Outline for establishment of the Taihu-Lake Basin early warning system

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Abstract The technical support system for establishment of the Taihu-Lake Basin early warning system (TBEWS) was designed based on the characteristics of water environment. It involves recognition and the dynamic environmental risk assessment, early warning, risk management, and emergency decision etc. Getting data and information on time, sharing information within different regimes, establishing the multiple coupling models for calculation, and the uncertainty analysis methods are the hardness works for establishment of TBEWS. This research suggested an outline for the first time to develop and exam the multiple coupling models for establishment of TBEWS.

Keywords Taihu Lake Basin · Risk assessment · Early warning system · Risk management

Introduction

Taihu Lake Basin is located in the southeast of China with about 37,000 km² area across Jiangsu Province, Zhejiang Province, and Shanghai City. The investigation in 2007 showed that it had total 43 million of population, 38 cities in this area and 5,500 km² of water area. The terrain of Taihu Lake Basin just looks like a dish in the middle as plain area and turns up in the sides as mountainous regions. The rivers densely cross in the basin and the total length is about 120,000 km with the density of 3.3 km km⁻².

Taihu Lake links up with Yangtze River which is an important source of drinking water for the basin people. But in recent decade, the water body of Taihu Lake Basin has been seriously polluted because of the rapid economic development and population enhancement. As a result of the increasing amount of pollutants discharged into Taihu Lake, the lake ecosystem has been deteriorated and frequent algal blooms occurred (Cheng and Li 2006).

Since 1970s, water pollution warning system has become a worldwide issue. The Danube Accident Emergency Warning System, for example, has been developed for environmental pollution control of the basin (Pinter 1999). The water accident warning for Taihu Lake Basin is currently predicted based on some biological indicators (such as fish, daphnia, and algal), but it is difficult to “really” monitor and estimate the contents of organic pollutants including persistent organic pollutants (POPs) in water (Borcherdin and Volpers 1994). However, general theory and methodology of early warning system (EWS) for water environment have been seldom reported both in China and in the world (Li et al. 2000; Yu et al. 2005; Huang et al. 2007; Aldhous 1992; Gerber et al. 2008).

This research based on integration of the reported approaches and the system of this basin will establish the dynamic environmental risk assessment system, water environment risk assessment system and database of EWS, the platform for predication and control of the deterioration of water environment quality and cyanobacteria bloom outbreak, alleviate pollution accident, and adjusting the
water environment contradictions in cross-border regions etc. (Okumura et al. 2007). The water environmental issues will be resolved with these basically technical supports.

Taihu-Lake Basin early warning system (TBEWS) targets

The main targets for TBEWS include as following:

1. Offering the recognized sensitive parameters, risk source, risk factor of Taihu Lake Basin which can be used as the pollution marker.
2. Establishing the database, modifying integrated link system and data processing system, and composing water environment risk information system.
3. Setting up the risk assessment index system of the water environment, and completing the dynamic environment risk assessment complete technology system.
4. Constructing couple model based on parameters of natural environment, socio-economic, pollutant discharge, water resources used, water environment quality and aquatic ecosystems for establishment of water environmental risk assessment system, TBEWS and early warning system (EWS) for the involved river and shallow lake.
5. Setting up the water environment risk management system that includes the reception of the risk and warning on Taihu Lake Basin, emergency treatment, and command dispatch.

6. Setting up the water environment risk assessment platform in the frame of the risk assessment on Taihu Lake Basin and TBEWS.

TBEWS structure

Figure 1 shows the water environment risk assessment system on Taihu Lake Basin constructed on the basis of the two province early warning subsidiaries and several lower centre units. Fig. 2 shows the three basic departments in each subsidiary constituted with communication system, emergency decision support system and technical support system. For each main subsidiary, the three branch systems

![Fig. 1 Early warning system (EWS) in Taihu Lake Basin](image)

![Fig. 2 Structure of the early warning system (EWS)](image)
are connected tightly. The communication system will work 24 h/day, to receive and analyze the data and the information. The technical support system will make an assessment of the living pollution issues for the especial selected area. Emergency decision support system will have the right, given by authorities, to make the warning decision for the polluted area or areas.

**TBEWS approach**

The technical support system is the most important branch system in TBEWS. It is the fatal tool to complete the water environment risk assessment and early warning. On the basis of recognizing the risk source for water environment, forecasting the time when the polluted water flows and the highest concentration of pollutant, the technical supports on the water environment management and emergency decision will be made through investigating and applying the water environment regime, early warning model and simulating the polluted water body transport in the other water bodies in the same area described as the following three parts.

Water environment risk analysis and recognition for Taihu Lake Basin mainly includes

- Recognition of the fixed and liquidity risk source; identification of the water environment risk sensitive areas; estimation of non-point source pollution; process analysis; risk identification; analysis and identification of aroused by hydrological and water condition change etc.

Water environment risk assessment in Taihu Lake Basin mainly includes

- Probability analysis of water environment risk accident on the typical zone demonstrated; cumulative risk hazard assessment on heavily contaminated areas and river district; emergent risk hazard assessment in shallow lake; construction of the database on risk assessment and early warning database and the risk dynamic assessment.

Water environment risk forecast and warn in Taihu Lake Basin mainly includes

- Setting the forecast model for the influence of sudden water pollution accident; simulating the risk process for non-point sources; coupling the model of hydrodynamics and water quality in river and shallow lake and risk forecast and warn; making the ecodynamic model and risk Early Warning System of cyanobacteria bloom; setting the forecast model for risk aroused by hydrological and water condition change under the influence of human activities; constructing the multiple risk water environment warning system by coupling model of natural environment, socio-economic, pollutant discharge, water resources used, water environment quality and aquatic ecosystem for the Taihu Lake Basin and its river district and shallow lake.

**TBEWS reality**

The water environment risk assessment and early warning on Taihu Lake Basin mainly includes:

- Water pollution and water quality database management, risk assessment, water quality simulation and risk early warning, and risk management and emergency decision-making. These four main functions make the emergency warning system work shown in Fig. 3 and described as following:

1. Management of the polluted water source and water quality database involving all the kinds of parameters for the basic water quality in one regime to early warning.
2. Assessment of the risk according to the sort of the current status of eco-environmental quality, predicted results and artificial protection facilities, recognizing all the risk symptoms before appearing, assessing the expense caused by emergence issues occurred.
3. Simulation of the water quality and forecast of the risks based on the model system of the historical data and mechanism research, forecasting the environmental pollution and ecological deterioration that will happen in future and recognizing the main method and evident of the accidents.
4. Information technology of risk and service management involves the reasonable and methods chosen which can be divided into two parts, emergency

![Fig. 3 Platform of risk assessment and early warning system (EWS) in Taihu Lake Basin](image)
response measures and long-term management decision-making, with the results of the evident and expense analysis on accidents.

TBEWS work

Difficulties for setting up TBEWS based on the characteristics of Taihu Lake Basin include:

1. Because of the limitation of monitoring techniques, it is difficult to gather the exact water quality data on time and to calculate the data for the simulation forecast system.

2. The routine water quality monitoring methods are used for the conventional parameters such as BOD, COD, POPs and some toxicological items at present, there are so many obstacles for measurement of the developing organic pollutants for early warning system (Ling et al. 2006).

3. Data sharing and pollution dissemination between the different regionalism are extrusive contradictions in the basin system composing of many regimes, that will lead to increase the difficulty of developing the early warning system (Dzyadevych et al. 2005).

4. Taihu Lake Basin is a typical water environment system. TBEWS needs to further research and develop a large amount models especially for the multiple coupling model. Development of efficient calculation methods and research on the coupling model involving nature, society and environment is urgently required following the increasing the model complexity (Gerber et al. 2008).

5. TBEWS will have many un-confirmed ingredients inevitably. It needs the incertitude analysis method for the basic procedure of the error transformation and the reliability assure of forecast results. The incertitude analysis method usually worked with simulation measurement can not meet the requirement in time so the work in this field develops slow-motion (Li and Wang 2006).

The following researches need to be carried out in the future: (a) Improving model calibration methods, tracer technology, improvement of new techniques of tracer experiments, model calibration and verification. (b) Improving technician operating level: awareness of emergent accidents, early warning system updating, risk analysis, etc. (c) Improving technique for establishment of TBEWS, integration of early-warning model, GIS and database, numerical solution of coupling models and intelligent scheme design for water pollution risk control.

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References


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