The conservation and management of plateau wetlands in Yunnan Province, China

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Abstract. Wetland represents an important type of ecosystem that supports the development of human society. As a unique category of wetland ecosystem, plateau wetlands play a key role in maintaining biodiversity and providing ecosystem functions and services. The current study focuses on five major aspects that are closely related to the protection and management of plateau wetlands in Yunnan Province, China, including wetland monitoring and assessment, ecological restoration practice, the establishment of protection and management system, cross-sector communication and cooperation, and the development of public education programs. Also, based on lessons from successful experiences in wetland protection and management on a national and international scale, as well as an analysis of current situation and existing problems in current practice of protecting plateau wetland in Yunnan Province, we put together some suggestions to help protect and manage these precious wetlands in Yunnan from the perspective of sustainable development.

1. Introduction
As an important component of aquatic ecosystems with high levels of ecological complexity, wetlands maintain high biodiversity and provide essential ecosystem functions, such as climate regulation, water purification, resource circulation and balance maintenance. As a special type of wetland ecosystems, plateau wetlands deliver particularly important ecosystem functions and services [1]. Taking Yunnan as an example (the most southwestern province in China), a great number of plateau wetlands are found in this province, especially the northwestern region. Because these plateau wetlands are distributed in the middle and upper reaches of some world-famous rivers such as the Yangtze River and the Mekong River, they exercise significant influence over downstream environmental, social and economic stability [2, 3]. Due to their unique geographical features that beget habitat diversity, these plateau wetlands are home to a wide variety of flora and fauna, including many rare and endangered endemic species [4]. In addition, these plateau wetlands provide valuable natural resources for local socio-economic development. In particular, wetland-related tourism has become one of the major financing sources in Northwestern Yunnan. However, with rapid population growth and economic development in Northwestern Yunnan, the conflicts between wetland protection and resource utilization have been intensified. Water contamination and vegetation damage associated with tourism activities, agricultural land extension, habitat fragmentation and overgrazing represent some of the most serious threats to plateau wetlands in this region. Meanwhile, the level of public awareness about plateau wetlands and
attitudes toward their conservation is generally poor. Therefore, it is not surprising that plateau wetlands in northwestern Yunnan in general, and their integrity and stability in particular, are seriously threatened. 

Through a review of the literature on the subject of the conservation and management of plateau wetlands, and a reflection on the status quo and existing problems of plateau wetland conservation in Yunnan, the present study focuses on five major aspects that are closely related to wetland conservation and management in Yunnan, including wetland monitoring and assessment, wetland restoration, the development of wetland conservation and management system, cross-sector communication and cooperation, and the establishment of public education programs.

2. Wetland monitoring and assessment

Since many plateau wetlands serve as the birthplaces of important rivers in China, and these wetlands are also vital to the survival and development of local communities, a key to maintaining their regulating services is through long-term monitoring of water quality. At present, two monitoring indicators, namely, physical and chemical measures, are widely used to reflect water quality, either through manual sampling or using automated sampling equipment. Although manual sampling is relatively cheap to conduct, it is proved time-consuming, laborious difficult, and hard to yield continuous monitoring results. By contrast, continuous sampling yields continuous sampling data, but the cost of the construction and maintenance of multiple monitoring sites is pretty high [5]. In view of this, domestic and foreign scholars generally believe that a systematic wetland dynamic monitoring system should be established in order to comprehensively and timely grasp the water quality of the wetland ecosystem. In view of this, domestic and foreign scholars generally believe that the development of an efficient and affordable monitoring method is a top priority in order to monitor water quality of wetland ecosystems in a consistent, cost-effective and timely manner. For example, wireless sensor network technology can remotely monitor the water quality status in real time, and its application can effectively monitor the wetland water environment [6]. In fact, many states in the United States have adopted this technology, so relevant water quality monitoring data for local wetland ecosystems can be regularly published on the local EPA website or on some popular social networking sites in the form of days, weeks, months or years [7]. This will not only provide important scientific evidence for the decision-making of the wetland authorities, but also help to promote the openness of information and protect the public’s right to know and supervise. Therefore, the water quality monitoring and evaluation of the plateau wetland ecosystem should actively explore the application feasibility of new technologies such as wireless sensor networks in water quality monitoring and evaluation while using traditional methods.

A sufficient number of studies have shown that in addition to physico-chemical indicators of water quality, several types of biological indicators, such as plankton, plants, amphibians, reptiles, insects and birds, could also effectively reflect the integrity and health status of a wetland. For example, Ottelia acuminate [8] and black-necked crane [9] are some well-known species that are very sensitive to changes in water environment, and thus could serve as indicator species of the health of plateau wetlands. Also, vegetation diversity could enhance ecological stability of plateau wetlands [10]. Therefore, together with environmental indicators, the monitoring and assessment of these biological indicators could help us better understand the composition, structure, and function of plateau wetlands over time and across spatial scales, and further enable us to take effective measures to provide plateau wetlands, which would then offer numerous benefits to people through enhanced ecosystem services [11]. The Wetland Evaluation Technique (WET) and the Vegetation-Based Index of Biotic Integrity for Wetlands (VIBIW), each containing a relatively complete list of quality indicators for wetlands, are currently widely used in North America, and should serve as important references as we are in the process of developing a comprehensive assessment system of plateau wetlands. Moreover, the application of remote sensing technologies and Geographic Information Systems (GIS) could help us assess the ecological integrity of plateau wetlands at the landscape scale. Overall, when the monitoring and assessment programs of plateau wetlands in Yunnan are conducted, multiple strategies, techniques, tools, instruments and assessment approaches should be applied so that we could have a more
comprehensive, accurate and objective assessment of the actual situations of the studied plateau wetlands.

3. The restoration of degraded wetlands
Due to the combined influence of natural and human factors, water quality of plateau wetlands in Yunnan is often compromised, and wetland pollution is particularly worrisome in northwestern Yunnan where some well-known wetlands are victims of environmental pollution, such as Lashihai and Jianhu plateau wetland. Therefore, the ecological restoration of these degraded plateau wetlands is very urgent. At present, the most commonly used wetland restoration strategies include wetland habitat restoration, wetland biodiversity restoration, as well as wetland ecosystem structure and function restoration, with each placing emphasis on some specific components of wetlands [12]. For example, wetland habitat restoration strategy focuses on enhancing the heterogeneity and stability of wetland habitats through engineering approaches, whereas wetland biodiversity restoration aims to increase biological diversity of wetland ecosystems. Wetland ecosystem structure and function restoration remains a challenging work, and here we focus on the application of phytoremediation in wetland restoration. For example, a field experiment conducted in the Florida Everglades found that some vascular plants (e.g., Typha orientalis) and algal species could effectively improve water quality by reducing phosphorus concentrations in water [13]. Studies conducted in China’s Sanjiang plain wetlands also showed that the optimal assembly of different vegetation types could herald significant changes in wetland structure and functions, which further contributed to social and environmental sustainable development in that region[14]. Therefore, when phytoremediation approach is used for the remediation of degraded plateau wetlands in Yunnan, we should use as many native plants as possible with different niche requirements, life history strategies and functional traits so as to promote multifunctionality. In addition, when we carry out wetland restoration projects, long-term monitoring activities of restored wetlands should also be conducted in order to assess the effectiveness of restoration efforts. Due to their sensitivity and vulnerability, global climate change may impose more destructive impacts on plateau wetlands than many other ecosystem types [15]. Therefore, in addition to pursuing effective restoration approaches, we should also actively seek strategies to protect plateau wetlands from climate change, and address several important questions, such as how to use advances in science and technology to combat climate change and protect plateau wetlands, how to enhance the adaptability of these wetlands so that they are more resistant to extreme weather, and whether potential feedbacks exist between plateau wetlands and climate change. If so, how to enhance the role of plateau wetlands in regulating climate change?

4. The development of wetland conservation and management system
In China, although the existing laws and regulations involve the protection of wetlands, China has not yet introduced laws and regulations on wetland protection at the national level. The legal basis for targeting, unity and enforceability makes a big gap between China’s wetland protection work and the international legalization and standardization management. Although Yunnan has its own wetland protection regulations, the protection and management of plateau wetlands is not sufficient enough, and many loopholes and ambiguities exist in the current safeguard measures. In these respects, the practices of European and American countries are generally successful [16]. For example, in the United States, the Federal Water Pollution Control Act clarifies the license management agencies and supervisory agencies for wetland development and protection, and has developed detailed management plans. Meanwhile, the United States also clearly stipulated the wetland water environmental protection, wetland ecological benefit compensation and wetland utilization permit system in the Clean Water Act, and introduced a policy including wetland protection tax exemption policy and wetland occupation and compensation policy. These series of policies has effectively promoted wetland protection processes and enhanced conservation effectiveness. The US Environmental Protection Agency (EPA) sets up special funds (Wetland Program Development Grants) for the protection of wetland ecosystems throughout the entire country. Each state also has its own regulations and policies of wetlands, playing emphasis on specific situations (e.g., the type, distribution and conservation status) of each wetland.
Therefore, China should clarify wetland management departments and their responsibilities during the improvement course of wetland legislation and related policies, ascertain wetland ownership and develop resource licensing approval system in order to ensure that the relevant judicial law enforcement departments have clear functions and perform their duties. At the provincial level, on the one hand, we should follow the Yunnan Wetland Protection Regulations, and formulate implementation rules in order to ensure that the supporting implementation rules of the regulations are implemented. Meanwhile, because special funds are an indispensable guarantee for the protection and management of plateau wetlands, Yunnan should also establish special funds for plateau wetland protection with diversified financing channels. On the other hand, we should also strengthen research on the ecological benefit compensation model of plateau wetlands. For example, in order to reduce overgrazing in the lakeside zone of the northwest plateau wetlands, the local herders should be guided to reduce grazing pressure by means of grazing ban or rotational grazing in accordance with specific conditions, and receive certain financial compensations for their sacrifices.

5. Cross-sector communication and cooperation
The protection of wetlands demands concerted efforts of relevant departments and organizations. Taking the protection of the Yangtze River wetland as an example, the development of wetland protection network in the middle and lower reaches of Yangtze River is a successful case of cross-regional and inter-departmental cooperation in China. Such a protection network integrates more than 40 natural reserves representing different wetland types in the middle and lower reaches of the Yangtze river, promotes the exchange and cooperation among multiple wetland-related nature reserves, management organizations, research institutions, social groups and the general public, and makes a unified planning and rational layout of wetland protection and management in the Yangtze river region. This remarkable exploration also provides a good reference for the cross-regional cooperation in issues related to the conservation of plateau wetlands. As many unique plateau wetlands are distributed in the Qinghai-Tibet plateau, Yunnan-Guizhou plateau and Mogolia-Xinjiang plateau and so on, if we can borrow successful experiences of the wetland protection network established in the middle and lower reaches of the Yangtze river, the governments at all organizational levels team up with wetland conservation organization in a close cooperation manner but also serve individual functional roles. Also, several standards should be established regarding the sharing of the monitoring data of plateau wetlands and the formation of the assessment system of the health status of plateau wetlands. By doing so, the linkage mechanisms of supervision of plateau and the strengthening of law enforcement are expected to be greatly improved.

6. The establishment of public education programs
In Europe and the United States, the public also plays a very important role during the processes of wetland conservation and management, and has become an inexhaustible driving force for sustainable development of wetlands. Actually, the public’s enthusiasm for wetland conservation is largely driven by successful publicity and education in environmental protection and the development of environmental awareness. In China, although similar publicity and education activities related to wetland protection have been conducted across the country, these propaganda and education activities are often superficial or serve as public stunt, but become difficult to truly win the trust of the public and improve their awareness of the importance of environmental protection. In addition, the lack of public participation mechanism also seriously affects the enthusiasm of the public. Since the quality of educational activities related to wetland conservation is a key point, we believe that education activities should be closely related to the theme of environmental protection and the improvement of people’s livelihood, and guide the public to understand the close associations between people’s livelihood and enormous ecosystem services sustained by plateau wetlands. For example, for the general public, the importance of the protection of plateau wetlands is probably not because such wetlands provide necessary habitats for wild animals. Instead, the protection of the plateau wetlands is linked to improving
the quality of life of the local people. Therefore, the organizers need to think carefully and wisely about the content when they are in the preparation phase of publicity and education activities. Also, as the public is an important force to promote the protection and management of plateau wetlands, we need to increase public participation channels, and encourage social groups to participate in different aspects of wetland protection.

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