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Current Situation and Protection Measures concerning the Wetland Resources in Yunnan Province

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Abstract Yunnan has various and rich wetland resources because of the special geographical environment. In recent years, Yunnan has made great achievement in the management, protection and development of the wetland resources, but many problems still exist. Based on the threats, this paper puts forward the protection and use measures for the wetland resources in Yunnan by analyzing and studying the wetland resources as well as types and basic features.

Key words Wetland types, Wetland resources, Threat, Protection measures

1 Introduction

A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. It is known as “biological supermarket”, “kidney of the earth” or “earth filter”^[1]. Currently, there is no unified definition about wetland in the world. In a narrow sense, wetland is generally considered as the transition zone between land and water. In a broad sense, all water bodies on earth except the ocean (water depth of more than 6 m) are regarded as wetland^[2]. In The Convention on Wetlands, wetland is defined as follows: “Wetland means the natural or artificial, permanent or temporary stagnant water, or flowing water, fresh water, brackish or salt water, marsh, fen, or peatland, including not only the marine water with depth of not more than 6 m at low tide, but also the river banks and coastal areas adjacent to wetland, as well as the islands within wetland or the marine waters with depth of not more than 6 m at low tide, especially those islands and water bodies as waterfowl habitat.” Yunnan has various types of wetland resources, including lake wetland, river wetland, glacier wetland, marsh wetland, and artificial wetland. The secretariat of The Convention on Wetlands listed Dabaoshan wetland, Lashihai wetland, Bitahai wetland and Napahai wetland in Yunnan Province as important international wetlands in 2005^[3], so that the importance of Yunnan wetlands was affirmed by the international community. However, with the social and economic development in Yunnan Province, the wetland protection work in Yunnan Province is also facing serious challenges.

2 Overview of the study area

Yunnan (21°8′32″–29°15′8″ N, 97°31′39″–106°11′47″ E) is a province of the People's Republic of China, located in the far

southwest of the country, spanning approximately 394000 km². The terrain is largely mountainous, especially in the north and west. A series of high mountain chains spreads across the province. There is a distinct canyon region to the west and a plateau region to the east. Yunnan's major rivers flow through the deep valleys between the mountains. The average elevation is about 2000 m. The highest point in the north is the Kawagebo Peak in Deqin County on the Diqing Plateau, which is about 6740 m; and the lowest is in the Red River Valley in Hekou County, near the Vietnamese border, with an elevation of 76.4 m. Under alternating control of the East Asian monsoon and the South Asian monsoon, it forms a plateau monsoon climate with distinct wet and dry seasons. November to April in the following year is a dry season; May to October is a rainy season, and 86% of the annual precipitation occurs during this period^[4–5]. Seven climate zones exist within about 900 km from south to north, including tropical zone, southern subtropical zone, central subtropical zone, northern subtropical zone, warm temperate zone, temperate zone and cold zone. All kinds of China's natural zones are distributed in Yunnan Province^[6]. Yunnan has 5635 km² of wetlands, mainly in Pu'er, Kunming, Dali, Yuxi, Diqing and Nujiang. The wetlands are mainly in the Yangtze River Basin (approximately 82.93%). Due to the special nature of climate, there are various kinds of wetland, and the main types of wetland in Yunnan Province include lakes, rivers, creeks, marshes, paddy fields, reservoirs, ponds and dykes.

3 Types of wetland

3.1 Lake wetland Yunnan has 37 lakes with an area of more than 1 km² each, divided into four lake groups (see Table 1). There are 24 permanent lakes and 12 seasonal lakes. The lake wetlands are composed of the shores of Lakes and the shallow water plant growth areas. Yunnan's lake wetland is on the Yunnan–Guizhou Plateau, so it is also known as “plateau lake” wetland.

Table 1 The lake with an area of more than 1 km² in Yunnan Province

Lake groups	Permanent freshwater lakes	Seasonal freshwater lakes
Central Yunnan lakes	Dianchi Lake, Fuxian Lake, Xingyun Lake, Qilu Lake, Yangzong Lake, Qingshui Lake	
Western Yunnan lakes	Erhai Lake, Chenghai Lake, Lugu Lake, Zibi Lake, Jianhu Lake, Tianchi Lake, Longhaizi Lake, Bitahai Lake, Haixihai Lake, Shuduhai Lake, Xihu Lake	Napahai Lake, Labu Lake, Qinghai Lake, Wenhai Lake, Mutun Lake, Lianhua Lake, Beihai Lake
Southern Yunnan lakes	Yilong Lake, Datun Lake, Changqiao Lake, Puzhe Lake, Chahei Lake, Yuxianhu Lake, Laowuhai Lake	Sanjiao Lake, Chirui Lake
Eastern Yunnan lakes		Yuehu Lake, Guanyinghai Lake, Yigu Lake, Yaoshang Lake

3.2 River wetland Many rivers flow in Yunnan Province, and there are six major river systems (Yuanjiang River system; Jinsha River system; Dulong River system; Nujiang River system; Lancang River system; Nanpan River system. The six major river systems consist of 600 rivers (180 major rivers and 37 international rivers). The permanent river wetland is mainly distributed in the areas along mainstreams and tributaries of six major river systems.

3.3 Marsh wetland Marsh wetland is mainly distributed in the warm temperate and subfrigid mountains at an altitude of over 2000 m, as well as the mountain valleys on the ancient planation surface, river beaches, terraces, glacial depressions, snow erosion depressions, lakeshore depressions, gentle mountain slopes, foothill alluvial fan edge depressions^[6-7]. The marsh wetland in Yunnan Province mainly consists of four types (forest swamps; herbaceous swamps; swampy meadows; shrub swamps), mainly distributed in the northwestern high mountains. The mountain snowmelt gathers on the surface to form the scattered small marsh wetland. Yunnan has a lot of lake and swamp wetlands, commonly known as “sea of grass”, located in the shallow areas of the lake edge.

3.4 Constructed wetland The constructed wetland is divided into small reservoirs in a hilly area and paddy fields. Since 1949, Yunnan has constructed a total of 4921 reservoirs in order to solve the problems of living water, industrial water and irrigation water. There are a total of 45000 small reservoirs. The constructed agricultural wetland – paddy field is widely distributed in Yunnan Province, of which the terrace is world-famous due to the advantages on number and area, such as Hani Terrace. Many small reservoirs and paddy fields contribute to a huge system of constructed wetland in Yunnan Province, and their area needs to be further identified.

3.5 Glacier wetland Yunnan's most areas are at high altitudes, and there are many permanent or seasonal snow peaks, some of which are called snow-capped mountains, mainly distributed in northwest Yunnan. By seasonal melting, a lot of thawing water directly filtrates into the soil, making the soil saturated or unsaturated semi-frozen, thereby forming a unique wetland environment – glacier wetland. The region has its unique flora and fauna, and forms its unique wetland ecosystems. For example, the glacier areas, at the top of Taizi Snow Mountain, Meili Snow Mountain, Jiawu Snow Mountain, Chali Snow Mountain, and Yulong Snow Mountain, can be classified as glacier wetlands.

4 Wetland resources

4.1 Biological resources The complexity of the terrain in Yunnan creates its biodiversity, and Yunnan is recognized as “kingdom of plants and animals”. In Yunnan's second wetland resource survey, 1006 kinds of wetland vertebrates are recorded, including 67 kinds of national key protected wild animals and 237 kinds of wild animals unique to Yunnan Province^[8]. The plateau wetland wild animals in Yunnan Province account for about half of national plateau wetland wild animals (Table 2). The survey results show that there are 12 types of wetland vegetation and 189 kinds of phytoformation. 2274 kinds of higher wetland plants are recorded, including 12 kinds of national key protected wild plants, and 116 kinds of unique plants in Yunnan Province^[7]. Yunnan's habitats for plateau wetland plants include lake water habitats, marsh habitats around lakes, river shoal habitats, gully habitats near rivers, swamp meadow habitats, pond marsh habitats and field marsh habitats^[9]. Yunnan's wetlands are all in the mountain environment with an altitude of over 1000 m, which is not conducive to the aquatic vegetation growth, but the wetland plant diversity is rich, and the wetland aquatic vegetation community is extremely complex. There are not only aquatic plant communities common in most domestic wetlands, but also the *Ottelia acuminata* var. *crispa* community unique to the Yunnan – Guizhou Plateau and *Isoetes hypsophila* unique to high and cold wetlands, as well as the arctalpine *Hippuris Vulgaris* community that is not seen in the Yangtze River Basin wetlands^[9].

4.2 Cultivated land resources The cultivated land in wetland resources mainly refers to the paddy field, mainly in the mountains and plains of Yunnan. The soil of Yunnan's paddy field is always in a water-saturated state, and it forms a constructed wetland system in which rice grows associated with other aquatic plants. The terraced paddy field in Yunnan is formed under the special natural and cultural environment, and the most typical example is Hani Terrace in Honghe Prefecture, with a high scientific value.

4.3 Water resources There are rich water resources in Yunnan's wetland resources, with 222.2 billion m³ of river runoff, 30 billion m³ of lake water storage and 1 billion m³ of glacier and mountain snow water storage. Yunnan has built over 280000 types of water conservancy projects (including nearly 50000 water storage projects), with total capacity of about 8.032 billion m³, and annual water supply capacity of 12.9 billion m³, and total effective

tive irrigation area of 212000 ha.

Table 2 The wildlife in Yunnan's wetlands

Wetland animals	Order	Family	Species	Remark
Wetland birds	8	20	134	The number accounts for 49.6% of the total number of China's wetland birds.
Waterfowls	7	18	125	Important waterfowls include black crowned crane, black stork, Chinese merganser, hooded crane, grey crane, etc.
Fish	9	27	432	The amount accounts for 42.2% of total amount of freshwater fish in China, ranking first in the county, and nearly one-third of the species live in the highland lakes.
Amphibians	3	11	118	The number accounts for 53.2% of total number of amphibians in China, more than 45 species can be found only in Yunnan, and 20 species are unique to Yunnan.
Reptiles	2	11	53	8 species can be found only in Yunnan.

4.4 Tourism resources Yunnan's wetland tourism resources include rivers, highland lakes, terraces and snow-capped mountains. The river tourism resources include three parallel rivers of Yunnan protected areas (Nujiang River, Lantsang River, and Jinsha River), and Hutiao Gorge in upper reaches of Jinsha River. The lake tourism resources include Erhai Lake, Fuxian Lake, Lugu Lake, and Dianchi Haigeng Dam. The snow mountain tourism resources include Yulong Snow Mountain, Meili Snow Mountain, Taizi Snow Mountain, and Chali Snow Mountain. Hani Terrace in Honghe Prefecture is a terrace tourism resource. These wetland tourism resources account for a large proportion in Yunnan's tourism industry.

5 Problems in Yunnan's wetland environment

There are some problems in Yunnan's wetland environment, such as over-exploitation of wetland resources, overuse of biological resources, deteriorating pollution and irrational use of water, shrinking natural wetland and degradation of ecological functions. In Central and Northeast Yunnan, the swamp meadows and freshwater wetlands have decreased by nearly 40% over a decade, and the ecological functions of some wetlands have degraded. 28% of natural wetlands are seriously invaded by alien species; 25% of wetlands face serious pollution threat and control difficulty; more than 50% of marsh and swamp meadow wetlands suffer from over-grazing; 18% of wetlands have the problem of travel barbarism^[8].

6 Recommendations

6.1 Speeding up the survey and regulatory system construction of wetland resources and promoting the sustainable use of wetland resources It is necessary to carry out the survey of wetland resources, strengthen the supervision and management on this basis, and establish a scientific planning system on wetland resource sustainability in Yunnan Province. There is a need to avoid over-exploitation of water resources, rationally allocate water resources, and strengthen the wetland water pollution monitoring; emphasize the intensity and scale of biological resource use to ensure the coordination of the wetland ecosystem components and keep the integrity of the entire ecosystem; strengthen the introduction management, pay attention to the strict quarantine of alien species, and establish early warning system for the alien species

invasion, in order to minimize the invasion risk and maintain wetland ecosystem safety in Yunnan Province^[10].

6.2 Accelerating the construction of wetland nature reserve

Yunnan Province has made great progress in the construction of protected areas, such as the establishment of Yunnan Plateau Wetland Research Center and introduction of Yunnan Wetland Protection Plan. So far, Yunnan has built 19 nature reserves regarding forest ecosystems, wetland ecosystems and wildlife, with a total area of 855400 ha^[11]. However, these initiatives still fall far short of the requirements of protecting all wetland resources, and it is necessary to accelerate the construction of wetland nature reserve.

6.3 Comprehensively utilizing legal and administrative means to protect wetland resources For the protection of wetland resources, we must use legal, administrative and economic control means to strictly strengthen the discharge standards of industrial wastewater and sewage; strengthen wetland use management, and strictly prohibit the illegal reclamation of farmland and illegal construction on wetlands; impose corresponding legal sanctions or necessary administrative punishment on the enterprises and units for violations; enhance the environmental awareness of the residents around the wetlands, strengthen environmental education and publicity, and mobilize the whole society to protect wetland resources.

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