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Q2 Determination of water environment standards based on water 2 quality criteria in China: Limitations and feasibilities

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A B S T R A C T

There is a need to formulate water environment standards (WESs) from the current water 17
 quality criteria (WQC) in China. To this end, we briefly summarize typical mechanisms 18
 applied in several countries with longer histories of developing WESs, and three limitations 19
 to formulating WESs in China were identified. After analyzing the feasibility factors 20
 including economic development, scientific support capability and environmental policies, 21
 we realized that China is still not ready for a complete change from its current nation-wide 22
 unified WES system to a local-standard-based system. Thus, we proposed a framework for 23
 transformation from WQC to WESs in China. The framework consists of three parts, 24
 including responsibilities, processes and policies. The responsibilities include research 25
 authorization, development of guidelines, and collection of information, at both national 26
 and local levels; the processes include four steps and an impact factor system to establish 27
 water quality standards; and the policies include seven specific proposals. 28

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42 Introduction

43 Water quality criteria (WQC) are the basis of water environ-
 44 ment standards (WESs) established to protect humans from
 45 water pollution, sustain the productivity of natural resources,
 46 and ensure the esthetic quality of the environment (Russo,
 47 2002). Traditionally, WQC have been established based on
 48 available data from the 1900s to the 1970s on pollutant
 49 toxicity toward aquatic organisms and species (Stephan,
 50 2002) and defined as the maximum dose or concentration of
 51 pollutants that might cause adverse or harmful effects to
 52 humans or aquatic organisms in the aquatic environment
 53 (Chèvre et al., 2006; Deland, 1979). In China, WESs are legal
 54 limits that are released by the state administrative depart-
 55 ments with consideration of WQC as well as natural, social,

economic, and technological conditions and other factors 56
 (Meng et al., 2006, 2009). China manages water quality 57
 according to its WESs as well as water environment capacity, 58
 pollutant discharge, and monitoring methods. However, 59
 almost all of these standards were derived from and/or 60
 based on WESs or quality criteria of other countries. Consider- 61
 ing that the geographic, regional, eco-environmental and 62
 socio-economic characteristics of China are quite different 63
 from those of the developed countries, the standards or criteria 64
 established in those countries do not necessarily or fully meet 65
 the current needs for environmental management in China (Fu 66
 et al., 2007). Therefore, it is necessary for China to establish 67
 more scientifically sound and appropriate WESs based on its 68
 own WQC (Feng et al., 2012; Jin et al., 2014; Wang et al., 2016; 69
 Yang et al., 2012). In fact, Chinese scientists have already 70

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conducted a substantial amount of research on water quality (Wang et al., 2013; Zhang et al., 1998). The site-specific WQC for Tai Lake were recently established (Chen et al., 2016) and more criteria are on the way (Yan et al., 2015). In addition, a national strategy for the next 15 to 20 years has been initiated to establish an entire WQC system, based on the regional features and current conditions, and more case studies on environmental quality criteria are being conducted (Wu et al., 2010).

Environmental standards are the scientific basis for implementation of environmental management at the national level. With rapid development of the economy, industrialization, agricultural production and urbanization, environment contamination has widely emerged (Wang and Hao, 2012; Zhang et al., 2013), forcing both the government and scientists to realize the importance of deriving a more scientifically sound WES system from the national WQC according to regional eco-environmental and socio-economic characteristics and regulatory needs. However, little thought has been given to approaches for transforming WQC into WESs in China. In the present study, three limitations in the current system used in China for formulating WESs from WQC are discussed. A comparison of management strategy for surface water quality for China and several other countries or regions was introduced. We have also proposed a framework for transforming WQC into WESs for use in China. In this framework, we have considered functional responsibilities, analyzed the proposed transformation process and outlined needs for policies to make the proposed WESs effective within the current and future social system in China. Finally, this information was applied to develop proposed science-based WESs to achieve reasonable protection and management for aquatic resources in China.

1. Mechanisms for formulating WESs from WQC in the developed countries

1.1. USA

Scientists in the United States (USA) have been conducting research on WQC since the 1950s (Kassem et al., 1969; Shaw and Grushkin, 1957). The Clean Water Act (CWA, 1972) established

basic structures for regulating discharges of pollutants into waters in the USA and deriving quality standards for surface waters. Under the requirements of the CWA, the US Environmental Protection Agency (US EPA) is responsible for developing WQC based on the latest scientific knowledge and processes for deriving WESs (Fig. 1). States and tribes are responsible for establishing their own WESs by: (1) directly adopting the recommended national WQC; (2) modifying the recommended national WQC to reflect site-specific conditions or (3) adopting criteria based on other scientifically defensible methods. Moreover, states and tribes are required to organize public hearings for the purpose of revising applicable WESs periodically and submitting WESs to the US EPA for authorization at least once every 3 years. Otherwise, the WESs cannot be applied without approval of the US EPA.

1.2. Australia

Unlike the United States, there are no mandatory WESs in Australia. Instead, water quality targets are used as WESs in the National Water Quality Management Strategy (NWQMS) and WQC are given as the national water quality guidelines. The NWQMS uses environmental values to describe particular environments which are important for ecosystem health or public benefit, welfare, safety and health that need to be protected from pollution, waste discharge and disposal. A three-tiered approach for water quality management is outlined as follows (Fig. 2): (1) At the national level — Sustainable utilization of water resources and coordinated development of the economy and society should be achieved by protecting and improving water quality. The administrative department should simultaneously establish the national criteria for the acceptable level of environmental water quality; (2) At the state or territory level — State water quality planning and environmental policy processes should be implemented, and a management framework including water quality goals based on national criteria should be provided; (3) At the regional or watershed level — Relevant stakeholders are encouraged to participate in establishing and implementing watershed management strategies to revise relevant water quality plans, and regional communities are encouraged to participate in identifying the local environmental

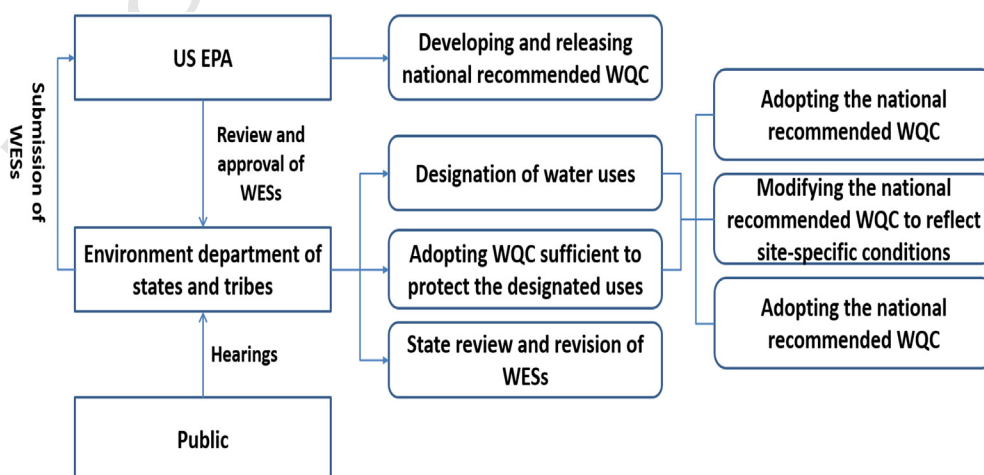


Fig. 1 – Mechanisms for deriving WESs from WQC in USA. WESs: water environment standards; WQC: water quality criteria.

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