Wetland Ecosystem Conservation and Management in China and Its Teaching Case Construction

Hongyan Shen[1,a], Lei Yang[2,b], Haoyu Sun[3,c], Yonghuan Bian[1,d,*]

[1]School of Environmental Science and Engineering, Hebei University of Science and Technology, Yuxiang Street, Shijiazhuang, China

[2] Hebei Chemical and Pharmaceutical College, Fangxing Street, Shijiazhuang, China

[3] Key Laboratory of Organic Compound Pollution Control Engineering, School of Environmental and Chemical Engineering, Shanghai University, Shangda Street, Shanghai, China

[a] 1178611805@qq.com, [b] 63211633@qq.com, [c] sunhaoyu2021@shu.edu.cn, [d] bianyonghuan@163.com

*Corresponding author

Keywords: Wetlands, ecosystems, conservation and management, case, higher education

Abstract: Case, which is a bridge combining practice with theory in the teaching process, is one of the main teaching ways in university. Based on the current situation of domestic wetland ecosystem protection and management, the wetland ecosystem protection and management in China are focused on the wetland protection policies, strategies, constructions and so on. A lot of work has been done in wetland protection and management, such as scientific and technological research, development and application promotion, and training of professional and technical personnel in wetland protection, especially in the artificial wetland purification of water quality. According to the needs of teaching in higher education, the sources of case materials as well as the principles of screening and the types of teaching cases are determined. In particular, the scientific research programs and their results are applied to construct the case of treating wastewater in wetland ecosystems, including source, background, overview, content and summary. All of these can provide references for the teaching of wetland protection and management in higher education.

1. Introduction

Wetland biodiversity is the richest on earth, and at the same time, it is one of the most important environments on which organisms depend for their survival. It not only provides a variety of resources for human production and life, but also has enormous environmental functions and benefits, and is an important part of the urban ecological security system and an important foundation for achieving sustainable economic and social development[1]. With the increase of world population and the pressure from survival and economic development, wetlands have suffered from transitional development and destruction, resulting in the shrinkage of wetland area worldwide as well as the loss of wetland biodiversity triggered by ecological and environmental problems, which have threatened the sustainable development of cities, countries and even the globe. Since the signing of the Convention on Wetlands in 1971, the international community has become more and more aware of the importance and urgency of strengthening the protection and management of wetland ecosystems and promoting the sustainable and rational use of wetlands, and the international community's attention to wetlands has also expanded from the initial emphasis on the function of wetlands as a habitat for waterfowl to all aspects of wetland ecosystem protection and rational use[2]. Based on the current situation of wetland ecosystem protection and management in China, a case of wetland ecosystem protection and management is constructed that serves the teaching of higher education by combining with the completed research results of the lecturer, and applied to the process of teaching, in order to provide solution ideas and application references for the enhancement of the quality of education and the reform of teaching.

  DOI: 10.25236/icemeet.2024.007

2. Current status of wetland ecosystem protection and management in China

The protection policies, strategies and constructions are mainly focused on the wetland ecosystem conservation and management in China[3]. In order to research wetland ecosystem protection, the State Environmental Protection Key Laboratory for Wetland Conservation and Vegetation Restoration was set in Northeast Normal University on October 26, 2006. The Technical Specification for Artificial Wetland Wastewater Treatment Engineering was created to make full use of the ecological benefits of wetlands and strengthen the reuse of sewage in 2010, stipulating the general requirements of process design, construction and acceptance, operation and maintenance, etc. It is applied to urban domestic sewage, effluent from urban sewage treatment plants, and other sewage treatment projects with similar properties to domestic sewage. To strengthen the monitoring of wetlands, the Technical Specification for National Ecological Condition Survey and Assessment Field Observation of Wetland Ecosystems was implemented on August 1, 2021, which stipulates the requirements for the general rules, technical process, selection of sample plots and setting up of sample squares for field observation, the indicator system of field observation, technical methods at observation of wetland ecosystems, etc. In summary, a lot of work has been done in wetland protection and management, scientific and technological research, development and application, training of professional, technical talents in wetland protection, etc. Especially, a great progress has been made in terms of purifying water quality through artificial wetlands, which is at the forefront in Beijing of China. Subsequently, various types of artificial wetlands were constructed across the country, taking into account the quality control requirements for effluent and surface water from local sewage treatment plants, to undertake the arduous task of purifying water quality, reduce pollution and emissions, and protect water environment quality.

3. Case Sources and Construction Methods

According to the offline and online materials mastered by the lecturer, there are no mature teaching cases on wetland protection and management in China. Based on the needs of classroom teaching, the lecturer collects and rearranges case materials from the national requirements of wetland protection and management, research results of scientific research, the relevant papers and publications, applied examples of artificial wetland, etc. Conserving water sources, regulating floods, purifying water quality, protecting biodiversity, mitigating heat island effects, and maintaining carbon cycling are demonstrated in terms of wetlands. Their role in maintaining urban ecosystem balance and ecological security is highlighted, and a case structure and content are constructed according to the following three principles.

The principles for selecting and constructing cases are representativeness, relevance, and relatedness. The representative is that the case can meet the current requirements for ecosystem protection and management in China. The relevance means its content must meet the requirements of higher education, and its presentation must be visual, vivid, and three-dimensional. The relevance refers to the content of a case can involve multiple knowledge such as environmental science and ecology. By explaining and analyzing a typical case, it encourages the learners to connect and associate with relevant theories and knowledge, achieving the effect of applying them to other situations.

According to the source and content of cases, they can be divided into theoretical cases and practical cases. The materials of practical cases originate from scientific research projects. Taking research results as cases is the process of summarizing, improving and disseminating of research programs. Such cases are a model of the perfect combination practice with theory. Teaching cases are persuasive and easy to penetrate into hearts of students and inspire their thinking. Secondly, the research projects can also be used as cases to support teaching. The specific practice is that the lecturer assigns special tasks to the students, such as wetland ecological environment survey. Before the research, the students are required to read the relevant information, plan the research route and research content according to the relevant information, and bring the experimental equipment and instruments, sampling and subsequent laboratory testing. After the investigation, students are

required to read and analyze the relevant literature, compare and analyze the results of the research using the internet technology and library databases, report the results of the study in a group, and their performances are regarded as the usual grade and will be included in the final grade.The teaching mode of topic + research + literature + team + report + grade is formed . The students can be effectively drived by the case teaching mode to use their brains, hands and mouths. At the same time, the organic combination bilingualism with cases highlights the characteristics of personalized education in higher education[4], and also builds a solid foundation for students carrying out scientific research in the future. Through the implementation of the above practical cases, students can not only exercise their scientific research ability, even deepen their understanding for the basic knowledge and theories of their specialities, but also comprehensively examine their ability, such as determining work plans, communicating with each other and operating in practice. The case model combining with scientific research projects and foreign Languages is innovative and efficient, and the teaching effect can be significantly improved when it is used in the teaching process.

4. Typical cases of wetland ecosystem for purifying effluent from sewage treatment plant

The lecturer assigns the research work of the cases to the students and guides them to complete the stage tasks of the cases. The cases are used to construct a teaching case of wetland ecosystem to purify effluent from wastewater treatment plant. The case is composed as follows.

4.1. Case sources

Wetland is an important ecosystem with abundant biological resources and important ecological functions. The pollutant concentration in the effluent from the wastewater treatment plant has also been further reduced by ecological wetlands. Ecological wetlands can make the water quality meet the local surface water environmental quality standards. The artificial wetland adjacent to the Huai river is located in Yuanshi County, Shijiazhuang City, Hebei Province. Establishing the wetland is to apply its purification and ecological functions to further purify the effluent of the sewage treatment plant, and to ensure the effluent water quality meeting the requirements of the water quality before discharging it into the Huai river, so a successful case is provided for the combination of the water environmental protection with the artificial ecological wetland in China.

4.2. Cases Overview

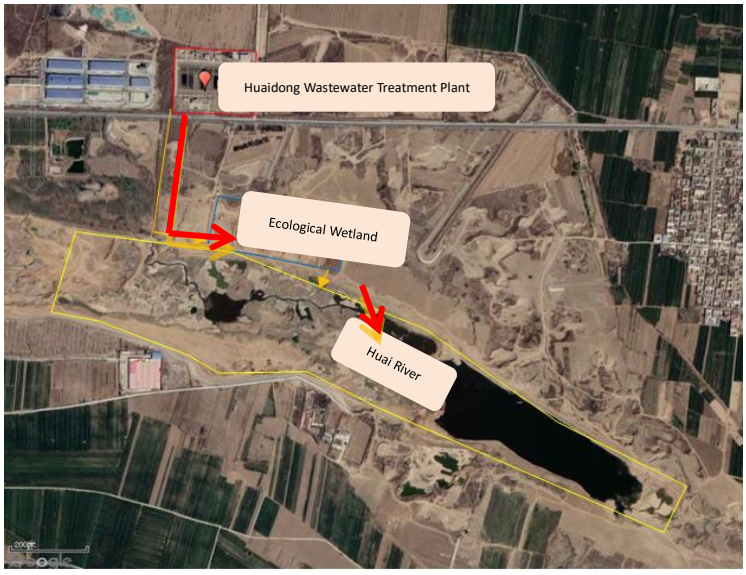

Figure 1 Location of Huaidong Wastewater Treatment Plant, Artificial Ecological Wetland and Huai River

In 2019, an ecological wetland was constructed on the south side of the Huaidong Wastewater Treatment Plant (Figure 1).The ecological wetland receives only the effluent from the Huaidong Wastewater Treatment Plant. The effluent is purified by the ecological wetland and then flows into

the Huai River. The ecological wetland is hydraulically simple and small in width, and the effluent can be fully mixed after entering the ecological wetland. This is beneficial for removing pollutants by aquatic plants (Table 1).

Table 1 Overview of aquatic plants in artificial ecological wetlands

Submerged Plants	Planted area (m^2)	Emergent plants	Planted area (m^2)
Dwarf bitter grass	6900	bulrush	1700
Hydrilla verticillata	2300	Typha orientalis	1130
Myriophyllum verticillatum	1500	lotus	1470
Potamogeton perfoliatus	900	Iris tectorum	2100
Najas minor	1200	Acorus calamus	500

4.3. Case content

4.3.1. Purification effect of ecological wetlands

The water quality of the effluent from Huaidong Wastewater Treatment Plant complies with the Emission Standards for Water Pollutants in the Ziya River Basin (DB13/2796-2018). Monitoring points are set at the ecological wetland inlet and outlet for testing, statistics and analysis of water quality indicators. Through the data of ecological wetland inlet and outlet water quality indicators, the corresponding removal efficiency can be calculated (Table 2).

Table 2 Removal efficiency of pollutants by ecological wetlands

Water quality indicators	Influent concentration (mg/L)	October 21, 2019		October 22, 2019		October 23, 2019	
		Effluent concentration (mg/L)	Removal rate (%)	Effluent concentration (mg/L)	Removal rate (%)	Effluent concentration (mg/L)	Removal Rate (%)
COD	40	20	50	18	55	21	47.5
BOD_5	10	5.7	43	3.9	61	5.1	49
NH_3-N	2.0	0.572	71.4	0.612	69.4	0.644	67.8
TN	15	6.23	58.5	5.41	63.9	6.72	55.2
TP	0.4	0.13	67.5	0.12	70	0.15	62.5

4.3.2. Ecological wetland purification effect assessment

Huai River ecological wetland is a surface flow artificial wetland, and its treatment system is divided into three grades, with an effective water area of 51,500m^2 and a water depth of 1.5m. The areas of submerged plants and aquatic plants respectively are 12,800m^2 and 6,900m^2. The water in the ecological wetland moves in a push flow type, and the water quality can be purified through a combination of physical, chemical, and biological processes. The data of water quality indicators for the influent and effluent of the ecological wetland show that after the advanced treatment of effluent from Huaidong Wastewater Treatment Plant in the ecological wetland, the removal rates of COD, BOD_5, NH_3-N, TN, and TP are 47.5~55%, 45~61%, 67.8~71.4%, 55.2~63.9%, and 62.5~70% respectively. This effectively reduces the concentration of pollutants in tail water, further improves the effluent water quality, and meets the local surface water quality management requirements. The perfect combination artificial wetland with the river not only realizes ecological integrity but also achieves the purpose of ecological protection.

From the point of ecological characteristics, the aquatic plants in the Huai river ecological wetland can effectively purify effluent from wastewater treatment plant and also provide habitat for wildlife. The water resources in the wetland maintain the regional water balance, and at the same time regulate the surrounding climate. In terms of functional indicators, the ecological wetland not only effectively removes pollutants in the effluent from wastewater treatment plant, but also has obvious environmental benefits.

4.3.3. Wetland ecological system health assessment

The wetland ecological system health assessment of the Huai River wetland ecosystem adopts the index system method, which includes 13 indices of water health, wetland elements, and wetland conditions. As the Huai River ecological wetland in Yuanshi County belongs to the river-type wetland, more evaluation indices are related to water quality. The weight of each evaluation indices is the same, and the overall health status is determined according to the final average score, as shown in Table 3.

Table 3 Huai River wetland ecological system health indexes and scores

Health indices		Healthy level					Score	Value
		Absolutely 5	Relatively 4	Generally 3	Sub-health 2	Illness 1		
Water healths	Water quality	Grade I	Grade II	Grade III/IV	Grade V	Worse Grade V	3	4.00
	Pollutant Concentration	Low	Relatively low	Moderate	Relatively high	High	4	
	Transparency	Extremely clear	Clear	Relatively clear	Muddy	Opaque	3	
	Flow	Uninterrupted flow	flow	Intermittent flow	Occasional flow	Not flow	5	
	Floating object	None	None	None	A few	More	4	
	Water color	Colorless	Light	Light brown	Brown	Dark	4	
	Water smell	Odorless	Odorless	Light	Moderate	Obvious	5	
Wetland elements	Species	Abundant	Relatively abundant	Relatively single	single	None	5	4.67
	Depth	deep	Relatively deep	moderate	Shallow	Relatively shallow	4	
	Area	Large	Relatively large	moderate	Relatively small	small	5	
Wetland conditions	Atmospheric	Excellent	Good	moderate	Poor	inferior	4	4.00
	Groundwater	Excellent	Good	moderate	Poor	inferior	4	
	Sound	Excellent	Good	moderate	Poor	inferior	4	

Based on the data in the above table, the average score of water body health of the ecological wetland is calculated, whose result is 4.00, belonging to a relatively healthy level. The average score of wetland elements is 4.67, which is close to the healthy level. The average score of environmental condition is 4.00, which belongs to relatively healthy level. Overall, the final score for the wetland ecological system health assessment is 4.22. Therefore, the ecosystem health of Huai River ecological wetland belongs to a relatively healthy level.

5. Conclusion

Wetland ecosystem protection and management have been focused on current ecological-environmental protection, principles, methods, and examples for the construction of teaching cases on the protection and management of wetland ecosystems in China are presented in this paper, and the conclusions are as follows.

(1) The effectiveness of wetland protection and management in China is remarkable. A wide range of case materials based on national conditions is available. Cases from scientific research findings not only allow for a perfect integration of theory and practice but also actively engage students, making them highly suitable as practical case materials.

(2)The selection principles for cases include representativeness, relevance and association. Cases can be divided into theoretical cases and practical cases.

(3)The teaching cases for the protection and management of wetland ecosystems include sources, backgrounds, overviews, contents, and summaries. The most important of all above is the content.

Acknowledgements

The research is funded by Hebei Higher Education Teaching Reform Research and Practice Project Case optimization design and operation for Sino-Australian Cooperation Course of Ecosystem Protection and Management (2022GJJG184), Hebei University of Science and Technology project for Environmental Impact Assessment, Ecosystem Protection and Management English Case Database Construction (202205).

References

[1] Zhang, X., Wei, H. and Li J.X. (2023) Research on the application of ecological wetland in the advanced treatment of tailwater of municipal wastewater treatment plant. Western Transportation Science and Technology, S1,13-15.

[2] Liu, W., Fan, H.T. and Qiang Y.W. (2023) Advancing Global Action for Wetland Conservation togethe. Safe Campus, 7, 90-93.

[3] Gao, T.H. (2022) Research on the status quo and management measures of wetlands in Fuyuan City. Forestry Exploration and Design, 6, 53-55+62.

[4] Wei, Q., Shi, X.L. and Chen, M.X. (2024) Teaching reform and exploration of bilingual course "Food Microbiology". Food Industry, 3, 248-250.