BIODIVERSITY MONITORING FOR AND MANAGEMENT OF FRESHWATER ECOSYSTEMS IN CHINA: A DISCUSSION AND POSITION PAPER

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Abstract: Due to the rapid economic growth and the continuous increase of human, ecosystem disturbances and habitat destructions, the biodiversity of freshwater ecosystems in China is rapidly declining. This issue is gradually gaining the government's attention as its environmental policy becomes more and more equally-weighed on both "pollution prevention and control" and "ecological conservation" issues while only the former was emphasized in the past. However, some unsolved issues still exist with regard to aquatic biodiversity monitoring and management in China. For example, there are functional overlaps among governmental departments; regional ecological function divisions are not clarified; biodiversity is usually neglected or not emphasized in environmental impact assessment for construction projects; and so on. In our opinion, the following areas should be emphasied: (a) enhancing the cooperation among governmental departments; (b) setting up mechanisms to allow ecological watershed management; (c) establishing the biodiversity conservation and ecological restoration planning for local freshwater ecosystem; (d) clarifying the ecological function divisions; (e) enhancing the biodiversity monitoring and management for freshwater ecosystem in environmental impact assessment studies for industrial construction and rural development projects; (f) establishing a technical regulatory framework for related monitoring and management activities which includes an index system for monitoring and assessment; (g) studying and establishing the related biological criteria for formulating assessment standards; and (h) paying attention to aquatic vegetation, fishes, benthic macro-invertebrates and other key aquatic assemblages.

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China is one of the countries in the world with the richest species biodiversity in freshwater ecosystem. However, due to the rapid economic growth and the continuing increase of human disturbances and destructions of aquatic habitats, the biodiversity of freshwater ecosystems is drastically declining. Waterbodies become more and more "deserted" of sensitive species. Water areas are reduced, fragmentized, and changed in their hydrodynamics (i.e. damming), causing changes in sedimentation and other changes. For instance, the area of the Dongting Lake was 4350 square kilometers in 1949 and had been reduced to 2619 square kilometers in 1983[1]. The diversity of species, including aquatic plants, macro-invertebrates and fishes, was greatly reduced. About 10% of the freshwater fishes now belong to the endangered species[2]. The situation is especially serious in the areas with high human population densities and heavy economic activity. A high biodiversity of freshwater ecosystem is the sign for both integrity of aquatic bio-resources and health of aquatic environment. Thus, this issue must be highly emphasized by resource and environment management to allow a sustained use of the resource and maintain a healthy environment. In the past, resource management focused on maximizing production while environment management paid more attention to pollution prevention and control. Compared with terrestrial ecosystems, the issue of the bio-

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diversity of freshwater ecosystems is far from receiving the attention it deserves by most people[1]. This is extremely disadvantageous to the conservation and sustainable utilization of the biodiversity of freshwater ecosystem in China. As the government's environment policy becomes more balanced on both "pollution prevention and control" and "ecological conservation", this issue gradually gains the attention of the management departments. The monitoring of the biodiversity of freshwater ecosystems is the basis for making sound decisions in various management schemes. At the same time, it is also one of the important aspects of regional and local management. Therefore, we will provide our opinions and comments on the related issues and discuss what is required for the monitoring and management of the biodiversity of freshwater ecosystem in China.

1 Problems

To maintain the integrity of the biodiversity of freshwater ecosystems is the objective of the management of water resources and water environment. However, the current status of the monitoring and management in China can not effectively support this objective. In this paper we will analyze the situation from both the basic science perspective and the applied perspective.

1.1 Problems in the basic understanding of biodiversity issues

1.1.1 System and mechanism Due to the past lack of the understanding for the importance of conservation measures to maintain biodiversity of freshwater ecosystems, the current works in various related aspects are weak and unsatisfied. The major problem for the monitoring and management of biodiversity in freshwater ecosystems is the functional division and sometimes overlap of the duties and involvement of governmental departments, and the geographically ecological functional divisions are not yet clarified.

In China, several governmental departments are responsible for the biodiversity conservation of freshwater ecosystems, including the ones for Environmental Protection, Agriculture (Fishery), Water Resources, Science and Technology, Education and others. The State Environmental Protection Administration of China (SEPA) is responsible for the overall management of biodiversity conservation. The Agriculture Ministry is responsible for the conservation, research and utilization of the freshwater fishery and bio-resources. Regarding monitoring, there are more than 2000 environmental monitoring stations in the SEPA system. The Chinese Academy of Sciences has two observation stations for wetland ecology. The agriculture system has 480 monitoring stations for agriculture environmental protection research[3]. However, the communication and cooperation among these related departments and branches are weak. Each individual unit seems to operate independently from each other. There is a lack of strong overall communication, organization and cooperation.

Division of the ecological functional regions is the effective means and the basic work for ecological conservation. After the government's issues and enforcement, they become legally effective. Although the government currently pays much more attention to the ecological conservation, the work of the local to regional ecological functional divisions is still neglected compared to the rapid economic growth. The resources and environments, including aquatic biodiversity, are usually not allocated optimally and thus are wasted and destructed.

1.1.2 Standards and technology The bio-criteria based on different ecoregion (bioregion) is the basis and standard for ecological environment conservation, restoration, monitoring and assessment. The bio-criteria[4] for the freshwater ecosystem in a specific eco-region is just its biodiversity criteria. It is the objective pursued by the biodiversity monitoring and management for freshwater ecosystem. Currently, in China, there is no eco-region division based on different compositions of flora and fauna as well as habitat which could be used for water environment management. The related bio-criteria for water environment have not yet been established. The "China Environmental Quality Standards for Surface Water" have been issued and executed for more than 20 years. Currently, its fourth version is put in practice. It deals with the chemical characteristics for water environment based on different functional requirements for water areas. There is no clear biological characteristics for water environment included[5]. The lack of biological objectives (i.e. the lack of biodiversity objectives) is a serious limitation of the water environment standards for water environment

management. Accordingly, considering technical aspects, the biodiversity monitoring and assessment system based on the bio-criteria of freshwater ecosystems has also not yet been established. In the past, there was not enough attention paid to the biodiversity issues of freshwater ecosystem in the environmental bio-monitoring in China. The monitoring objects are mainly plankton, periphyton, benthos and others, rarely involving macrophytes and fishes[6]. However, for biodiversity conservation of freshwater ecosystem, aquatic vegetation, fishes, benthic macro-invertebrates and other taxa are part of the key assemblages, which have important ecological functions and need to be included into future biodiversity considerations.

1.2 Problems at application level

1.2.1 Environment management The construction projects in a specific region are the key human factor affecting local natural ecological patterns and habitats, which in turn are highly related to the local variation and functional integrity of the biodiversity of any freshwater ecosystem. Environment Management Agency will execute a comprehensive management plan for construction projects, including environment impact assessment procedures, and will also handle the verification and acceptance upon the completion of projects, the daily routine environment management during the regular operation of projects after completion, and other issues. Since the environment impact assessment for the construction projects will estimate the environmental feasibility and the potential damages which cannot be mitigated, the scales and sites of projects and their impact to the environment from ecological point of view, considerations of the biodiversity conservation for freshwater ecosystem becomes especially important. Nevertheless, the environment impact assessment process and other environment management steps as presently handled by the responsible agencies usually do not pay enough attention to the biodiversity conservation issue. They rarely consider biodiversity conservation issues for freshwater ecosystems in their procedures. The only exceptions are those inside nature reserves. For many regions outside natural reserves, there is a clear lack of effective management means to deal with biodiversity.

In China, the environment quality assessment procedure is in its inceptive stage when compared to other parts of the world, especially from an ecological point of view. The importance of biodiversity in the assessment is just now being recognized. The acknowledgement that "the aquatic biodiversity is the important aspect of water environment quality" is still low in many industry and government circles. The pros and cons of biodiversity indicators or indices for the management of freshwater ecosystems has not been well manifested and needs serious consideration, identification of priorities and implementation across various legal entities.

1.2.2 Resource management Although the biodiversity conservation for freshwater ecosystems is within the functional scope of the Departments of Agriculture (Fishery), Water Resources and other resources management departments, the awareness of the needs for ecological conservation is still weak. The level of the sustainable utilization and management of aquatic bio-resources in the country is still low. Most of them remain in the previous level which focused more on exploitation and utilization. This has led to some non-sustainable developments. For example, the lake pen cultivation of fish has led to overloading the water bodies with nutrients and organic waste (especially in the regions of the middle and low reaches of the Yangtze River). The banks of the water bodies are "hardened" (concreted). Dams and gates are usually operated without ecological consideration. All these habitat alterations and intensive human use of water resources badly affected the biodiversity of freshwater ecosystems.

1.2.3 Scientific research application The Chinese Academy of Sciences and university are two main systems in the research for a better understanding of the biodiversity of freshwater ecosystems. The monitoring and management of the biodiversity of freshwater ecosystems are the important application areas of such scientific research. Taking a non-optimistic reality view, it seems that the technical support for these scientific institutions working in this area is not at all sufficient to provide the enough evidence in time that management can effectively use.

1.2.4 Monitoring and management The relationship between those agencies and organizations involved in monitoring and those dealing with environmental management is not sufficiently cooperative. On one hand, the management level is not given equally high priorities than for development. There is no clear and systematic require-

ment and legal framework for monitoring. Management not often rely on the technical support from monitoring and therefore do not incorporate such data into the decision making process. On the other hand, the level of monitoring itself is still limited and not very systematic (especially the monitoring undertaken by environmental monitoring departments). The monitoring data are therefore limited or even restricted and can not well fit the needs of management. The function of serving management is not strong.

2 Suggestions

Aiming at improving the above cited problems and issues, we suggest the following two aspects for management and monitoring improvements in order to effectively support the conservation issues, the recovery needs for severely degraded habitats, and the support of the integrity of the biodiversity in freshwater ecosystems.

2.1 Management

2.2.1 Organizational needs

There is an urgent need to enhance the cooperation among the various governmental departments responsible for conservation of aquatic ecosystems by (a) setting up the mechanism for watershed-based ecological management systems, (b) establishing the planning strategies and responsibilities for biodiversity conservation and ecological restoration at local level.

2.2.2 Ecological functional region

SEPA[6] issued "Outline for Planning the Eco-Funetional Zone (on trial)" which should be used as basis. The geographically ecological function divisions should be clarified for local regions, including those for the freshwater ecosystems. The mechanism of management based on the classification of ecological funcations should be established. The related legislation should be made accordingly.

2.2.3 Environment and resources management

The government should enhance the capacities for biodiversity monitoring and management for freshwater ecosystems in the general environment and resources management departments. The issue must be considered in the environment impact assessment procedures directly, in particular for large important construction projects and those (even small ones) which must be considered as ecologically sensitive construction projects because of the sensitive habitat in which they are taking place. The government should also enhance its monitoring and management capabilities, establishing effective management procedures and rules for different types of ecological functional regions, thereby approaching the objectives for biodiversity conservation of freshwater ecosystems more effectively.

Resources management authorities should (a) control the scale of the production of fishery, change the operational manner for water resources management to minimize ecological impacts or reduce existing impacts, (b) maintain and balance the ecological linkages among freshwater ecosystems, (c) improve the link and ecological interaction among different systems, (d) restore and maintain the biodiversity of freshwater ecosystems, (e) realize the potential and advantages of developing an ecological fishery and ecological water resources management, and finally, (f) promote more aggressively a sustainable utilization of resources which requires highly restrictive resource allocation approaches.

The governmental authorities at different levels (federal, provincial, local) should gradually introduce the concept of biodiversity in their ecological environment quality assessment approaches and the related public information should be issued by them to create a broad understanding of the issues in the public at large. This will greatly enhance the environment quality assessment system and support the mechanisms for public participation.

3 Monitoring

3.1 Bio-criteria

Based on the biogeographic distribution of different aquatic flora and fauna, and the habitat structures, the different eco-regions (bio-regions) should be identified based on scientific criteria and should be established. Upon this, reference site which remain unimpaired or minimally impaired by human activity should be used as representative entities for the biological integrity in the same eco-region (or sub-ecoregion, which can be further selected[4]. To establish the aquatic bio-criteria and management assessment standard for related ecoregion or sub-ecoregion is critically important, providing the support for the biodiversity monitoring and assessment for freshwater ecosystems and the support for the ecological health assessment for water body.

3.2 Technical regulations

With regard to the water body functions or their biological integrity, various technical aspects such as the selection of sampling stations will have to be considered, including sampling procedures, target species identification, data analysis and the application of assessment methodologies and tools, especially emphasizing on aquatic vegetation, fishes, benthic macroinvertebrates and other key aquatic assemblage. This would permit to establish a sound biodiversity monitoring and assessment system based on bio-criteria for freshwater ecosystems.

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