

Value Assessment of the Lake Honghu Wetland & Protection of Its Biodiversity*

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A wetland ecosystem's value may be considered as the value derived from its natural resources, the value derived from its eco-environment, the value for special protection and values in cultural, research and educational aspects. Lake Honghu, in the heartland of Hubei Province, covers a vast but shallow body of water and surrounding marshlands. It is conducive to farmland irrigation, flooding regulation, adjustment of the local climate and self-purification of the water quality. Because of its benign functions, the native ecosystem of the lake is ecologically sound, and the thriving wildlife in its ecosystem makes it a primordial pool of biodiversity. Besides, it is possible to transform it into a national base for environmental education and an R&D center for freshwater organisms, so that it can play a constructive role in heightening the public's awareness of environmental protection.

A wetland ecosystem is noted for its enormous ecological, economic and social benefits. Historically, a water body and its neighborhood were always the cradle of human civilization, such as the Yellow River and Yangtze River valleys in China and the marshlands in Mesopotamia. Yet, over thousands of years up until modern times, the ecologies of wetland ecosystems have become worse. Many wetlands in the world today have been "tamed" or "harnessed" by man as a result of the booming development of agriculture and industry, as well as the explosive situation caused by urbanization and population growth around the world. In the form of wasteland reclamation and recovery of farmland from lake basins,

malpractices motivated by short-term interests leads to environmental degeneration, waste and abuse of the natural endowment and ecosystem depletion. According to statistics, at present, about half of the world's original wetlands have disappeared. To a great extent, the worldwide shrinkage of wetlands has been caused by the long-standing and popular misconception that wetlands are unproductive. This, in turn, has resulted from our incorrect understanding of the unique function and values of wetland ecosystems.

Since the advent of the 21st century, wetland resources have been playing a more and more important role, so that both decision makers and economists are scrambling to show more and more concern for the evaluation of wetland ecosystems. Both the values and functions of a wetland ecosystem are diverse and multi-colored, present-

ing distinctive variances as a result of the different settings derived from its background of natural geography and peripheral socio-economic conditions. If a government, a social community or an individual works out a scheme for wetland exploitation in line with private needs, other aspects of the wetland functions or values will be impaired. So, an all-round scientific evaluation of a wetland's functions and values is not only capable of advancing the width and depth of probes into a wetland ecosystem so as to step up our intensity and academic level in monitoring and protection of it, it can also provide solid scientific grounds for sustainable development and utilization of wetland resources.^[1-4]

1. An overview of the Lake Honghu wetland ecosystem

Lake Honghu is located in Hubei Province, on the middle reaches of

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the Yangtze River. It is a vast natural body of water situated in the group of lakes and marshlands at the confluence of the Yangtze and its largest tributary, the Hanjiang River. Lake Honghu is a large but shallow body of water between the mainstream of the Yangtze and the Dongjinhe, a tributary of the Hanjiang River. It is 23.4 kilometers long from east to west and 20.8 kilometers wide from south to north, with the length of its peripheral coastline some 104.5 kilometers. The coefficient of its coastline development is 1.56. It has a water surface of 348.2 square kilometers. The lake is situated on the northern fringe of a temperate subtropical area. As it has a typical pattern of the humid monsoon-dominated climate of the northern subtropical zone, its climatic characteristics include rich solar energy, plentiful precipitation, and the coincidence of its rainy season synchronized with high temperatures. Its annual average rainfall is 1,174mm, annual tran-

spiration volume 1,354mm, annual runoff depth 360mm and annual runoff volume up to 37.35×10^8 cubic meters. The annual precipitation of the lake is always concentrated in the period from May to October, and its average annual temperature is 16.6°C. The lakebed is flat, averaging 22.8 – 24.0m in elevation. During the four seasons, the lake's average water depth is 1.21m, 1.77m, 1.46m and 0.98m, respectively. The lake is rich in organic matter in its bottom sediments, amounting to 6.32% in the dried silt sample fetched from the lake bed. The lake's main function is to regulate the flood currents of the Yangtze mainstream in the rainy season; concurrently it has functions conducive to irrigation, fisheries, inland navigation, urban construction and supply of potable water to lakeside residents. It is representative of numerous shallow lakes in the middle and lower reaches of the Yangtze.^[5]

Because of its shallow depth, fertile silt and temperate climate, the

lake itself is a paradise for faunal, floral and microbiological organisms. The whole surface of the lake is covered with thriving vegetation including various water-loving plants (hydrophytes) such as Cyperaceae and Gramineae. The latter now account for a smaller percentage in the lake, while the dominant aquatic vegetation in the lake water consists of communities of *Zizania latifolia* and *Nelumbo nucifera*, roughly covering 100 square kilometers in total area. The floating hydrophytes include *Trapa incisa*, *Nelumbo nucifera*, and *Euryale fero*. They are mixed with communities of various submerged plants such as *Potamogeton malaiianus*, *Potamogeton maackianus*, *Myriophyllum spicatum*, *Vallisneria*, etc. According to the current hydrological, soil and vegetational conditions, the lake and its neighborhood should be defined as a wetland ecosystem consisting of a shallow water body and littoral marshlands.

In order to protect the faunal and floral legacies, the marshland ecosystem and the unpolluted freshwater resources in the lake, and the biodiversity attached to it, wetland ecosystem reserve has been set up under the State's protection, a wildlife sanctuary on the middle and lower reaches of the Yangtze.

2. The value of the Honghu wetland

A wetland ecosystem is of value and benefit for human and wildlife development, and the pristine environment. Specifically, the value



A elegant scene of the lotus flower native to Lake Honghu.

of a wetland ecosystem may be classified as the value derived from the natural endowment (water resources, bio-resources, etc.), the value of the eco-environment (flooding regulation, environmental purification, climatic adjustment), the value of special protection (biodiversity) and benefits derived from cultural, scientific and educational undertakings.

2.1 The value of natural resources

Lake Honghu is rich in water resources, consisting of surface runoff coming from precipitation, underground water and passing currents of outside water flows. Totaling 3,314 square kilometers in area, the confluent catchment covers the eastern fringe of Changhu lake under the jurisdiction of Jinzhou City in the west, up to Fengkou and Laoxinkou in the north, while it is limited by the Jinjiang and Honghu embankments in the south. Slightly tilting from northwest to southeast, the catchment area is a flatland, averaging 24–28 meters in elevation. The average annual precipitation is somewhere between 1,000 and 1,300mm; its annual volume of surface runoff reaches $19.1 \times 10^8 \text{ m}^3$; and that of the passage run-off is $7.8 \times 10^8 \text{ m}^3$. Each year, an average of $19.6 \times 10^8 \text{ m}^3$ of water enters the lake, with a velocity of up to $513 \text{ m}^3/\text{s}$, while the maximum velocity is $727 \text{ m}^3/\text{s}$. The water resources on the surface are quite plentiful, while the underwater resources are still far from being well exploited. The lake's natural conditions favor the sound growth of various aquatic organisms. According to a survey conducted in the 1980s, the lake is home to 54 fish species and more than 70 species of higher aquatic plants, producing 1.57×10^6 tons of biomass each year. It has 92 species of phytoplankton, with 2.438 mg/L in annual biomass

productivity, totaling 1,400 tons in annual production, and 169 species of zooplankton with 0.559 mg/L in biomass productivity, and 66 species of benthonic animals, totaling 4.4×10^5 tons in biomass output. The thriving communities of aquatic life provide an ideal and productive fish-



In the mid-1950s, in the low-lying Honghu area a lot of water bodies were transformed into croplands, leading to a 75% decrease in the area's flood-storage capacity.

ing ground. In 1998, for example, the output volume of aquatic products in the lake and its accessory water bodies reached 57,000 tons, including 49,000 tons of fish catch. Its aquatic crops have been noted for high economic returns and fast growth in recent years. In addition, some water weeds are used as forage for fish farms, forming a benign cycle in the lake's ecosystem.

2.2 Lake Honghu's value for ecosystem improvement:

(1) Regulation of floods. The Honghu area is frequently hit by inundation or waterlogging due to the uneven distribution of precipitation spatially and temporally, and fluctuations in passage runoffs passing through the area, so that an over-concentration of floodwater in a given locality becomes an inevitable perennial threat, while insufficient rainfall always causes drought, especially in the springtime. Before the

disengagement between the lake and the Yangtze mainstream, Lake Honghu used to act as a reservoir endowed by nature on the middle reaches of the Yangtze. Since a large-scale drive for water conservation engineering construction starting in the mid-1950s, in the low-lying

Honghu area a lot of water bodies have been transformed into croplands, leading to a 75% decrease in the area's flood-storage capacity, and only Lake Honghu and similar large lakes are capable of accommodating floods in the basin. In such a situation, the lake actually works as a voluminous reservoir to retain floodwater in the rainy season and supply water for farmland irrigation in winter and spring. As the lake can store $5 \times 10^8 \text{ m}^3$ of floodwater, a flood calamity is almost impossible to result from a single torrential downpour in the area. The planned water level for the lake's anti-flooding capacity is 25.5m, and the water level of the designed storage zone is 24–24.5m in elevation. At the same time, the lake provides water for summer irrigation. In the dry seasons, the water table is at its lowest, at 24m above the sea level, responding to $2.5 \times 10^8 \text{ m}^3$ in the lake's total capacity, which is ca-

pable of irrigating up to 600 km² of farmland.^[6]

(2) Adjustment of the local climate. Apart from the floodwater capacity, the wetland eco-system of the locality is also conducive to the improvement of air temperature, rainfall and other climatic conditions. According to an analysis of the meteorological data collected from the area from 1961 to 1999, the Honghu wetland plays a certain regulatory role in the local climate. The lake nestles within the city of Honghu, while in nearby counties there are no lakes with large water surfaces. Although the meteorological stations in the three places are similar in terms of the latitude and elevation, the average values of meteorological parameters in long-run observation vary. For example, the annual average temperature sampled in Honghu City is 0.3°C higher than that recorded in the other two places; the former's frost-free period is 5.9–7.5 days longer than that of the other two, while the annual precipitation is 122–190mm higher. All of these variances are caused by the presence of the lake, as it changes the local climatic conditions considerably.^[7]

(3) Self-purification of water quality. Because of farmland irrigation, water pumping, discharge

and other approaches, the lake water is in constant exchange with the outside world. In addition, the lake used to be a paradise for aquatic organisms, so the lake's water is a good agent for purifying water quality, diluting pollutants and eliminating dirt and other contaminants. On the whole, the water quality of the lake is good (see Figure I). With the exception of total phosphorus content being above the decreed norm and slightly going beyond the standards of potassium permanganate index at the two monitoring outposts of Liukou and Xiaogang Chakou, all entries in the regular surveys of the lake water surveillance are up to Ground Water Standard II. So far, Lake Honghu enjoys the status of having "pollution-free" water. The reason for this is the powerful self-purification capacity of the lake itself.

2.3 Special value for protection.

The effect of marginalization in a wetland's eco-landscape makes its native taxa diverse and thriving, providing ideal habitats for various endemic species in different ecological niches so that the wetland itself becomes a fecund gene pool. At the same time, it provides a consummate sanctuary for avian creatures and other forms of wildlife. So a wet-

land ecosystem is universally known as a hub for biodiversity, and therefore it has special value for protection. Investigations show that the Honghu wetland is home to 472 species, 21 variants and one modified variant of vascular plants, 280 species of phytoplankton, 158 species and five variants of higher aquatic plants, including 10 endangered species under special State protection. In the area, 133 species of birds are found in 40 families distributed in 14 orders, including 19 endangered species under State protection. Of the 19 rare birds, *Ciconia boyciana*, *C. nigra*, *M. squamatus*, *Haliaeetus albicilla*, *Aquila heliaca*, and *Otis tarda Dybowskii* are of the first category for State protection, while the other 13 winged creatures are of the second category. In addition, a total of 38 avian species are under key protection by Hubei Province. Each year, more than one million individual waterfowl come here for wintering, as the marshlands surrounding the lake are ideal and customary habitats of various migratory water birds from the north.

In the Honghu wetland nature reserve, biodiversity is the centerpiece of the ecosystem under State protection, while waterfowls are the focus of the protection. The lakeside

Figure I. The current-state evaluation of water quality of Lake Honghu (1993)

Section under supervision	Water discharge lock	Lake center	Liukou	Xiaogang Chakou
pH value	8.37	8.41	8.09	8.25
Soluble oxygen	9.6	9.52	8.48	8.69
Index of KMnO	3.81	3.91	4.48	4.03
Nitrite	0.026	0.009	0.047	0.092
Nitrate	0.46	0.53	0.52	0.629
Total phosphous	0.042	0.089	0.069	0.043
Percentage of entries reaching the preset standards	91	91	82	82
Conclusion	up to the norms set for Ground Water Standard II			



The thriving wildlife in Lake Honghu makes it a primordial pool of biodiversity. The picture shows the Ecosystem Garden in Lake Honghu.

marshlands are the waterfowl's spawning grounds, living habitat, wintering resort and stopovers on their migratory journeys. According to the definition of waterfowl stipulated in the international treaty on the waterfowl habitats, they are birds ecologically relying on wetlands for their survival. From this, we may see that wetland is a critical factor for the survival of waterfowl, and at the same time waterfowl are an important component of a wetland ecosystem. To protect a wetland ecosystem not only means the preservation of its ecological setting, but also of its biodiversity. For the subsistence and biodiversity of waterfowl, such protection is of vital importance.

2.4 The cultural, scientific and educational values of the Honghu Lake wetland

The Honghu wetland is a natu-

ral large-scale fluvio-lacustrine ecosystem in the low-lying marshlands of the Jiangnan Plain on the middle reaches of the Yangtze. Its picturesque scenery, abundant and unique natural endowment and relatively unpolluted eco-environment have won unanimous acclaim from experts both at home and abroad. Popularly renowned as a "Land of Rice and Fish" or a "Pearl inlaid on the middle reaches of the Yangtze Valley," the lake itself has great tourism potential.

As a scientific research hub, Honghu Lake is capable of providing backgrounds and an ideal experimental base for some basic disciplines such as ecology, biology, geography, hydrology and climatology, as well as for wetland research and waterfowl research. A number of scientific surveys and R&D tests have been conducted

there by CAS institutes and universities, such as the Institute of Geodesy & Geophysics, Institute of Hydrobiology, Wuhan Institute of Botany, Wuhan University and Central China Normal University, leading to a bumper harvest of R&D results. In particular, an ecological experimental station at Xiaogang, beside the lake, has been inaugurated by the CAS, as a major base for probing the wetland ecosystem. The station is equipped with a monitoring system for supervision of the eco-environment and natural resources, and makes valuable contributions to the protection and exploitation of the lake's natural legacies.

3. The protection & exploitation of the Honghu wetland

In the evolutionary course of Lake Honghu's wetland ecosystem, human activity has played a critical

role in influencing its surroundings. Reclamation of farmland from the lake's water surface used to be the main way local people made use of the lake's natural resources, drastically reshaping the wetland ecosystem. Because of the excessive human interference, the Honghu wetland's eco-environment is threatened, resulting in structural simplification of its ecosystem, fewer species in its taxonomic composition and downgrading of its biodiversity. Hence, its ecosystem is plagued by increased structural instability, shrunken self-adjustment capacity and the increasing fragility of the ecosystem itself. As a result, the wetland ecosystem has lost much of its value.

The eco-environmental change is greatly influenced by various forms of human exploitation. If we adopt effective measures to restore the lake's eco-system, the whole lacustrine system can operate in a benign cycle. If the lake's natural endowment is subject to predatory exploitation in disregard of the protection of its ecological setting, the precious values of the Honghu wetland might

be completely lost, and it would evolve into a terrestrial eco-system.

In order to protect and utilize this precious national legacy, we must insist on the unity of eco-environmental benefits and economic returns, between partial interests and overall interests, and between immediate income and long-term revenue.

The concrete steps we have to take are as follows:

(1) Both reconstruction and administration of the wetland reserve surrounding the lake must be improved, and the work must be concentrated on the wetland ecosystem, the waterfowl which live there as their wintering habitat, and the aquatic and lakeside populations of indigenous fauna and flora;

(2) The lake's water surface must be rehabilitated by returning reclaimed farmland to the original vegetation so that the lake's function of flooding regulation can return to its previous level;

(3) The rivalry between the lake and its peripheral waterworks has to be defused. A regular practice has to be introduced to inject the Yangtze

mainstream's water and fries into the lake by unclogging the waterway passage between the two, so that the structure, function and biodiversity in the fluvio-lacustrine system caught between the Yangtze mainstream and the lake can return to their original state of equilibrium.

(4) In order to step up the protection of the wetland eco-system, it is necessary for us to take all possible measures for the control and reduction of harmful individual and social behavior such as the over-discharge of agricultural and industrial fluid waste, farmland reclamation from marshlands and reckless exploitation of the lake's fish and other valuable aquatic bio-resources.

(5) Based on key districts selectively developed for rational exploitation of lacustrine resources, the lake's aquaculture should become the economic mainstay of the locality. Staged development is imperative, while forestry and animal husbandry should be controlled at the level of moderate development in lakeside areas, so that the whole wetland legacy might be developed in an active and appropriate way. ■



By courtesy of Wang Xueli.

Lake Honghu has long enjoyed a fame of a "Land of Rice and Fish" or a "Pearl inlaid on the middle reaches of the Yangtze Valley" in China.