Spatial and Temporal Patterns of Wetlands in Hebei Province

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Abstract. Wetland is an important part of the ecosystem and an important research subject in global environmental change and sustainable development. This study parents a wetland analysis of Hebei Province in China for the period from 2009 to 2017, on the basis data statistics and GIS technology. The results show that, wetland area decreased from $27.0 \times 10^4$ hm$^2$ to $24.0 \times 10^4$ hm$^2$, decreased of 3853.42 hm$^2$ with an average annual, decreased rate 0.7%-2.4%. The structure of costal shoal、inland shoal and marshland remained at 0.36:0.60:0.04 level. The transition between wetland and other types of land were calculated by Matrix Model of Land Transfer. The results show that the wetland area mainly from cultivated land, water-water conservancy facilities land and woodland, mainly converted to urban industrial land and transportation land. The characteristics of spatial and temporal pattern change is significant. where wetlands have declined dramatically are concentrated in four areas. They are District of Bashang Plateau-Yanshan Mountain northern, District of Qin-Tang-Cang coastal city, Central plain of the province, Southwest of the province respectively.

1. Introduction
Wetland is the lung of the earth and an important part of the ecosystem. Classification is an important method of scientific research, so wetland classification is the basis of wetland conservation management and scientific utilization. Convention on the Protection of Wetlands (In 1971) formulated by representatives from 18 countries, 3 primary types and 35 secondary types were divided [1]. Scholars put forward wetland classification, on the basis of the cause-effect-descriptive classification, hydro geomorphological classification [2], systematic classification [3], RAMSAR [4] method and so on. The results show that integrity data is the key guarantee for wetland classification [5]. In quantitative research, the quantitative changes of wetlands in Sri Lanka, the Atlantic coast and Kansas were calculated, by using satellite remote sensing data [6-8]. Wetland ecological function was estimated through the use of Landscape Model [9] and HGM Evaluation Method [10]. Wetlands divided into 5 categories and 28 types, in national wetland standards of China. The characteristics of wetland change in typical areas, such as Yancheng coastal wetland, Zhalong wetland, River Wetland in the lower reaches of Weihe River and wetland in the Pearl River Source Nature Reserve, were studied and analyzed [11-13]. The county governments play an important role in wetland utilization management and protection, which is the main body of policy implementation. Hebei Province is east to the Baohai Sea, and embraces Beijing city and Tianjin city. It is Component of Beijing-Tianjin-Hebei Cooperative Development national strategy, that is also ecological function area.

This paper first analyzed the quantity and structure change characteristics of wetland, quantitatively calculated the law of mutual transformation between Wetlands and other land types. Secondly, presented
spatial and temporal pattern change of the main wetland types, from 2009 to 2017 of Hebei Province by using data statistics and GIS technology.

2. Study area and methods

2.1. Study area
Hebei Province is east to the Baohai Sea, and embraces Beijing city and Tianjin city. There are 121 cities in Hebei, including Shijiazhuang, Handan, Tangshan and so on. She is the only province who has highland, mountain land, plain, lakes and shores. Taihang Mountain in the west, Yanshan Mountain in the north, and Zhangbei Plateau in the north of Yanshan. In the geomorphological pattern, from northwest to southeast, plateau, mountain and plain are arranged in turn, with obvious zonal distribution characteristics. There are four main river systems in the province: Haihe River System, Luanhe River System, Inland River System and Liaohe River System. With the coordinated development Hebei Province has become more and more important as the ecological environment supporting area for Beijing-Tianjin-Hebei Urban Agglomeration.

2.2. Data sources
In the paper, coastal shoal, inland shoal and marshland were taken as research objects, according to national standard. Research data mainly come from Land-use change investigation, which unified arrangement of the state. There are 110 counties with wetland resources, of which 7 counties have coastal shoal, 10 counties have marshes and 93 counties have inland shoal. Among them, 15 counties have two or more types of wetland. There are 107 counties with wetland area changes from 2009 to 2017. The data analysis method, land transfer matrix and GIS technology were used to analyze structure change and present spatial and temporal pattern change.

3. Research results and analysis

3.1. Area and structure Change
The total wetland area decreased from $27.0 \times 10^4$ hm$^2$ to $24.0 \times 10^4$ hm$^2$. Wetland decreased of 3853 hm$^2$ with an average annual, the coastal shoal decreased 1268 hm$^2$, the inland shoal decreased 2196 hm$^2$, and the marshland decreased 388.48 hm$^2$. Taking 2009 as the base period, the annual wetland change rate from 2010 to 2019 was calculated. The wetland decreased by 0.7%-2.4%, coastal shoal decreased by 0.7%-3.0%, inland shoal decreased by 0.3%-1.8%, marsh marshland by 0.03%-1.8%, except for 25.94% in 2017. From the perspective of wetland internal structure, the proportion of coastal shoal in total wetland increased from 36.20% to 36.62%, the inland shoal increased from 59.86% to 60.23%, and the marshland decreased from 3.94% to 3.15%. Overall, the structure of coastal shoal, inland shoal and marshland remained at 0.36:0.60:0.04 level.

3.2. Land Types Change
The transition between wetland and other types of land are calculated by Matrix Model of Land Transfer. The results show that the wetland area increased by 4950.41 hm$^2$, mainly from cultivated land (accounted for 49.06%), water-water conservancy facilities land (accounted for 26.93%) and woodland (accounted for 10.54%). From 2009 to 2017, the wetland area decreased by $3.6 \times 10^4$ hm$^2$, mainly converted to cultivated land, urban industrial land and transportation land. Wetlands were converted to cultivated land area is $2.0 \times 10^4$ hm$^2$ (accounted for 56.10%), urban industrial land is $1.3 \times 10^4$ hm$^2$ (accounted for 36.2%), and transportation land 1682.03 hm$^2$, (accounted for 4.7%). According to the survey of some areas, coastal shoal is mainly developed for construction land, while inland shoal is mainly developed for cultivated land. The policy of total arable land dynamic balance and degree of difficulty in development are key factors for wetland types change. With the increasing awareness of ecological environment, the land use pattern will change, the decreasing trend of wetland area is
expected to be alleviated.

3.3. Spatial pattern change
With SPSS Software and GIS Technology, presented spatial and temporal pattern change of the main wetland types, from 2009 to 2017. It can be seen that the coastal beach area has been greatly reduced, concentrating on Luannan County and Tanghai County, with a total reduction of 8300 hm$^2$. The main reason is that in 2012, the Caofeidian District was established, and a large-scale reclamation project has been carried out in the region. The swamp area changed slightly, the reduction of swamp land is about 5 hm$^2$ of most areas, only Fengnan County has the largest marsh reduction of 450 hm$^2$. Climate factors such as rainfall is the main reason for the decrease of marshes.

A total of 9 counties have increased wetland area, of which 5 counties have increased wetland area by more than 100 hm$^2$. There are 101 counties in which wetland area has been reduced, 27 counties of which less than 10 hm$^2$; 32 counties ranged from 10 hm$^2$ to 100 hm$^2$; 24 counties from 100 hm$^2$ to 300 hm$^2$; 18 counties have reduced area more than 300 hm$^2$, of which 5 counties have reduced area more than 1000 hm$^2$. Five counties reduced the wetland area by $1.43 \times 10^4$ hm$^2$ accounted for 45.3% of the total reduced area. The results show that areas where wetlands have declined dramatically are concentrated in four areas. ① District of Bashang Plateau-Yanshan Mountain northern (I District), which has abundant precipitation and abundant reserved land resource for cultivated land. Wetland is mainly exploited as a large area of cultivated land. ② District of Qin-Tang-Cang coastal city (II District). There are a large number of coastal wetlands, which are affected by sea reclamation, Demand arising from economic development, resulting in a significant reduction in wetland area. The large reduction of wetland area after the establishment of Caofeidian District is representative. ③ Central plain of the province (III District). Most of this area belongs to plain area, and wetlands are concentrated in the vicinity of water system. In recent years, low rainfall has led to the reduction or even drying up of some rivers, which has led to the rapid reduction of wetland area, especially inland wetland and marsh area. ④ Southwest of the province (IV District), The area is mainly distributed in the southern part of the province, including Wuan City, Linzhang County and other counties. The main reason for the decrease of wetland is the small amount of regional water resources.

4. Conclusion
Ecological civilization is a new stage in the development of human civilization. Wetland is an important part of the ecosystem. The results showed that: (1) The total wetland area decreased from $27.0 \times 10^4$ hm$^2$ to $24.0 \times 10^4$ hm$^2$, with an annual average of 3853 hm$^2$, for the period from 2009 to 2017. Overall, the wetland showed a decreasing trend, with a decrease range of 0.7%-2.4%. The structure of costal shoal, inland shoal and marshland remained at 0.36:0.60:0.04 level. (2) The transition between wetland and other types of land were calculated by Matrix Model of Land Transfer. The results show that the wetland area mainly from cultivated land, water-water conservancy facilities land and woodland, mainly converted to urban industrial land and transportation land. (3) The characteristics of spatial and temporal pattern change is significant, where wetlands have declined dramatically are concentrated in four areas. They are District of Bashang Plateau-Yanshan Mountain northern, District of Qin-Tang-Cang coastal city, Central plain of the province, Southwest of the province. The decrease of coastal shoal wetland is mainly concentrated in Luannan County and Tanghai County, which total reduction was 8300 hm$^2$. The decrease of swampland was mainly concentrated in Fengnan District, with a reduction of 450 hm$^2$. In Pinghsan, Zanzhuang and Jinglong counties in the western part of Taihang Mountains, the inland shoal area increased by 1395 hm$^2$. 
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