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REVIEW

## Water quality, agriculture and food safety in China: Current situation, trends, interdependencies, and management



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### Abstract

Water quality in China is becoming a severe challenge for agriculture and food safety, and it might also impact health of population *via* agriculture and food. Thus, it is causing widespread concern. Based on extensive literatures review and data mining, current situation of water pollution in China and its effects on food safety were analyzed. *The 2nd National Water Resource Survey in China* show that the surface water all over the country was under slight pollution and about 60% of groundwater is polluted. Drinking water quality is basically guaranteed in urban area but it is worrisome in rural areas. In addition, China is the largest consumer of fertilizer and pesticide in the world and the amounts of application still show increasing trends. Fertilizers and pesticides are the most important sources of pollution, which affect human health as persistent organic pollutants and environmental endocrine disruptors. Eutrophication of surface water and nitrate pollution of groundwater are serious threats to drinking water safety. Sewage irrigation is becoming a pollution source to China's water and land because of lacking of effective regulations. Although, with the advance in technology and management level, control of nitrogen and phosphorus emissions and reducing water pollution is still a major challenge for China.

**Keywords:** agriculture, drinking water, eutrophication, fertilizer, food safety, groundwater, heavy metals, microcystin, nitrate, pesticide, pollution, water quality

## 1. Introduction

Water resources in sufficient quantity and appropriate quality are essential to ensure food production and food security. While 1.3 billion people are fed and clothed, China is fac-

ing shortage as well as pollution of water resources and impacts on the environment. Since chemical fertilizers and pesticides are ensuring the food supply, their application also exacerbates the deterioration of water resources, and results in eutrophication, excessive groundwater nitrate, organics and heavy metals pollution. Excessive application of fertilizers and pesticides are the major sources of water pollution in China, and people's health has been affected by the deterioration of drinking water and food quality.

Agriculture development ensured the China's food safety successfully, thus brought in economic growth. Meanwhile, an overdraft on water resources was made and has been taking their toll on future's food safety. Therefore, it is of great significance to understand the current situation of water quality and its effects on food safety in China. The

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objectives of the study are to reveal the current water quality situation, investigate the interaction of agricultural activities and water quality, and analyze their effects on food safety and human health.

## 2. Water quality in China: Current situation and trends

### 2.1. Changes in surface water quality

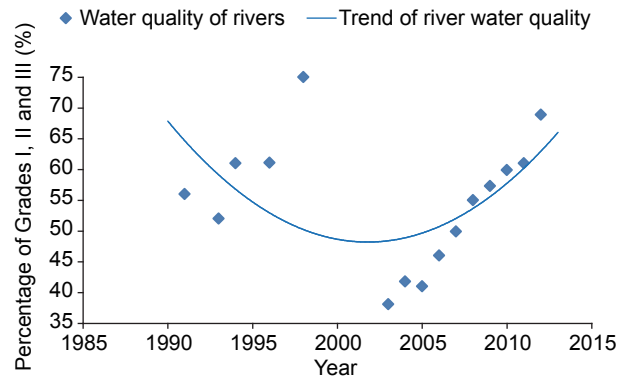
In the 1970s, with the development of economy and urbanization, 90% of industrial wastewater and urban sewage in China discharged directly without any treatment, which led to serious contamination of natural water bodies. Because of this reason, China started to monitor its water quality since then (Wang 1982).

In 1981, Ministry of Water Resources of China (MWR) conducted a nationwide survey and evaluation of water quality. This was the first nationwide water quality survey in Chinese history. Thereafter, the surface water quality survey and evaluation gradually became a routine work. Meanwhile, the Environmental Quality Standard for Surface Water of China was published and amended several versions (GB 3838-1983, GB 3838-1988, GHZB 1-1999 and GB 3838-2002) to meet the needs of water environmental protection. The water quality of surface water is divided into five categories, Grade I (well protected water source in natural reserve), II (first class drinking water), III (second class drinking water), IV (water applicable for industry), and V (water applicable for agriculture) (GB 3838-2002).

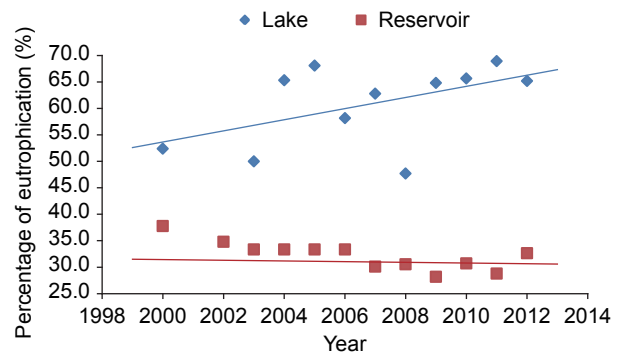
Due to the differences in evaluation criteria, it's difficult to give a quantitative comparison of the surface water quality by using the above category. But their results are still comparable. Because water bodies of Grades I, II and III are able to be used as drinking water source in every amendment. Grades IV and V are not applicable as drinking water.

**River water quality are gradually improving** Fig. 1 shows the annual changes of river water quality over China. The proportion of water quality that met the Grade III or above declined till 2003, when it reached the historic low 38%. After that, rivers that had water quality better than Grade III increased gradually and reached a percentage close to 70% in 2012, which was better than the quality of the 1990's.

**Eutrophication in lakes and reservoirs** In the 1980s, a lot of lakes and reservoirs were under the condition of oligotrophic. However, their nutrition status were almost all above mesotrophic condition in 2000 (Zhou et al. 2004). Fig. 2 shows the percentage of the lakes and reservoirs that are above eutrophication level after year 2000. The findings showed that the lakes which suffer from eutrophication had increased rapidly, and more than 65% lakes were above



**Fig. 1** The annual changes of water quality of rivers in China. Data are from *Report on the State of the Environment in China* (MEP 1990–2013). Water quality is evaluated according to Environmental Quality Standard for Surface Water of China. Grades I, II and III mean qualified to be as drinking water source. The same as below.



**Fig. 2** The percentage of the lakes and reservoirs which suffer from eutrophication. Data of the year 2000 are from the Assessment of Surface Water Quality in China conducted by the Ministry of Water Resources of China (MWR). Other data are from *China Water Resources Bulletin* (MWR 2000–2012).

the eutrophication level after 2009. The situation is better for reservoirs, in which the proportion of eutrophication is basically between 30 to 35%.

### 2.2. Changes in groundwater quality

**Groundwater quality** There is no routine national wide monitoring of groundwater quality currently, but there are only some individual investigations of certain areas by some departments. Therefore, there are actually no data of groundwater quality and pollution trends over the country. What commonly referred on China's groundwater quality is "90% of groundwater is polluted, 60% of it seriously so", which is published in both *Nature* and *Science* by Qiu (2010, 2011) is no reliable data source.

Up to now, there are only two surveys carried out to

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