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Study on the utilization and protection of water resources in the eco-tourism development of the Boluo Lake wetland nature reserve in Jilin Province

Zhao Zhuang[a], Sun Yan[b], Wang Wen[c,*], Yang Yilin[d]

[a]*College of Business Administration, Jilin Engineering Normal University, Changchun, Jilin, China*
[b]*Headmaster's Office, Jilin Engineering Normal University, ChangChun, Jilin, China*
[c]*Beijing Research Center for Science of Science, Beijing, China, email: 544218087@qq.com*
[d]*Basic Teaching Department, Liaoyuan Vocational Technical College, Liaoyuan, Jilin, China*

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ABSTRACT

Jilin Boluo lake wetland nature reserve is located in the northwest of Changchun city; the reserve has rich biodiversity and unique wetland water resources to develop eco-tourism. This paper first analyzes the general situation of Jilin Boluo lake wetland nature reserve and its water resources, second analyzes the water-related eco-tourism resources in the reserve, and then analyzes the status quo of eco-tourism development in the reserve on this basis. Third, the status of ecological quality and water resource management in the reserve was evaluated. Finally, based on the above research, the countermeasures of water resource utilization and protection in the development of eco-tourism in the reserve are put forward.

Keywords: Wetland nature reserve; Water resources; Management status; Utilization and protection countermeasures

1. Introduction

1.1. Overview of Jilin Boluo lake wetland nature reserve

Jilin Boluo lake wetland nature reserve is a nature reserve of "natural ecosystem" and "inland wetland and water ecosystem". Located in the northwest of Changchun city, the nature reserve is a natural barrier against sandstorms in the west of Changchun city and its surrounding areas. With abundant water resources, elegant environment and beautiful wetland scenery, it plays an important role in flood storage, natural disaster prevention, ecological balance maintenance, tourism development and local economic development [1–9].

In addition, the inland closed-flow lake wetland system in Boluo lake is one of the three typical inland closed-flow lakes in Jilin province. This area is best to study the hydrodynamic processes of the wetland, such as water volume, water level, flooding period, flooding frequency, duration, flooding depth and turnover rate, and the changes of water input and output with time [10,11]. This area is of great value in analyzing and predicting the changes of water level in wetlands and lakes.

1.2. Overview of water resources in Boluo lake wetland nature reserve

The water resources in the reserve mainly include the closed flow area of the Boluo lake and part of the depression in Wazhonggao.

1.2.1. Closed water system of the Boluo lake

The closed flow area of the Boluo lake is the unique water resources basin of Nongan county. It starts from Sanbao township in the east to Fulongquan town in the west, and

* Corresponding author.

runs from Bajilei township in the south to Sanshengyu town and Yongan township in the north. And it across the border into the former Nong'an county and Gorlos Mongol autonomous county [12–15].

The drainage area in the closed flow area of the Boluo lake is 1,378 km² (Among them, the catchment area of the county is l,297.5 km, and the former Gorlos Mongolian autonomous county is 80.5 km). There are five pools in the closed flow area, including Boluo pool, Aobaotu, Yuanbaowa, Mobo and Guangxingdian.

The western and northwestern parts of Nongan county, with many terraces and hilly areas, are dry and lack of rain. They are independent and not connected to each other, and there are guard posts between the bubble ponds. At the junction of the guard ponds and the guard ponds, the ground drops precipitously, falling for tens of meters, and then extends for several or more miles at a low level [16–25]. In this way, low-lying boxed bottom in the middle and closed flow bubble ponds surrounded by surrounding hilly land are formed, with a total surface runoff of 1,378 km. In this vast arid region, there are several pools, which reduce the dryness and provide cheap water.

The high bubble in the depression adjacent to Po Po zi turned out to be a closed flow pond of this type. In 1940, after artificial excavation, it was connected with the Xinkai river at the beginning, and changed to the Yitong river in 1963, which changed the natural condition of the low-lying, medium-high basin and no longer regarded as a closed flow area. See Table 1 for the characteristic values of the pond above.

Flow in a closed region, in addition to the five bubble pond, there are around the perimeter of the bulb polo several natural canal system, including large GouZi have an empress MiaoGou, room ditch, ditch, ditch written four tigers, the trench catchment area is small, short process, from 1950s to 1970s in the groove of a hierarchical, built the reservoir, reservoir flood was held the rainy season, dry season is spring subtle flow [26]. The main characteristic values are shown in Table 2.

1.2.2. Groundwater

The total amount of groundwater resources in the protection zone is l million m, the aquifer is 0 ~ 5 m, mostly fine sand, and the water output of a single well is less than 5 t/h, which cannot meet the requirement of water withdrawal.

- Silt gravel pore diving area in Lacug depression

It is mainly distributed in the five depressions (BoluOpaozi, Aobaotu, Yuanbaowa, Guangxingdian, Mobopo, etc.) and the middle and high depressions, among which the five depressions are 388 km and the middle and high depressions are 405.6 km [27–30]. The total amount of groundwater in the region is 3 million m^3, of which 2 million m^3 of cultivated land is occupied. Aquifer thickness less than 2 m, mostly silt and fine sand, single well water yield of 3.15 t/h, is basically PinShui District, but the eastern edge of the polo bulb presenting a banded lake terrace accumulation formation is composed of coarse sand and gravel, water quantity is rich, single well water yield of 30.7 tons, but only 27 square kilometers area is very small.

- Pore diving area of sand and gravel in hilly platform

Sanshengyu, Fulongquan, Xinyang township (town). The total amount of groundwater exploitation in the region

Table 1
Characteristic values of bubble pond

Bubble pond name	Basin area (km²)		Normal water depth (m)	Normal water (km²)	Storage capacity (10,000 m³)
	Whole basin	In the county			
Full close flow area	1,378	1,297.5			
Boluo pond	1,070	989.5	1.3	51	6,600
Aobaotu	91	91	0.5	14	570
Yuanbaowa	112	112	0.8	8	620
Guangxingdian	27	27	0.3	2	50
Mobo	78	78	0.5	3	145

Table 2
River characteristic values in closed flow area

Drainage	A tributary				Basin area (km²)		Length of the river (km)		Gradient P ‰
	Level 1	Level 2	Level 3	Level 4	Whole basin	Length in the county	Length of the river	Length in the county	
Boluo pond	Niangniangmiao				531.0	474.5	29.8	29.8	1.5
	Laohugou				179.0	155	18.8	18.8	1.4
	Fangshengou				74.9	74.9	25.2	25.2	2.7
	Chengshengou				32.4	32.4	14.7	14.7	4.4

is 152 m, among which the cultivated land occupies 10,000 m. It is divided into the following three communities according to the water abundance. The community is rich in water: the area is 229 km, distributed in some areas of Sanshengyu, Yongan and other townships (towns) [31–35]. The aquifer is composed of coarse sand, sand and gravel, and pebbles, with a thickness of 5 ~ 38 m and a depth of 5 ~ 35 m for the static water level. Water volume medium community: in some areas of Yongan, Fulongquan, Xinyang and other townships (towns), the aquifer is composed of coarse sand, sand and gravel with a thickness of 2 ~ 37 m and a depth of 5 ~ 20 m for the static water level. Water-poor community: it is distributed in some areas of villages (towns) such as Fulongquan and Xinyang. The aquifer is composed of medium sand and gravel, with a thickness of 2 ~ 1 m and a depth of 3 ~ 11 m for the static water level.

2. Overview of water-related eco-tourism resources in the reserve

The water-related eco-tourism resources in the natural protection area of Jilin Boluo lake wetland are mainly under the jurisdiction of Sanshengyu protection management station at the northwest end of the protection area [36]. The unique geographical location, beautiful natural scenery and rich cultural relics constitute an extremely rich ecological tourism landscape resource.

2.1. Hydrological landscape resources

Hydrological landscape is the main vein of landscape resources in the reserve. Fulongquan lake west, north by Yongan township, the northeast coast for the town of Sanshengyu, Wanshun township, the southern half of the town for Bajilei. It is a natural lake and wetland integrating water, grass and reed [37]. It is known as the bright pearl on the edge of "vast ocean of eight hundred miles". It collects over 80 km^2 of water and has a vast territory.

2.2. Biological landscape resources related to water

The Boluo lake wetland is rich in plankton, fish and bird resources. A large area of leymus meadow is distributed outside the lake, while in the shallow water area outside the water accumulation area, a large area of reed marsh is distributed as far as the eye can see. It is the combination of these aquatic plants that gives birth to abundant fish and bird resources [38]. The vast lake and the fresh air create a beautiful picture of nature. In early spring, wild flowers are blooming; in midsummer, the lake is breezy and green with grass; in midautumn, golden yellow; in severe winter, white and boundless. A good ecological environment has greatly stimulated people's enthusiasm for caring for nature and caring for life.

3. Current situation of eco-tourism development

At present, the development of wetland eco-tourism resources is still a new field, and the development and utilization of water resources in Jilin Boluo lake wetland nature reserve is in the initial state, and has not entered the stage of sustainable development and utilization [39]. At present, the supporting degree of eco-tourism elements in the protection zone is relatively low, with an annual average of about 10,000 tourists. However, the reserve is rich in water resources, and the biological resources related to water are rich and diverse. At the same time, the agricultural production condition in the protected area is good, and the agricultural sightseeing prospect is very broad.

4. Evaluation of the status quo of ecological quality and water resource management in the reserve

4.1. Ecological quality evaluation

Boluo lake wetland is located in the west of Nongan county, a temperate continental climate. As one of the three inland closed-flow lakes in Jilin province, lake Boluo is centered on the closed-flow waters such as lake polo and composed of reed marsh and meadow grassland, forming a relatively stable natural ecosystem. The diversity of species and the complexity of the food network play an important role in regulating the climate, storing flood water and purifying water quality [40]. The Boluo lake wetland is located in the west of Nongan county wind, sand arid areas, belongs to the temperate continental climate, the annual prevailing southwest wind, its characteristics are dry and windy spring, warm and rainy summer, autumn sunny cold temperature difference, winter cold and long. The lake water is shallow, the water temperature is hot and rainy, aquatic plants flourish, bait rich, rich carp, carp, grass carp.

4.2. Current evaluation of surface water environmental quality

According to the monitoring data show that of the wetland water quality reaches the surface water environment quality standard (GB3838-2002) III in the waters of the water body function.

4.3. Evaluation of the current situation of water resources management

The natural resources of the Boluo lake wetland were developed and utilized freely by surrounding towns and villages before 1970. In order to reduce the damage to wildlife resources, the national fishery of the Boluo lake was established with the approval of Nongan county government in 1970. The fishery and reed industry development of the wetland in the Boluo lake shall be under unified management. In 1982, the lake Boluo resources management office was established, and the water police station was set up to strengthen the patrol and management of lake Boluo, prevent the indiscriminate exploitation of aquatic and terrestrial wildlife resources in the lake polo wetland, and effectively curb the occurrence of resource destruction. In 1982 and 1984, successive circulars were issued that 167.2 m elevation was regarded as no-man's land, and no one was allowed to cultivate land within the area. Measures for watershed management were formulated, including returning farmland to forests and creating a protective belt around the lake, so as to keep the ecosystem of the Baltic lake basically in a natural state. It ensures the integrity of the ecosystem and the biodiversity, and provides a good habitat for the survival and reproduction of many rare and endangered birds.

Table 3
(GB3838-2002) Standard limit of surface water environment quality standard Unit: mg/L

S.No.	Standard values classification project	I class	II class	III class	IV class	V class
1	Water temperature (°C)	Man-made changes in environmental water temperature should be limited to: Weekly mean maximum temperature rise ≤1 Weekly mean maximum temperature drop ≤2				
2	PH value (dimensionless)	6–9				
3	Dissolved oxygen ≥	Saturation rate 90% (or 7.5)	6	5	3	2
4	Permanganate index ≤	2	4	6	10	15
5	Chemical oxygen demand (COD) ≤	15	15	20	30	40
6	Five days biochemical oxygen demand (BOD_5) ≤	3	3	4	6	10
7	Ammonia nitrogen (NH_3–N) ≤	0.15	0.5	1.0	1.5	2.0
8	Total phosphorus (in P) ≤	0.02 (lakes and reservoirs 0.01)	0.1 (lakes and reservoirs 0.025)	0.2 (lakes and reservoirs 0.05)	0.3 (lakes and reservoirs 0.1)	0.4 (lakes and reservoirs 0.2)
9	Total nitrogen (lakes, reservoirs, in N) ≤	0.2	0.5	1.0	1.5	2.0
10	Copper ≤	0.01	1.0	1.0	1.0	1.0
11	Zinc ≤	0.05	1.0	1.0	2.0	2.0
12	Fluoride (in F) ≤	1.0	1.0	1.0	1.5	1.5
13	Selenium ≤	0.01	0.01	0.01	0.02	0.02
14	Arsenic ≤	0.05	0.05	0.05	0.1	0.1
15	Mercury ≤	0.00005	0.00005	0.0001	0.001	0.001
16	Cadmium ≤	0.001	0.005	0.005	0.005	0.01
17	Chromium (hexavalent) ≤	0.01	0.05	0.05	0.05	0.1
18	Lead ≤	0.01	0.01	0.05	0.05	0.1
19	Cyanide ≤	0.005	0.05	0.2	0.2	0.2
20	Volatile phenol ≤	0.002	0.002	0.005	0.01	0.1
21	Petroleum ≤	0.05	0.05	0.05	0.5	1.0
22	Anionic surfactant ≤	0.2	0.2	0.2	0.3	0.3
23	Sulfide ≤	0.05	0.1	0.2	0.5	1.0
24	Fecal coliforms (per/L) ≤	200	2,000	10,000	20,000	40,000

5. Water resources utilization and protection countermeasures in eco-tourism development

5.1. Formulate scientific plans for the protection and utilization of water resources

From the perspective of long-term sustainable development, the utilization of water resources must be limited by the number of people. The utilization of water resources should consider the carrying capacity of water bodies and the law of water circulation, put an end to the unrestricted access of tourists, establish a periodic water circulation system, and make comprehensive utilization and planning of the water environment in the protection zone.

5.2. Strengthen policy support for introducing capital and talents

Actively strive for the input of central finance and local finance to the protection and utilization of water resources in the protection zones, and strengthen the infrastructure construction in the protection zones; Actively strive for the investment of the central finance in the protection and construction of wetland water resources, and accelerate the construction speed of the protected area with the project funds of water diversion project, such as returning farmland to wet land; actively carry out internal and external citation, and strive for scientific research topics and projects; attract public welfare investors, implement risk sharing and benefit sharing; actively introduce professional and technical personnel with experience in reserve management and scientific research, and provide a good working and living environment for them; to strengthen the selection and sending of the existing staff to relevant colleges and universities for further study in order to improve the overall quality of all staff as soon as possible.

5.3. Strengthen the publicity of water resources protection, and contribute to the protection awareness of tourists

Local governments at all levels and the protection areas should publicize through various ways, improve tourists'

awareness of water resources protection, establish the idea of taking protection as the premise, and put an end to the practice of pollution first and treatment afterwards, so as to prevent the occurrence of an emergency.

5.4. Improve the system and strengthen the administration according to law

Establish, improve and perfect the administration of attendance management, personnel management, file management, financial management, and other rules and regulations. The staff of the administration must abide by the laws and regulations of the state and local governments concerning the protection of water resources in nature reserves, strictly enforce the law and act in accordance with the law. Abide by the rules and regulations formulated by the administration of nature reserves and abide by rules and regulations.

References

[1] C. Xiaohe, Research on the Planning of Reservoir Type Water Conservancy Scenic Spot Based on Water Environment Protection [D], Fujian Agriculture and Forestry University, Fuzhou, Fujian, 2014.

[2] Y. Li, S. Wang, M.A. Ashraf, Preparation and performance of Al_2O_3-ZrO_2 ceramic powders, PaperAsia Compendium, 2 (2018) 16–19.

[3] S. Xiao, X. Xi, S. Wu, M.A. Ashraf, Effect of SiC Whisker on Microstructure and Mechanical Properties of Ti (C, N)-based Cermets, PaperAsia Compendium, 1 (2018) 22–27.

[4] L. Xiyin, Research on Resource Protection and Utilization of Reservoir Type Water Conservancy Scenic Spot, Fujian University of Agriculture and Forestry, Fuzhou, Fujian, 2012.

[5] B. Sen, S. Goswami, G. Devi, H.P. Sarma, A. Bind, Valorization of *Adenanthera pavonina* seeds as a potential biosorbent for lead and cadmium removal from single and binary contaminated system, Geol. Ecol. Landscapes, 2 (2018) 275–287.

[6] Y. Hairong, Research on the Comprehensive Utilization of Reservoir Water Conservancy Scenic Spot Resources, Huaqiao University, Quanzhou, Fujian, 2012.

[7] S. Qian, The damping loss prevention research on aerobics special shoe materials based on intelligent analysis, Sci. Heritage J., 3 (2019) 20–23.

[8] Z. Zhuang, W. Wen, Landscape quality evaluation of Shengshan National Nature Reserve in Heilongjiang and countermeasures for eco-tourism development, China Urban Economy, 3 (2010) 252–255.

[9] Z. Zhuang, W. Wen, Analysis on Ecological Tourism Development of Shengshan National Nature Reserve in Heilongjiang Province, Consume Guide, 5 (2010) 43.

[10] L. Chuanlei, L. Guomin, H. Yuanfei, W. Guojun, Research on mental health status and the relationship between spiritual belief and self–harmony, Sci. Heritage J., 2 (2018) 16–20.

[11] R. Hashima, Z.A. Latif, F.M.M.N. Zamhury, The Praxis of Langkawi's Sustainable Regeneration Strategy through Eco-Tourism, Procedia Social Behav. Sci., 170 (2015) 49–57.

[12] W. Huizhan, Problems and countermeasures in the tourism development of water conservancy scenic spots in China, Econ. Social Dev., 4 (2007) 109.

[13] A.A. Sabuti, C.A.R. Mohamed, Correlation between total suspended particles and natural radionuclide in Malaysia maritime air during haze event in June-July 2009, J. CleanWAS, 2 (2018) 1–5.

[14] D. Guirong, S. Jinna, X. Bin, S. Yazhi, Research on foreign water resource management model, People's Yellow River, 4 (2012) 50–54.

[15] Z. Maryam, A.H. Hazrin, A. Hizrri, A. Norhidayah, N. Samsuddin, M.A. Mohd Shukri, Association of particulate matter (Pm) with respiratory symptoms among children in selected primary schools in Pahang, J. CleanWAS, 2 (2018) 11–15.

[16] H. Zhuo, Discussion on the index system of water ecological civilization construction in China water conservancy, 6 (2013) 17–19+9.

[17] L. Chunfang, On the current situation of water resources in China, Sci. Technol. Vision, (2012).

[18] M.R. Dager, Composición de la materia orgánica, pH, intercambio catiónico y textura de cinco suelos ubicados entre 670 y 1600 msnm en la cuenca del río Maracay, Venezuela, Revista de la Facultad de Agronomia de la Universidad del Zulia, 34 (2017) 130–157.

[19] M. Kumar, J. Jaafar, Preparation and characterization of TiO_2 nanofiber coated PVDF membrane for softdrink wastewater treatment, Environ. Ecosyst. Sci., 2 (2018) 35–38.

[20] N.G. de Colmenares, Composición química y actividad antibacteriana del aceite esencial de los frutos de una nueva especie del género Zanthoxylum (Sección Tobinia-Rutaceae) de Venezuela, Revista de la Facultad de Agronomia de la Universidad del Zulia, 34 (2017) 158–174.

[21] S.A. Hab, F.N. Talpur, J.A. Baig, H.I. Afridi, M.A. Surhio, M.K. Talpur, Leaching and exposure of phthalates from medical devices; health impacts and regulations, Environ. Contam. Rev., 1 (2018) 13–21.

[22] H. Barazarte, Características físicas y químicas de cladodios de *Opuntia ficus-indica* (L.) Mill, Revista de la Facultad de Agronomia de la Universidad del Zulia, 34 (2017) 157–186.

[23] N. Huerta-Leidenz, Retail display case merchandisings consist and price-elasticity of demand for US beef and pork variety meats sold in Mexican grocery stores, Revista de la Facultad de Agronomia de la Universidad del Zulia, 34 (2017) 216–235.

[24] E. Ates, Slope aspect has effects on vegetation and forage traits of anthropogenic pasture under two grazing treatments, Revista de la Facultad de Agronomia de la Universidad del Zulia, 34 (2017) 236–252.

[25] Z. Yuanqing, S. Dianmei, Estimation of semi-parametric varying-coefficient spatial panel data models with random-effects, J. Stat. Plann. Inference, 159 (2015) 64–80.

[26] M.M. Parvez, M.M. Billah, M.M. Iqbal, M.M. Rahman, M.K.A. Bhuiyan, S.S. Romkey, M.A.O. Dawood, M.S. Islam, Fish diversity and water characteristics in the Reju Khal River Estuary, Bangladesh, Water Conserv. Manage., 2 (2018) 11–19.

[27] D. Huanhe, Z. Kun, Y. Hongwei, L. Yuqing, Generalised (2 + 1)-dimensional super MKdV hierarchy for integrable systems in Soliton Theory, East Asian J. Appl. Math., 3 (2015) 256–272.

[28] Z. Tongqian, M. Xinzhu, Z. Tonghua, Global dynamics of a virus dynamical model with cell-to-cell transmission and cure rate, Comput. Math. Methods Med., 1 (2015) 1–8.

[29] L. Fei, W. Zhiyu, W. Fang, Hamiltonian systems with positive topological entropy and conjugate points, J. Appl. Anal. Comput., 3 (2015) 527–533.

[30] Q. Ain, G. Rehman, M. Zaheer, An analysis of an underground water flow using Adomian decomposition method, Water Conserv. Manage., 3 (2019) 27–29.

[31] L. Gang, C. Ming, Infinite horizon linear quadratic optimal control for stochastic difference time-delay systems, Adv. Difference Equations, 1 (2015) 14–22.

[32] C. Yujun, Z. Yumei, Monotone iterative technique For (K, N - K) conjugate boundary value problems, Electr. J. Qualitative Theory Differential Equations, 69 (2015) 1–11.

[33] T. Cheng, Z. Weihai, On observability and detectability of continuous-time stochastic Markov jump systems, J. Syst. Sci. Complexity, 28 (2015) 830–847.

[34] Y. Zhiguo, Z. Guoshan, W. Jiankui, Z, Weihai, State and output feedback finite-time guaranteed cost control of linear it stochastic systems, J. Syst. Sci. Complexity, 28 (2015) 813–829.

[35] M. Xinzhu, L. Rui, Z. Tonghua, Adaptive dynamics for a non-autonomous Lotka-Volterra model with size-selective disturbance, Nonlinear Anal. Real World Appl., 16 (2014) 202–213.

[36] L. Xikui, L. Yan, Z. Weihai, Stochastic linear quadratic optimal control with constraint for discrete-time systems, Appl. Math. Comput., 228 (2014) 264–270.

[37] Z. Jianguang, H. Binbin, A new class of smoothing functions and a smoothing Newton method for complementarity problems, Optim. Lett., 7 (2013) 481–497.

[38] J. Tang, H. Guoping, F. Liang, A new non-interior continuation method for second-order cone programming, J. Numer. Math., 21 (2013) 301–323.
[39] Z. Yumei, C. Yujun, Existence results for a functional boundary value problem of fractional differential equations, Adv. Difference Equations, (2013).
[40] T. Fabio, A.A. Elsadany, X. Baogui, H.N. Agiza, Local stability of the cournot solution with increasing heterogeneous competitors, Nonlinear Anal. Real World Appl., 26 (2015) 150–160.