Study on the space-time distribution and sustainable development of wetland ecotourism resources in Shandong Province

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Abstract. Wetland, ocean, and forest are regarded as the world’s three major systems. Among them, wetland has always been regarded as one of the signs of sustainable development of urban ecological environment. Therefore, its ecological problems, rational development and protection have become the focus of the sustainable development of wetlands and even cities. This study took wetlands in 17 cities in Shandong Province as the research object, then collected relevant data on the area of various types of wetlands in Shandong Province in 2008 and 2013 and analyzed the changing trend of wetland area in Shandong Province in recent 5 years by using methods including multivariate statistics and GIS space analysis, and raised some ecological problems at the same time. The results showed that: 1) In terms of time, the wetland area in Shandong Province has been reducing in the past five years. Compared with 2008, the wetland area in Shandong Province decreased by 24.57% in 2013; 2) In terms of space, the wetland area in coastal areas was seriously degraded, with a reduction rate of more than 50%; 3) In terms of wetland types, natural wetlands such as lakes and rivers were decreasing year by year. They have respectively reduced by 1.02×105 hectares and 4.21×105 hectares while the artificial wetland has increased by 5.33×105 hectares, which means some natural wetlands have been converted into artificial wetlands. The most obvious was the construction of wetland parks; 4) There were a series of ecological problems in the wetlands in Shandong Province, such as blind reclamation and deterioration of the quality of water resources.

1. Introduction
Shandong Province is located in the lower reaches of the Yellow River and is an important province on the east coast of China. Wetland resources are rich, and the types of wetlands are diverse. Besides, the area of wetlands accounts for about 11.09% of the total area of the province. However, with the expansion of the scope and intensity of human activities, there has been obvious improper development of wetland tourism resources in Shandong Province. The extent of wetland reclamation, transformation and destruction in Shandong Province is quite serious. [1]. Studying the development status of wetland tourism in Shandong Province can promote the healthy and orderly development of wetland in Shandong Province eventually.
Foreign experts have made abundant research achievements in wetland tourism, which are mainly reflected in the various aspects including protection, development and utilization of wetland resources and influencing factors of wetland tourism. In 1987, Bacon discussed the special value of wetlands as tourism resources in the study of the value of Caribbean wetland tourism. In 1999, Compbell [2] and others combined the sustainable development concept, landscape ecology and wetland ecosystem research. Based on the research on wetland ecotourism in Britain and France, Platte concluded that the development of wetland ecotourism requires scientific wetland information management and completed rules and regulations.

Regarding the protection and development of wetlands, the theoretical results of domestic scholars have become more and more abundant in recent years. The main research topics are development model research and development strategy, wetland ecological security research, ecological protection research, and so on. For instance, Yuzheng Sui and others [3] combined the development status of coastal wetland ecotourism in Shandong Province and proposed a suitable development model and development strategy for coastal wetland ecotourism in Shandong Province. Youai Wang [4] put forward the tourism development model of lagoon wetland through classification and evaluation of lagoon wetland resources in Shandong Province. Xinlei Meng [5] studied the development status of the Caofeidian Wetland Ecotourism from several aspects of the plant resources, animal resources and socioeconomic conditions of the Caofeidian Wetland. At present, there is no systematic research on the development status and ecological problems of wetland resources in Shandong Province by using GIS.

Consequently, this study successively analyzed and discussed the wetland ecotourism resources in Shandong Province. Then problems in the development of wetland ecotourism resources in Shandong Province were concluded while relevant suggestions were also put forward accordingly in this study. The purpose of this study is to enhance people's awareness of wetland ecological protection, to develop wetland ecotourism resources in Shandong Province scientifically and reasonably, to promote the sustainable development of wetland ecotourism in Shandong Province finally.

2. Materials and methods

2.1. The overview of the study area

Shandong Province is located on the eastern coast and possesses the estuary of Yellow River. It belongs to warm temperate zone monsoon climate which leads to a mild climate. The annual average temperature of the province is 11-14.5℃ while the lowest average temperature is below 0℃, and the highest average temperature is 24-28℃. Greatly affected by the ocean, precipitation is relatively abundant, especially in the eastern coastal areas. Since 2017, the average annual precipitation has been 427.4 mm accordingly.

2.2. Sources of research data

(1) China National Bureau of Statistics wap.stats.gov.cn - China Statistical Yearbook
(2) Official website of Forestry Bureau of 17 cities in Shandong Province
(3) Official website of wetland China www.shidi.org

2.3. Research methods

(1) Field investigation method: It conducted field surveys on wetlands in 17 cities in Shandong Province and collected various types of wetland area related data.
(2) GIS spatial analysis method: With the help of corresponding working software such as ArcGIS10.0 and Excel, data analysis was carried out. In addition, GIS technology was introduced to describe the degree of changes and display the characteristics of spatial distribution changes.
(3) Inductive summary method: Combining literature review and field survey data, it analyzed and summarized the ecological problems in the development of wetland ecotourism resources in Shandong Province, and put forward relevant suggestions.
3. Results and analysis

3.1. The overall characteristics of space-time changes of wetland ecotourism resources in Shandong Province

Wetland changes mainly have two processes: time change and space change, from 2008 to 2013, the wetland area in Shandong Province has decreased from $2.30 \times 10^6 \text{hm}^2$ to $1.74 \times 10^6 \text{hm}^2$ in recent 5 years. As a result, the reduction rate is 24.57%, that is, the annual decline rate of wetlands in Shandong Province is 4.91%.

In order to explore and discuss the changes in wetland area in Shandong Province more intuitively, we introduced GIS technology, which not only described the degree of change in the wetland area in Shandong Province, but also highlighted the spatial change characteristics of wetland areas in various cities in Shandong Province.

Through the analysis of Figure 1 and Figure 2, it is founded that the wetland area in the coastal areas of Shandong Province is significantly larger than the wetland area in the inland areas. The area of coastal wetlands decreased sharply from 2008 to 2013, and the area of wetlands in the northeast reduced most obviously, such as Yantai, Weihai, and Dongying whose reduction rates were 83%, 77%, and 56% respectively. The eastern regions, such as Qingdao and Rizhao, had a reduction rate of 55%. Besides, the wetland areas in the central, northwest and southern regions had fewer changes; however the total amount was still lower than that of the coastal regions.

![Figure 1. Wetland area in 2008](image1)

![Figure 2. Wetland area in 2013](image2)

3.2. Space-time distribution characteristics of various wetland types in Shandong Province

3.2.1. Spatial distribution characteristics of various wetland types in Shandong Province. The types of wetlands in Shandong Province can be divided into artificial wetlands and natural wetlands. In addition, Natural wetlands include offshore and coastal wetlands, rivers, lakes and swamps. This study collected the area of each wetland type in 17 cities in Shandong Province from 2008 to 2013, and used GIS technology to show the characteristics of its spatial distribution change during five years. As presented in Figure 3 and Figure 4, after carefully analyzing the following two figures, it can be concluded that: Firstly, the distribution characteristics of various types of wetlands: (1) Offshore and coastal wetlands are mainly distributed in the east, northeast and northwest regions. The east coast and the northeast are close to the Bohai Sea and the Yellow Sea, as consequence the coastal wetlands are relatively large. For example, Dongying possesses the estuary of Yellow River, so the coastal wetlands are correspondingly large. (2) The rivers are mainly distributed in the west, middle and southwest of Shandong Province. For instance, the river area including "Jiangbei Water City" Liaocheng and Beijing-Hangzhou Grand Canal which passes through Dezhou and Heze is relatively large. (3) The lakes are mainly distributed in the central part of Shandong Province, such as Tai'an, Jining, Laiwu and Jinan. Dongping Lake in Tai'an, Daming Lake in Jinan, and various of lakes are all included. (4) A
small amount of artificial wetland are distributed in various cities. Secondly, the characteristics of the spatial changes in the area of various types of wetlands: a. The area of natural wetlands in various cities has decreased at different degrees. Meanwhile, the amount of artificial wetland is increasing, especially in the central and western regions. At the same time, it can be speculated that some natural wetlands such as rivers have been transformed into artificial wetland. b. Lakes in parts of the central region even disappeared.

3.2.2. Temporal distribution characteristics of various wetland types in Shandong Province.
Comparing the wetland in 2008 with the wetland in 2013, as presented in Table 1, the analysis indicates that the area of and coastal wetlands, rivers, and lakes in Shandong Province decreased in 2013, with a reduction rate of 46%, 62% and 62% respectively. On the contrary, the area of marsh and artificial wetland has increased, which have increases by $5.02\times10^{3}$hm$^2$ and $5.33\times10^{5}$hm$^2$ respectively. This shows that the main feature of the change in wetland area in Shandong Province is that natural wetlands are reducing, with a decrease of 50%. Meanwhile, the artificial wetlands are expanding, and the decrease in natural wetlands is much larger than the increase in artificial wetlands.

3.3. The spatial distribution characteristics of wetland ecotourism resources development in Shandong Province.
In recent years, Shandong Province has set up more than 200 wetland parks, 65 of which are national wetland parks whose amount rank first in the country. Besides, There are 126 provincial wetland parks and 23 nature reserves as well, the protection rate of natural wetlands increase by 23%.
In this study, the level and number of wetland parks that have been developed into 17 cities in Shandong Province were made statistics respectively, and they were visually displayed through the use of ArcGIS. As presented in Figure 5 and Figure 6, (1) The number of national and provincial wetland parks in Linyi ranks first in the province, whch can account for 5.61% of the province's wetland parks. Secondly, Dezhou and Weifang have more national wetland parks that account for 2.34% and 2.8% respectively. (2) The number of national wetland parks established in the east and northwest is much smaller than that in the west and southwest. (3) There are on average more than 3 provincial wetland parks in the eastern, northeastern and southwestern cities. (4) The number of wetland parks in the central and western regions is relatively small, with an average of about 2 in each city.
Among the basic conditions for establishing a national wetland park, in addition to the area should be more than 20hm2, the wetland ecosystem should also be representative. For example, the Wenhe National Wetland Park in Tai'an, currently has complete supporting facilities with an area of 1200.1hm2 and has become a demonstration base for water science education, which has played a positive role in popularizing the concept of healthy life and improving people's awareness of conservation and love to water. In the past two years, Shandong Province has continuously added new
pilot projects for national wetland parks. However, there is still a long way to go to protect the ecological environment of wetland parks.

4. Discussions and conclusions

4.1. Discussions

Blind reclamation and transformation of wetlands: Some wetlands in coastal cities in Shandong Province have dropped sharply from more than 10,000 hectares to 1,780 hectares. The reclamation of fish ponds and paddy fields, and the life and production of nearby villages have had a significant impact on the wetlands.

Increased wetland pollution: The wetland pollution in Shandong Province has been increasing, mainly due to the leakage and oil spill accidents caused by industrial wastewater and oil and gas development, as well as the pollution caused by the disposal of domestic wastewater and garbage, and the use of pesticides, fertilizers and other chemicals.

Irrational use of water resources: Natural wetlands are facing threats due to the irrational use of water resources. The irrational use of water resources is mainly manifested in excessive industrial and agricultural water, domestic water, construction of large-scale water conservancy projects in the upper reaches of the wetland, interception of water sources, and unreasonable development of aquaculture.

The imperfect management system of wetland protection: Wetland protection and management involve many departments. Production activities such as tourism, fisheries, papermaking, and aquaculture consume wetland resources thus to increase the burden on wetlands, and present problems that are difficult to coordinate and solve, which seriously affects the protection and sustainable use of wetlands.

4.2. Suggestions

(1) Strengthen the construction and management of wetland nature reserves and wetland parks. For many years, the forestry departments at all levels have actively promoted the construction of wetland reserves and parks, and energetically established a number of wetland nature reserves and wetland parks[6]. At the same time, management facilities were improved positively to effectively protect the diversity of wetlands.

(2) Attach importance to wetland investigation, monitoring, protection, restoration, and a series of process. It is necessary to establish a system of regular wetland surveys and dynamic monitoring, grasp the dynamics of wetland resources and the environment, and provide a scientific basis for wetland protection, rational utilization and management.

(3) It is also necessary to raise the awareness of wetland protection among cadres and masses. It is recommended to actively carry out wetland publicity and education activities during the "World
Wetland Day" and "Bird Love Week" every year, and use the media such as TV and newspapers to expand the audience. At the same time, it is indispensable to strengthen the training of wetland protection as well.

4.3. Conclusions
This study analyzed the space-time distribution characteristics of wetland ecotourism resources in Shandong Province, the number and level of wetland park development, and the conclusions are as follows:
(1) On the whole, Shandong Province's natural wetland resources continue to be lost. wetland functions continue to decline, and pollution is increasing considerably. The problems of wetland protection and management are still very formidable.
(2) In terms of time, the area of wetland in Shandong Province has been reducing in the past five years. Compared with 2008, the area of wetland in Shandong Province decreased by 24.57 % in 2013.
(3) In terms of space, the area of wetland in coastal areas is seriously degraded, with a reduction rate of more than 50%.
(4) In terms of wetland types, natural wetlands such as lakes and rivers are reducing year by year, with decreases by 1.02×105 hectares and 4.22×105 hectares respectively. The artificial wetland has increased by 5.33×105 hectares, and some natural wetlands have been converted into artificial wetlands. The most obvious is the construction of wetland parks.
(5) There are some ecological problems such as blind reclamation and water quality decline in wetland in Shandong province whose causes are man-made and natural. The most major causes are man-made.

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