]. The problem of ecological environment is becoming more and more prominent. The protection of wetland ecosystem, rational utilization and recovery of



resources are currently hot topics in the world [2]. Since China joined the “Convention on Wetlands of International Importance Especially as Waterfowl Habitat” in 1992, two large-scale wetland surveys were conducted successively. However, due to the limitation of the administrative regions, it is still not possible to provide a comprehensive scientific basis for the protection, utilization and management of wetlands. In order to solve this problem, it is necessary to conduct a scientific investigation, especially on some important area of wetlands [16]. In this case, using the county as a unit for wetland resource protection, the efficiency of protection can be improved.

Wetland is an important part of Pingshan County regional, and this research was carried out in Pingshan County. Pingshan County is located in the west of the Hebei Province (113°31'~114°51', 38°09'~38°45'), the eastern foot of Taihang Mountain, and at the upper reaches of the Hutuo River [17], with a total land area of 2415.58 km². The total wetland area of Pingshan County is 162.61 km², accounting for 6.73% of the total land area. The wetland includes river wetland and artificial wetland, which can be divided into five types such as riverine wetland, flood plain, reservoir and pond, water-conveyance canal, and paddy field, accounting for about 14.7% of the country's 34 wetland types.

2. Scope, content and method of wetland resources investigation

2.1. The scope investigation

2.1.1. Riverine wetland. The boundary is defined according to the area submerged in the highest annual maximum water level during the investigation period, and fine-tuning according to the second national land survey results.

2.1.2. Flood plain. This includes the flooded river banks, river valleys, and seasonal overflow of grasslands during the flood season.

2.1.3. Artificial wetland. The area is not less than 5 hm² reservoir and pond, water-conveyance canal, paddy field.

2.1.4. Reservoir and pond. These water catchment areas include reservoirs, agricultural ponds, urban park landscape etc., caused by water storage, power generation, agricultural irrigation, urban landscape and rural life.

2.1.5. Water-conveyance canal. These include the artificial river wetlands built for water transmission for irrigation purpose.

2.1.6. Paddy field. This includes a paddy field or winter water storage or a wet farmland.

2.2. Survey content

With reference to the National Technical Regulations for Wetland Resources Survey (the trial), we choose research contents included the wetland type, area, distribution (administrative region, coordinate range), average altitude, vegetation type, the main plant species, etc. The survey of wild

wetland animals include assessing the type, distribution and living environment of main aquatic and terrestrial vertebrates in wetland, such as aquatic birds, mammals, reptiles, amphibians and fish; wetland management and protection, wetland utilization, and threatened status.

2.3. Survey method

The investigation of wetland resources in Pingshan County was carried out by means of "3s" technology as well as combining the literature analysis of precipitation, field investigation and laboratory analysis. According to the National Technical Regulations for Wetland Resources Survey (the trial) issued by the State Forestry Administration (December 2008), we collected the original data from the 0.5m resolution aerial photography image, contour vector data, 1:50000 land use status map. The other raw data was sorted using ARCGIS10.2 to make a field investigation map, and a hand-held GPS to conduct field and spot visit. Finally, the wetland type, distribution, area, average altitude, main vegetation type, wetland wildlife, and the protection management status were obtained.

3. Results of the survey

3.1. Types and distribution of wetlands

3.1.1. Identification of wetland patches. The wetland in Pingshan County is classified as a wet area because of its close hydrological relationship. According to the difference of wetland type, the wet area of Pingshan County is divided into five wetland patches including the Huangbizhuang reservoir wetland patch, Gangnan reservoir wetland patch, Yehe wetland patch, Hutuo upstream wetland patch and other wetland patches (Figure 1).

3.1.2. Type, area and distribution of wetland. Pingshan Wetland is located in the upper and middle reaches of the Hutuo River, and belongs to an inland wetland and the transitional zone from Shanxi platform to North China Plain [18]. It consisted of 2 wetland kinds and 5 wetland types, with a total area of 162.61 km² at an altitude of about 115~710 m. The area of various types of wetlands and their proportion are shown in Table 1.

The permanent rivers of Pingshan County include the Hutuohe River mainstream and its 12 branches, which are fan-shaped, with a total area of 43.96 km². The flood plain that includes the flood waters and seasonal grasslands in flood season, are mainly distributed along the banks of permanent rivers with a total area of 19.78 km². The storage area of the reservoir and pond distribute in the whole Pingshan County, the area of which is less than 5 km². The total reservoir and pond area was 94.74 km². The water area of the two large reservoirs is 72.10 km², and the water surface area of the small and medium-sized reservoirs is about 22.64 km². The water-conveyance canal is distributed in the low mountains and hills and plain areas of Pingshan County with a total area of 1.33 km², of which the paddy fields consisted of a total area of 2.80 km².

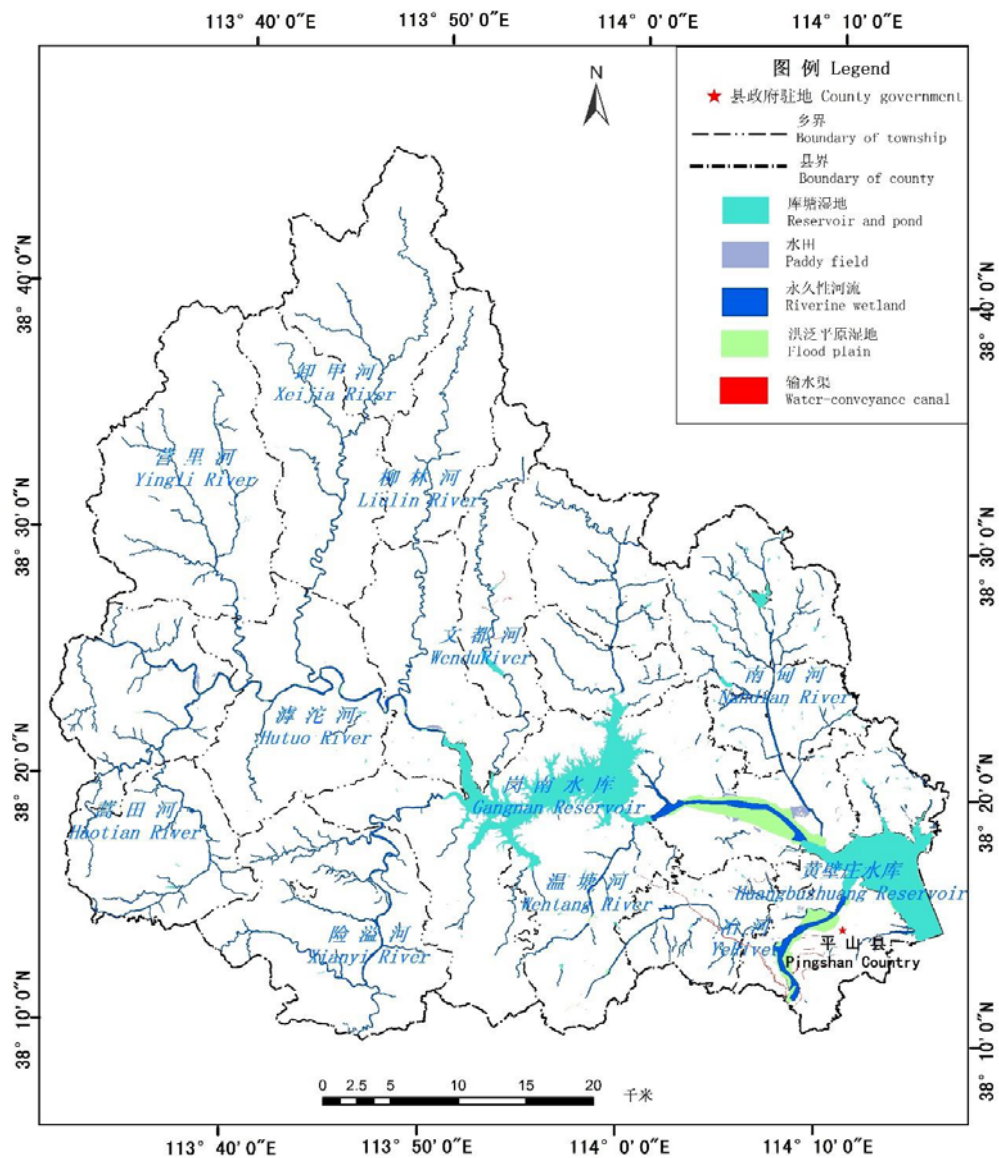


Figure 1. Spatial distribution map of wetlands in Pingshan County.

Table 1. Statistics of types of wetlands in Pingshan County.

Wetland types	Area/km ²	The proportion of the total area /%
Riverine wetland	43.96	27.04%
Flood plain	19.78	12.16%
Reservoir and pond	94.74	58.26%
Water-conveyance canal	1.33	0.82%
Paddy field	2.80	1.72%

3.2. Plant resources in wetland

3.2.1. Composition of plant in wetland. Pingshan County has a diverse variety of wetlands. There are 311 species of wetland higher plants, accounting for 10.13% of the 3071 species in Hebei province. These include 10 species of bryophytes accounting for 3.2%, 5 species of fern (1.6%), and 296 species of angiosperms (95.2%). Among the angiosperms, there are 42 species of gramineous plant, accounting for 14.2%. Of them, 40 species of composite (13.5%), 22 species of cyperaceae (7.4%). There are 20 kinds of legumes, accounting for 6.8%; there were 20 species of polygonaceae, accounting for 6.8%. No gymnosperms are found in this investigation. Among them, *Glycine soja* is the national secondary protection plant. The survey area is dominated by the herbaceous plants, and the dominant species included the *Echinochloa crusgalli*, *Setaria viridis*, *Polygonum maackianum*, *Typha orientalis*, *Phragmites australis*, *Carex spp.*, *Cyperus rotundus*, *Potentilla chinensis*, *Artemisia annua*, *Salsola collina*, *Glycine soja*, as well as a variety of algae, etc.

3.2.2. Types of plant communities. According to the sample lines and the sample sites, there are 19 species of the main plant populations in Pingshan County wetland, as shown in Table 2.

Table 2. Major types of plant communities

Order Number	Community Name	The Main Plants
1	<i>Echinochloa crusgalli</i> community	<i>Echinochloa crusgalli</i> , <i>Cyperus rotundus</i> , <i>lisma plantago-aquatica</i> , <i>Sagittaria trifolia</i> L. var. <i>Sinensis</i>
2	<i>Echinochloa crusgalli</i> ~ <i>Rumex acetosa</i> community	<i>Rumex acetosa</i> , <i>Echinochloa crusgalli</i> , <i>Polygonum aviculare</i> , <i>Potentilla chinensis</i>
3	<i>Echinochloa crusgalli</i> ~ <i>Cyperus rotundus</i> community	<i>Echinochloa crusgalli</i> , <i>Cyperus rotundus</i> , <i>Typha orientalis</i> , <i>Salix babylonica</i> , <i>lisma plantago-aquatica</i> , <i>Rumex acetosa</i> , <i>Potentilla chinensis</i>
4	<i>Cnidium monnieri</i> community	<i>Cnidium monnieri</i> , <i>Potentilla chinensis</i> , <i>Artemisia argyri</i> , <i>Conyza canadensis</i> , <i>Echinochloa crusgalli</i>
5	<i>Ixeridium sonchifolium</i> ~ <i>Humulus scandens</i> community	<i>Ixeridium sonchifolium</i> , <i>Humulus scandens</i> , <i>Salsola collina</i> , <i>Lagopsis supina</i> , <i>Salix babylonica</i> , <i>Ulmus pumila</i> , <i>Dendranthema indicum</i>
6	<i>Equisetum arvense</i> community	<i>Equisetum arvense</i> , <i>Setaria viridis</i> , <i>Artemisia annua</i> , <i>Tribulus terrester</i> , <i>Chenopodium glaucum</i> , <i>Humulus scandens</i> , <i>Lespedeza bicolor</i>
7	<i>Vicia sepium</i> ~ <i>Artemisia</i>	<i>Vicia sepium</i> , <i>Glycine soja</i> , <i>Artemisia argyri</i> , <i>Potentilla supina</i> , <i>Chenopodium glaucum</i> , <i>Xanthium sibiricum</i> ,

	<i>argyri</i> community	<i>Humulus scandens</i> , <i>Plantago asiatica</i>
8	<i>Artemisia argyri</i> community	<i>Artemisia argyri</i> , <i>Bidens pilosa</i> , <i>Medicago sativa</i>
9	<i>Zoysia japonica</i> community	<i>Zoysia japonica</i> , <i>Carex</i> spp., <i>Polygonum aviculare</i> , <i>Amaranthus lividus</i> , <i>Atriplex patens</i> , <i>Cyperus nipponicus</i> , <i>Portulaca oleracea</i> , <i>Rorippa indica</i> , <i>Eleusine indica</i>
10	<i>Abutilon theophrasti</i> community	<i>Abutilon theophrasti</i> , <i>Zoysia japonica</i> , <i>Amaranthus tricolor</i> , <i>Tribulus terrester</i> , <i>Chenopodium glaucum</i>
11	<i>Scirpus triqueter</i> community	<i>Scirpus triqueter</i> , <i>Bidens pilosa</i> , <i>Potentilla supina</i> , <i>Polygonum hydropiper</i>
12	<i>Chloris virgata</i> community	<i>Chloris virgata</i> , <i>Cyperus rotundus</i> , <i>Carex rigescens</i> , <i>lisma plantago-aquatica</i> , <i>Rumex acetosa</i> , <i>Rorippa indica</i>
13	<i>Heleocharis dulcis</i> ~ <i>Polygonum aviculare</i> community	<i>Heleocharis dulcis</i> , <i>Polygonum aviculare</i> , <i>Scirpus triqueter</i> , <i>Plantago asiatica</i> , <i>Bidens pilosa</i> , <i>Sparganium stoloniferum</i> , <i>Salvinia natans</i> , <i>Artemisia annua</i> , <i>Phragmites australis</i>
14	<i>Halerpestes ruthenica</i> community	<i>Halerpestes ruthenica</i> , <i>Arthraxon hispidus</i> , <i>Echinochloa crusgalli</i> , <i>Setaria viridis</i> , <i>Bidens pilosa</i>
15	<i>Calamagrostis pseudophragmites</i> community	<i>Calamagrostis pseudophragmites</i> , <i>Miscanthus floridulus</i> , <i>Phragmites australis</i> , <i>Dendranthema indicum</i> , <i>Leonurus artemisia</i> , <i>Humulus scandens</i> , <i>Artemisia lavandulaefolia</i>
16	<i>Phragmites australis</i> community	<i>Phragmites australis</i> , <i>Humulus scandens</i> , <i>Artemisia scoparia</i> , <i>Dendranthema indicum</i> , <i>Artemisia mongolica</i> , <i>Chenopodium glaucum</i>
17	<i>Typha orientalis</i> community	<i>Typha orientalis</i> , <i>Humulus scandens</i> , <i>Scirpus triqueter</i> , <i>Bidens pilosa</i> , <i>Commelina communis</i> , <i>Draba nemorosa</i> , <i>lisma plantago-aquatica</i> , <i>Glycine soja</i> , <i>Polygonum orientale</i> , <i>Phragmites australis</i>
18	<i>Sagittaria trifolia</i> L. var. <i>Sinensis</i> ~ <i>Potamogeton distinctus</i> community	<i>Sagittaria trifolia</i> L. var. <i>Sinensis</i> , <i>Potamogeton distinctus</i> , <i>lisma plantago-aquatica</i> , <i>Typha orientalis</i> , <i>Polygonum hydropiper</i> , <i>Scirpus triqueter</i> , <i>Cyperus rotundus</i> , <i>Myriophyllum verticillatum</i>
19	<i>Eleusine indica</i> ~ <i>Typha orientalis</i> community	<i>Eleusine indica</i> , <i>Typha orientalis</i> , <i>Plantago asiatica</i> , <i>Oenanthe javanica</i> , <i>Scirpus triqueter</i> , <i>Artemisia argyri</i>

3.3. Wetland resources of phytoplankton

According to a case study of the investigation on the aquatic biological resources of the national aquatic germplasm resources reservation at the Gangnan reservoir and referring to the results of the survey conducted in the case of Gangnan reservoir, we find 81 types of phytoplankton. Among them, there were 46 species of *Chlorophyta*, 14 species of *Bacillariophyta*, 5 species of *Cyanophyta*, 5 species of *Xanthophyta*, 5 species of *Cryptophyta*, 3 species of *Euglenophyta*, 2 kinds of *Pyrrophyta*, and 1 species of *Chrysophyta*.

The results of this survey are quite different from those of Liang Chunguang *et al.* (2014) [19]. Our survey has found an increased number of species of *Xanthophyta* by 39, including 24 species of *Chlorophyta*, 6 species of *Diatoms*, 5 species of *Bacillariophyta*, 4 species of *Cryptophyta*, and 1 of *Euglenophyta*, *Pyrrophyta*, and *Chrysophyta*, respectively.

3.4. Wetland wildlife resources

3.4.1. Species of wetland birds. According to the results of the field investigation combined with the research on the scientific investigation and biodiversity of the Hebei Tuoliang reserve and China Vertebrate Bibliography [20-21], we have found 186 species of birds in Pingshan wetland belonging to 17 orders, 52 families, and 105 genus. The species of wetland birds in Pingshan wetland accounted for 13.96% of the 1332 species of known birds in China, accounting for 39.74% of the 468 species of the known birds in Hebei Province.

Among the wetland birds in Pingshan County, there are 74 species of 23 families, 42 genus, and 44.23%, 40% and 39.78% of the total families, genus, and species respectively of the passeriformes. There are 112 species of non passeriformes, 63 genus, which accounted respectively for 55.77%, 60.00% and 60.22% of a total family number, genus number and species number. In level of the family, genus, species, the non passeriformes birds was more than that of the passeriformes.

Among the 238 species of birds in the wetland and *Ciconia nigra* protection village in Pingshan County, 20 species of national key protected birds accounted for 10.75% of the total number of birds in the region. Among them, three species of national II level protected birds are *Ciconia nigra*, *Grus japonensis* and *Otis tarda*, which accounted for 1.7% of the total number of birds. The 17 species accounted for 9.14% of the total number of birds belongs to the national II level, including *Platalea leucorodia*, *Cygnus Cygnus*, *Cygnus columbianus*, *Anser albifrons*, *Aix galericulata*, *Milvus korschum*, *Accipiter nisus*, *Pandion haliaetus*, *Grus Grus* and *Grus vipio*.

3.4.2. Major fishes. According to the preliminary investigation and statistics, combined with the relevant data records [22], there are 35 species of fishes in Pingshan wetland, belonging to 5 orders, 11 families and 34 genus, and accounted for 41.2% of freshwater fishes in Hebei Province. The *Cyprinidae*, a total of 23 species, accounted for 65.7% of the total area of fish. *Cobitidae*, a total of 3 species, accounted for 8.6% of the total fishes. 5 families and 5 species of *Perciformes*, 2 families and 2 species of *Siluriforms*, and one species each of *Cyprinodontiformes* and *Synbranchiformes*, accounted for 14.3%, 5.7% and 2.9%, respectively, of the total number of fishes in the each investigation area. Among the 32 monotypic species, a total of 20 species belong to *Cyprinidae* accounting for 62.5% of the monotypic genus of fish; 3 *Cobitidae*, accounting for 9.6% of the

monotypic genus of fish, and one species each of *Bagridae*, *Siluridae*, *Oryziatidae*, *Eleotridae*, *Giurinus*, *Anabantidae*, *Channidae*, *Mastacembelidae*, *Synbranchidae*, accounting for 3.1% of fishes of the monotypic genus.

3.4.3. Major amphibians and reptiles. Through the combination of field visits and the wild animal survey data, 5 species of amphibians are found in Pingshan County, which belong to 3 families. There are 14 species of reptiles that belong to 9 genus and 6 families.

Rana chensinensis was the dominant species of amphibians in the wetland area of Pingshan County accounting for 84.7% of the total number found in amphibians. *Bufo raddei* and *Bufo gargarizans* are found often in a humid environment full of luxuriant trees and abundant grasses that accounted for 8.6% and 5.1%, respectively. *Rana nigromaculata* and *Kaloula borealis* are found in the pit ponds and stream waters and accounted for 1.6%.

The amphibian family, genus, and species of wetland in Pingshan County accounted for 60%, 60% and 50% of the Hebei Province respectively, and the reptile family, genus and species accounted for 75%, 69.2% and 58.3%, respectively; thus it can be seen that the amphibians and reptiles in Pingshan wetland are relatively abundant in the whole province (Table 3).

Table 3. Composition and proportion of amphibians and reptiles in Pingshan wetland.

Group of Animals	Pingshan wetland	Hebei Province	The proportion of the total number of Hebei/%	China	The proportion of the total number of China/%
	Family:	Family:		Family:	
	Genus:	Genus:		Genus:	
	Species	Species		Species	
Amphibian	3:3:5	5:5:10	60.0:60.0:50.0	11:51:321	27.3:5.9:1.6
Reptiles	6:9:14	8:13:24	75.0:69.2:58.3	24:125:407	25.0:7.2:3.4

There are 19 species of amphibians and reptiles in the Pingshan wetland. Among them, *Gekko swinhonis*, *Eumeces elegans* and *Eumeces capito* are the endemic in China, while *Pelodiscus sinensis* is included in IUCNS and VU in the red list of Chinese species. *Elaphe anomala*, *Elaphe davidii*, *Elaphe taeniura*, *Gloydus brevicaudus* and *Gloydus intermedius* are also listed as vulnerable VU in the red list of Chinese species. *Rana nigromaculata* is listed in the red list of Chinese species (NT).

3.4.4. Major mammals. According to investigation, there are 19 species of mammals belonging to 6 orders, 13 families, 18 genus in the wetland and surrounding areas of Pingshan County. There are 2 species of 2 families of *Insectivora*, 2 species of 2 families of *Chiroptera*, 1 species of 1 family of *Lagomorpha*, 3 species of 3 families of *Lagomorpha*, 7 species of 4 families of *Carnivora*, 1 species of 1 family of *Artiodactyla*.

Due to Pingshan wetland are located in warm temperate zone, belonging to semi-humid to semi-arid monsoon type continental climate, the geographical environment is complicated. There are many different kinds of vegetation and abundant resources and Pingshan County offering a variety of different types of good animals breeding environment. This is the result of long-term evolution and animals' adaptation to the environment. The species composition of wetland in Pingshan County is

relatively rich. The number of the order and the genus in Pingshan County is at the middle level of all protection areas. However, for animal species, the number and proportion of wetland species are all at a low level.

4. Problems in the utilization and protection of wetlands

4.1. Water pollution in wetlands

The main sources of pollution in Pingshan County are the industrial wastes from mining and the household waste. In addition, agricultural production caused by pesticide and fertilizer runoff, also pollutes the water, in flood season. When flowing into the reservoir of high concentrations of nitrogen, phosphorus and other nutrients [23], a large number of pollutants can't realize self-purification, the wetland system of wetland water quality declines, the biomass decreases, ecological system is damaged.

4.2. Unreasonable development and utilization reduces sustainability of wetlands

The unreasonable exploitation and utilization of wetland is a serious of threats to the sustainable development of wetland. In 2006, the total area of wetlands in Pingshan County was 195.50 km² [24]. In 2016, the total area of wetland in Pingshan County was 162.61 km². The main reason is reclamation that reduced the wetland area and declined the plant community, especially the distribution of reed and shrub forest. The number of animals is reduced and the function of wetlands is degraded. Overgrazing and irrational farming have damaged the vegetation in the wetlands, making the habitat of birds smaller and fewer. Overfishing has led to a huge decline in the number of fish in the reservoir and the rivers, and the variety has reduced.

4.3. Poor planning and low protection efficiency for wetlands

Due to the lack of coordination, utilization and protection of wetland resources, the wetland management departments have no unified scientific planning. In addition, the laws and regulations are not stringent enough to protect a relatively perfect system due to lack of specification and basis of the wetland protection. Although some departments have launched some research and taken measures to protect the wetland, the effect is not significant, and the destruction of the wetland resources and waste are still growing.

5. Countermeasures and suggestions for wetland utilization and protection

5.1. Strengthening the protection of wetland water quality

The mining factories and enterprises should be prohibited to discharge sewage into the wetland, and instead the municipal solid waste and domestic sewage treatment shall be used. By controlling the species and quantity of fish and plants in the wetland, the ecological stability and the ability of purifying water can be controlled. The quality inspection of water bodies should be strengthened.

The sampling points should be reasonably arranged in the water body, and real-time comprehensive data should be obtained to control the dynamic changes of wetland water quality in a timely manner.

5.2. Wetland restoration and ecological restoration mechanisms

According to the actual situation of Pingshan County, we propose the measures to transfer farmland into wetland and fishery. We propose that by prohibiting overfishing, illegal and unreasonable grazing in farming, reclamation activity and increase the penalties, the wetlands can be duly protected. Besides, we can appropriately adjust the compensation, and provide economic benefits to local residents, which will reduce the interference of human activities on the wetland, and the sustainable development and utilization of wetlands can be harnessed.

5.3. Refining wetland reserve planning and wetland science management

We propose to perfect the wetland protection management agencies and administration department that will lead to strengthen the departments' linkage, form resource sharing mechanism, and implement the relevant work. Hierarchical planning for nature reserves in wetland areas should be undertaken, such as rational utilization of areas, conservation areas, restoration and reconstruction areas, etc. Improvement in the construction of wetland laws and regulations, rational exploration of the current situation of wetland resources, and provision for the basis of the protection and management of wetlands can help in managing the wetlands successfully.

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