Spatial distribution and development trend of the state-level wetland park in China

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Abstract: Wetland Park is an important part of wetland protection system. It acts as a new way of wetland protection and a new carrier of ecotourism. Based on the basic information of the state-level national wetland parks(SLWP) and the visualized ArcGIS platform, geographic concentration index, comprehensive density index, and inverse distance weighted analysis were used to explore the spatial distribution characteristic and development trend of SLWP. Results show that: (1) There are gaps in the consciousness and capability of the managers in the eastern, central and western China for applying and constructing the wetland park along with insufficient management. (2) The spatial distribution of SLWP shows the dominant characteristic of the population pattern, and the distribution of NWP was sparse than that of NUWP. (3) SLWP shows the development trend of urbanization.

1. Introduction

Wetland park has the functions to regulate local climate, purify water quality, improve urban heat island effect etc., and it can improve the adaptability of the city under the background of world changes. As an emerging research field, the wetland park has already drawn the urgent attention from the domestic and foreign research field on wetland and ecological tourism. In China, state-level wetland park(SLWP) has been classified as national wetland park(NWP) and national urban wetland park(NUWP).

At present, scholars have paid more attention to the spatial analysis of the wetland park, but most of them have taken the formal and pilot NWP as the overall object of study to explore its spatial distribution characteristics. However, the comparative researches on the spatial distribution of the formal NWP and the NUWP were quite few, the discussion and research made on their location relationship with the city can be even rarely found. In recent years, along with the occurrence of those problems that the pilot NWP haven't been passed the acceptance, there are more and more pilot qualifications under rectification within time limit and cancellation, and the resources waste caused by the uncertain responsibility and repeated construction of the SLWP, it did bring the negative influence on wetland conservation and its sustainable development accordingly. Based on above issues, whether there's difference in the spatial distribution of the formal NWP and the NUWP, and whether the main entity of repeated construction was caused by the different dominant government institutions, this shall be a scientific problem which needs to be discussed and expounded accordingly. Therefore, it shall have important significance for the construction and management of SLWP in the future to systematically analyze the spatial distribution of current formal SLWP and explore its development trend.

2. Data and method

2.1 Data source

Till the end of 2015, there are total 53 NUWP and 705 NWP in China, among them, 98 are the formal NWP, and 607 pilots. By combining the investigation on relative materials, the retrieval on the list of SLWP issued by the institutions of the State Forestry Administration (SFA) and the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)

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and the information of those authorized website such as wetland in China etc., the geographic locations of the NUWP and NWP in 31 provincial administrative regions have been collected. According to official materials, the barycentric coordinate of the wetland parks have been selected to establish the space database of SLWP. Wetland area, land area, population data were taken from the official data in China Statistical Yearbook 2016. Area of wetland parks was sorted according to the statistical data in official website.

2.2 Methods

2.2.1 Geographic Concentration Index

Geographic concentration index refers to such an index to study the concentration rate of some geographical things on the certain regions. It's such an equilibrium index to measure the concentration rate of the NUWP and NWP in eastern, western and central China. The calculation formula was given below.

$$G = 100 \times \sqrt{\sum_{i=1}^{n}(Xi/T)^2}$$

Where G is the geographic concentration index, n is the number of provincial administration regions (PAR), X_i is the number of NWP or NUWP located in the i-th PAR, and T is the total number of the NWP or NUWP.

With the consideration of the large gap in the quantity of NUWP and NWP among different PAR, Zhu et al. have pointed out that, for different values of n, the calculated G-value cannot be compared with each other, so the concentration coefficient G' was introduced which can reflect the concentration rate of wetland parks more reasonably, scientifically and sensitively. The related calculation formulas were given below.

$$\overline{G} = 100 \times \sqrt{\sum_{i=1}^{n}(1/n)^2}$$

$$\Delta G = G - \overline{G}$$

$$G' = 100 \times (\Delta G/\overline{G})$$

Where $\overline{G}$ represents the geographic concentration index with the complete even distribution of wetland parks, and ΔG is called the deviation value. The ration between ΔG-value and $\overline{G}$-value can reflect the concentration rate of wetland parks, such ratio can be named as the concentration coefficient of wetland parks G'. The higher concentration coefficient it was, the more concentration rate it may represent, and the smaller then means more dispersed.

2.2.2 Comprehensive Density Index

Comprehensive density index refers to the index through comprehensive analysis on all factors influencing the density and reflects the relative quantity of wetland parks in certain area. The calculation formula for comprehensive density of NUWP and NWP was given below.

$$D = Q/\sqrt{SP}$$

Where D is the comprehensive density, Q is the number of NUWP or NWP, S means the area of each PAR and the unit is 10000 km^2, P is the population of each PAR and the unit is 100 million. D shall be influenced by the area and population. The larger area and more population it did have, the smaller D-value it may get accordingly. The concentration rate shall also be smaller.

2.2.3 Inverse Distance Weighted analysis

Inverse distance weighted method means that according to the similarity principle, the closer distance between the two objects, the more similar properties the two objects may have with each other, and vice versa. It takes the distance between the interpolation points and sample points as the weight to perform the weighted mean, the sample points with closer distance to the interpolation point shall be entrusted with higher weight By taking city as the sample points, and NWP or NUWP as the interpolation point, through the distance between them to calculate the dispersion degree of SLWP against the city, to make the quantization and prediction on the correlation between the two factors. The formula for IDW was given below.

$$\hat{Z}(s_0) = \sum_{i=1}^{N} \lambda_i Z(s_i)$$

$$\lambda_i = d_{i0}^{-p} / \sum_{i=1}^{N} d_{i0}^{-p},\ \sum_{i=1}^{N} \lambda_i = 1$$

Where $\hat{Z}(s_0)$ is the predicted value at s_0; N is the number of samples surrounding the prediction sample to be used in prediction calculation process; λ_i is the weight of each sample, such value shall be decreased along with the increased distance between the samples and prediction sample, and p is the exponential value to control the reduction of weight value; p value which is the parameter of IDW is generally given as 2. $Z(s_i)$ is the measured value acquired at s_i. The closer distance of $\hat{Z}(s_0)$ value with the 0, the shorter relative distance between the two factors and they may have stronger relationship accordingly.

3. Results and Analysis

3.1 Characteristics of NUWP and NWP

Till the end of 2015, there are 98 formal NWP and 53 NUWP in China. (1)As for NUWP, there's quite obvious difference existed in the quantity of NUWP in the eastern, central and western China along with the eastern China at the leading position (Fig. 1). After 2007, due to the restraint factors of urban economy, land, capitals etc., the quantity of approved NUWP has decreased with slower development, and then gradually entered the period of sTable development. (2)As for NWP, Incoming 5 years, 98 formal NWPs have obtained the acceptance successfully, and there's no acceptance in 2012. The quantity of approved NWPs in the central and western China has had the gradual uptrend, and in the eastern China, it showed the fluctuation up and down (Fig.2). In recent years, there were more and more NWP under the rectification within scheduled time limit. The rectification rate got the increase in 300%[①] from 2015 to 2016. The rectification-involved areas include 7 in western China as the majority, and 5 in central China, 3 in eastern China (Fig.3). For the ratio of rectification within scheduled time limit, the range of the ratio was from 1.89% to 27.27%. The western China did have quite bigger ratio, and such ratio in central and eastern China were both less than 10.00%, except in Jilin as 15.79%(Fig.4). Jilin, Jiangxi, Shandong and Tibet are the four areas under rectification within scheduled time limit in the 2 consecutive years from 2015 to 2016(Fig.4). In 2015, one of the pilot NWP in Sichuan was canceled, and in 2016, three of the pilot NWP in Jilin, Fujian and Henan were also canceled respectively. The quantity of canceled NWP just increased year by year, involving the three regions.

Table 1. Overview of NUWP and NWP in eastern, central and western China

Area: 1000ha

	Eastern		Central		Western	
	Quantity	Area	Quantity	Area	Quantity	Area
WP	31	103.48	36	706.28	31	3658.2
NUWP	29	51.32	15	123.39	9	157.83
Total quantity /Total area	60	154.80	51	829.67	40	3816.03
Ratio of area	1.32%		7.32%		12.58%	

Annotation: Ratio of area= the area of SLWP / the total area of wetland

① the ratio of rectification for the pilot NWP within scheduled time limit = quantity of NWP under such rectification/ total pilot quantity of NWP in such area×100%)

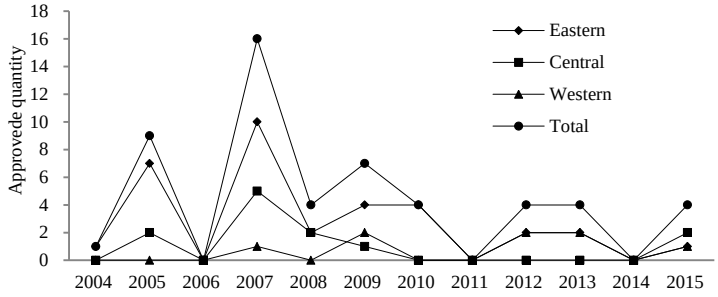


Fig 1. The approved quantity of NUWP

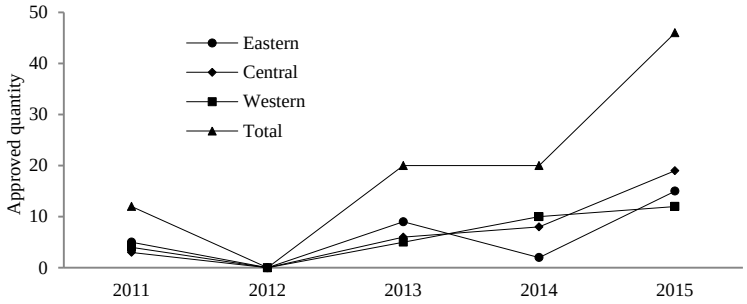


Fig 2. The approved quantity of NWP

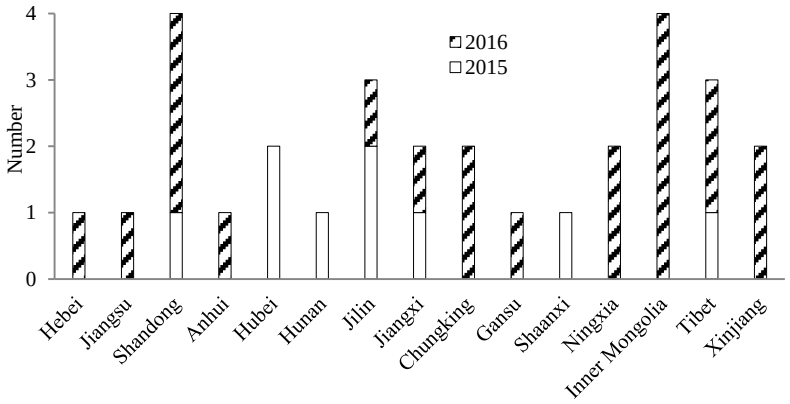


Fig. 3 The number of rectified national wetland pilot parks

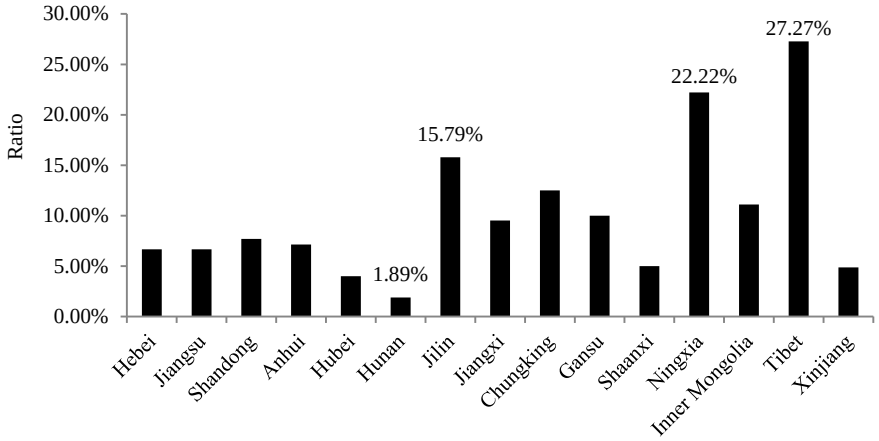


Fig.4 The ratio of rectification for the pilot national wetland park in recent years

3.2 Geographic concentration difference between NUWP and NWP

The geographic concentration index of NUWP and NWP in eastern, central and western China

and the geographic concentration rate of population were calculated, and the results were shown in Table 2. The geographic concentration rate of population is the effective indicator of the spatial distribution of population, which has comprehensively considered the regional population, regional area and other factors. It can reflect the geographic distribution pattern of densely populated area in eastern China, the population mean area in central China and the sparsely populated area in western China. The calculation of the geographic concentration rate of population is based on the research of Yang. In comparison with China's population distribution, the spatial distribution of SLWP was quite similar with China's population distribution, most of them were distributed in the areas with a large population, as we see that P(Eastern)>P(Central)>P(Western).

Table.2 Comparison of concentration index between NWP and NUWP

	PAR	SLWP	P	G	G′
Eastern	Beijing,Fujian,Guangdong,Hainan,Hebei,Jiangsu,Liaoning,Shandong,Shanghai,Tianjin,Zhejiang	NUWP NWP	3.72	47.91 41.94	58.88 39.08
Central	Anhui, Henan, Heilongjiang, Hubei, Hunan, Jilin, Jiangxi, Shanxi	NUWP NWP	1.80	40.55 40.82	14.70 15.47
Western	Chungking, Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Sichuan, Tibet, Xinjiang, Yunnan	NUWP NWP	0.38	40.06 43.40	38.78 50.34

Annotation: P is the geographic concentration rate of population. And the division of eastern, central and western China shall be subject to the scope of State Statistics Bureau, except Hong Kong, Macao and Taiwan areas.

Table 2 shows that G-value reflected the large difference in the concentration rate of geographic distribution between NUWP and NWP in eastern and western China. In eastern China, G-value(41.94)<G-value(47.91) shows that the concentration rate of NUWP was higher than that of NWP, and in western China, the situation was just opposite. While, in central China, G-value(40.82)>G-value(40.55), there's quite little difference between the two values, reflecting that the geographic distribution of NWP and NUWP were in equilibrium. The G′-value reflected the concentration rate of NWP as: G′-value(western) >G′-value(eastern) > G′-value(central) and the concentration rate of NUWP: G′-value(eastern) > G′-value(western) > G′-value(central). Results did not respond to the status of geographic concentration rate of population with the sequence that P-value(eastern) > P-value(central) > P-value(western), which indicates that SLWP tends to be distributed in the densely populated areas. The reason for this may be that SLWP acts as one of the tourism destinations and to service human beings shall be one of its main purposes. Although in western China, the population was quite sparse and the number of SLWP was small, the aggregated distribution of SLWP along with population density can better play its service function accordingly.

3.3 Geographic distribution density

Based on comprehensive density index formula, the density of NUWP and NWP was calculated respectively. Table 3 showed that the comprehensive density indexes of NUWP were: D-value(eastern) > D-value(central) > D-value(western), reflecting that the per capita amount of the parks in eastern China was so far higher than that in central and western China. For the NWP, they were: D-value (central) > D-value (eastern) > D-value(western), reflecting that the per capita amount in central area was the highest relatively. At the same time, the comprehensive density index of NWP in the whole China was bigger than that of NUWP, but its geographic concentration index was quite smaller relatively, which reflected that the distribution of NWP was more disperse than that of NUWP.

Table.3. Comprehensive density of NUWP and NWP

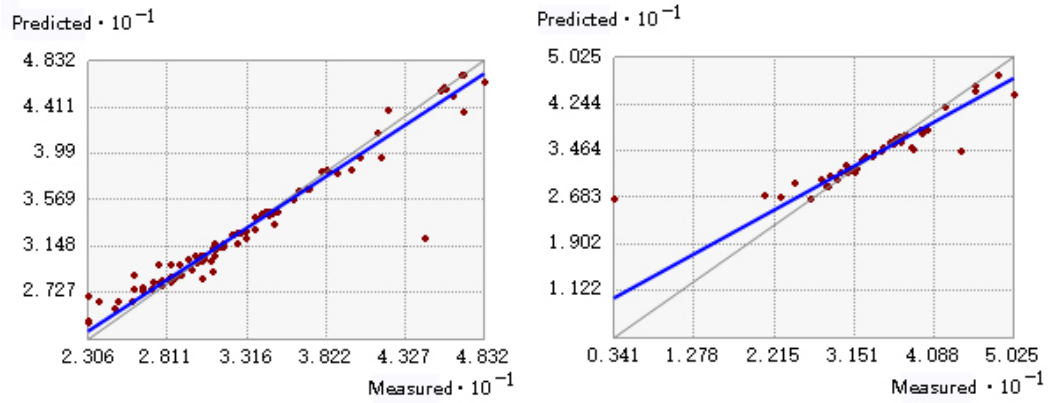
	D(Easter)	D(Central)	D(Wester)	D(Mean)	G
NUWP	1.17	0.56	0.18	0.46	29.41
NWP	1.26	1.34	0.62	0.85	24.28

3.4 Influence of cities on the spatial distribution of SLWP

According to the distance between NWP or NUWP and the cities, the prefecture-level cities in China were took as sample points and SLWP were took as the interpolation points by using the inverse distance weighted method. The dispersion for SLWP against the cities was calculated through ArcGIS. And results showed that the prediction value on the measure of dispersion for the NWP against the cities was less than that of NUWP (Table.4). Fig.5 are the fitting effect on the interpolation analysis for the SLWP against the cities, which show that the dotted line represents the cities, the red dots represent the SLWP, and the blue line represents the distribution trend of SLWP. The results showed that both the interpolation fitting curves (blue line) of the SLWP did meet the city's fitting curve (dotted line) quite well, and with quite good interpolation effect. In comparison with NUWP located in urban planning areas, the interpolation fitting curve of NWP did show better fitting effect, reflecting that it shall have even shorter distance to the cities relatively. Then it can confer that currently most of NWPs are located in the urban planning areas, representing the urbanized development trend.

Table. 4 The discrete degree prediction of SLWP

Predicted value	NWP	NUWP
Mean	-0.07	0.13
Root-Mean-Square-Error	1.62	3.86



(a)NWP (b) NUWP

Fig.5 Fitting effect on interpolation analysis between SLWP and city

Wang et al. and Fan et al. did point out that there were repeated construction and resources waste in the SLWP, to make the unified definition and arrange the unified guidance and construction of the SLWP shall be the problem which needs to be considered in future. By combining the results in this paper, it can get the conclusion that there's urbanized development trend for NWP, it shall make the trial to divide the NWP and NUWP from the perspective of geographic location, so as to provide reference for the site selection, subarea classification and management on the SLWP in future accordingly. According to the dependence of the wetland park on the cities, the wetland park can be divided into three categories such as the independent category, the suburb category and the urban category respectively. The independent wetland park shall be usually located at the cities' outskirts, which is quite so far from the city and its location and function are relatively independent. Such category shall be defined as national urban wetland park, for that has met the requirements of NWP that should focus on wetland ecological conservation and be constructed in the wetland area far from the cities and with good ecological protection. The suburb wetland park and the urban wetland park shall be located in the city or the suburb surround the city, which can be influenced by urban environmental system, urban economic development and socio-cultural pattern, they shall have quite close correlation with the cities and pay more attention to people's experience demand, so that they can be defined as national urban wetland park.

4. Conclusions

Combine the development of SLWP with the results of Geographic Concentration Index and Comprehensive Density Index indicated that there's a gap in consciousness and capability of those local managers in the three regions for applying and constructing the wetland park, with insufficient management. On the other hand, differences of the G-value and the D-value of NWP and NUWP showed that the distribution of NWP was sparse than that of NUWP. And the spatial distribution characteristics of NWP and NUWP mutually responded the guiding significance of Heihe-Tengchong Line, the spatial distribution of those parks did have certain correlation with population distribution in China, that most of those parks were distributed in population centers. Based on the definitions on SLWP in two categories, NUWP should be closer to the city than NWP. But the inverse distance weighted results showed that the interpolation analysis on NWP with the city did have better fitting effect than that of NUWP, which were basically distributed near the city and did have more obvious correlation with the city, representing the urbanized development trend. The results showed the problems that the wetland park construction dominated by two different government institutions did have the repeated construction and the concept of wetland parks cannot be distinguished clearly. Then it proposed to divide the wetland parks into independent wetland park, suburb wetland parks and urban wetland park according to their geographic location and defines the independent wetland park as the NWP and defines the suburb and urban wetland park as the NUWP according to the different properties and functions. Such classification method can reasonably guide the spatial layout of those wetland parks in two categories, also can realize the overall planning and clarify their own functions, so as to avoid the problems of repeated construction of wetland parks and the waste of wetland resource accordingly.

Acknowledgements

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References

[1] Pastor, I.M., Pedreño, J.N., Gómez, I., et al. 2010. Detecting drought induced environmental changes in a Mediterranean wetland by remote sensing. Applied Geography, 30(2), 254-262.

[2] Zhou, T., Niu, A.Y., Xu, S.J., et al. 2019. Spatio-temporal pattern of national wetland parks. Journal of Natural Resources. 34(1):26-39.

[3] Duan, N., Liu, X.D., Dai, J., et al. 2011. Evaluating the environmental impacts of an urban wetland park based on emergy accounting and life cycle assessment: A case study in Beijing. Ecological Modelling. 222(2), 351-359.

[4] Zhu, Q.F., Li, Z., Yang, X. 2011. An improvement of evaluating method on tourist concentration degree with geographic concentration index. Tourism Tribune.26, 26-29.

[5] Wang, L.L., Lu, L., Tang, Y., et al. 2010. Running status, distribution pattern and type classification of the state-level wetland parks in China. Acta Ecological Sinica. 30(9), 2406-2415.

[6] Fan, H.L., Wang, F. 2016. Similarities and differences in spatial distribution and its influencing factors of two kinds of national wetland parks in China. Acta Scientiarum Naturalium Universitatis Pekinensis. 52(3), 535-544.

[7] Wu, H.J., Dan, X.Q., Shu, Y., et al. 2015. Status quo, challenges and strategies of national wetland parks in China. Wetland Science. 13(3), 306-314.

[8] Yang, Z. 2008. Study on relationship between population and economic spatial distribution in China. Lanzhou: Lanzhou University.