Water Quality Monitoring System for Water Distribution Project in Jiaxing, Zhejiang Province

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Abstract. In the construction of water distribution pipeline system in Jiaxing City, in order to monitor the water quality and water environment, a continuous observation network is constructed according to the existing technical specifications. At present, the system runs well and produces continuous monitoring data, which provides basis for local water quality protection.

1. Introduction

1.1. Engineering Profile

Jiaxing external water distribution project (Hangzhou direction) intake water from XianLin distribution wells, whose starting point is Hangzhou Renhe node and the end is Jiaxing water plants. Qiandao Lake raw water was conveyed through tunnel, pipeline and pumping station. Hangzhou section adopts gravity self-flow mode, while Jiaxing section adopts pump station pressurized water supply mode. Engineering diversion is 230 million m³ per year.

![Diagram](image-url)

Figure 1. Jiaxing external water distribution project (generalization route).
The total length of water conveyance line is 171.6 km, of which Hangzhou section is 23.1 km, Jiaxing section is 14.5 km long. Hangzhou section is all shield tunnel with excavation diameter of 6.2 m and lining diameter 5.5 m. The length of shield tunnel in Jiaxing section is 1.7 km, and the rest is pipeline, of which the main line is 74.2 km, the branch line is 72.6 km in length.

1.2. Natural Profile
Jiaxing City is located in the southern wing of the Yangtze River Delta, and in the eastern part of Hangzhou Lake Plain, northern Zhejiang Province. It is 93.56 km long in east-west direction and 77.84 km in north-south with area of 3915 km². The terrain is slightly tilted from southwest to northeast, whose elevation is 4.0 m–5.0 m along Hangzhou Bay, 3.2 m–4.2 m in south-central region and 3.0 m–3.6 m in northwest region. River network is dense in Jiaxing City, which belongs to the typical river network area of Jiangnan Plain. There are Beijing-Hangzhou Canal, Pinghu pond, Jiashan pond, Changshui pond, Haiyan pond, Suzhou pond and so on. River network density ranges from sparse to dense from south to north, with water surface rate 6.1% in the south and 10.3 in the north.

Yuhang District is located in the transition zone of HangjiaHu Plain and western Zhejiang hilly region. The terrain is inclined from northwest to southeast, roughly bounded by Dongpu River. The northwest region is mountainous and hilly area, belonging to the remaining veins of Tianmu Mountain. The eastern part is the accumulation plain whose terrain is low and flat with altitude of only 2 m–3 m above sea level. The southeast part is a beach plain, with solitary hills standing.

1.3. Present Research
Surface water monitoring data, gathered as part of the EU Water Framework Directive and comprising the occurrence of 352 organic contaminants in 31 European countries, was used to evaluate past and current environmental risks for three aquatic species groups: fish, invertebrates, plants. Monitoring quality indices were defined per country and found to improve over time.[1]

An optimal sampling strategy was proposed using remote sensing (RS) big data and spatial sampling annealing (SSA) integrated approach for sampling design. Total suspended sediment (TSS) observations were taken at Poyang Lake, China, as the case study and application region.[2] The DOIF allows for consideration of how dispositional variables, such as sociodemographic characteristics and motivations for participation, may relate to organizational variables (e.g., program efficacy, results, and recognition); both overarching variables relate to indicators of commitment.[3] The theory of ZigBee technology and traditional methods of water quality monitoring, water quality monitoring is proposed wireless system based on ZigBee technology.[4]

The effects of commonly used protective housings on in situ sensor readings was assessed.[5] Based on mathematical models, a computational experiments of a miniature unmanned underwater vehicles (MUUV) was set up.[6]

2. On-line monitoring system of water quality
The online water quality monitoring system is divided into local monitoring station and central station. The monitoring stations are fully automatic, and the water quality is monitored and recorded in real time. Through specialized communication system, the monitoring data are uploaded to the central station to realize the remote monitoring function. The layout and quantity of site monitoring stations and central stations are shown in the table below.

| Location | Station Type       | amount |
|----------|--------------------|--------|
| Renhe    | monitoring station | 1      |
| Haining  | monitoring station | 1      |
| Nanhu    | Central Station    | 1      |

Table 1. Water quality monitoring stations.
A water quality monitoring system consists of three main components:

- Water quality monitoring station are made up of station and water intake, water quality on-line monitoring instruments, system integration and other hardware equipment constructed by the field monitoring system. 3 automatic monitoring stations in Renhe node, Haining pumping station and Nanhu pumping station were set up in this project.

- Communication networks consists of connect network lines, communication equipment and computer networks built on these facilities between on-site monitoring stations and information centers. This project realizes communication function through rented public network and internet inside pump station valve room.

- Information center refers to the server, network components, storage system, data backup system, platform software and system software set in the control center. A water quality automatic monitoring center is set up in Nanhu pumping station dispatching control center to collect all monitoring information.

![Figure 2. Water Quality Monitoring System.](image)

The water quality monitoring station is composed of station room, instrument analysis unit, water collection unit, water distribution unit, control system, data acquisition-processing/transmission system, auxiliary system, lightning protection equipment and so on. The instrument analysis unit is a multi-parameter analyzer (temperature, pH, dissolved oxygen, conductivity, turbidity, etc.). The water collection system pretreats the water sample for each analysis instrument. The system pump valve and auxiliary equipment are controlled by the PLC control system. The data from each instrument is collected and processed by the industrial control equipment through the RS232485 interface, and is transmitted through optical fiber. In order to prevent lightning strike, water quality automatic monitoring station needs to be equipped with direct and induction lightning protection measures.

This system is equipped with intelligent environment monitoring unit to monitor the overall safety, fire protection and power distribution. The video monitoring device is equipped for water quality automatic monitoring station to monitor the water intake condition and the internal condition of the station room.
Communication and data interaction between water quality monitoring station and central station of Haining pumping station in this project are realized by using the inner network control area in the leased public network. Data from Renhe node monitoring station is transported through the leased public network transmission to Damawu ~ Renhe Avenue water supply pipeline engineering control center, and then to Nanhu pumping station center station through the public network.

According to engineering practice and water quality, the monitoring parameters are as follows:

Table 2. Monitoring parameters and analysis methods.

| No. | Monitoring Item | Analyze Method                  | Standard                                                                 | Monitoring Frequency |
|-----|-----------------|---------------------------------|--------------------------------------------------------------------------|----------------------|
| 1   | Water temperature | Temperature sensor method        | Technical requirements for automatic pH water quality analyzer (HJ / T96-2003) | Continuous           |
| 2   | pH              | Glass electrode method          | Technical requirements for dissolved oxygen (do) water quality automatic analyzer (HJ / T99-2003) | Continuous           |
| 3   | Dissolved oxygen | Membrane electrode method       | Technical requirements for water quality automatic conductivity analyzer (HJ/T97-2003) | Continuous           |
| 4   | Conductivity    | Conductance electrode method    | Technical requirements for turbidity water quality automatic analyzer (HJ/T98-2003) | Continuous           |
| 5   | Turbidity       | Infrared scattering method      | Technical requirements for turbidity water quality automatic analyzer (HJ/T98-2003) | Continuous           |

3. Conclusions
In the construction of water distribution pipeline system in Jiaxing City, in order to monitor the water quality and water environment, a continuous observation network is constructed according to the existing technical specifications. At present, the system runs well and produces continuous monitoring data, which provides basis for local water quality protection.
This water quality automatic observation system provides the raw data of local water quality changes, and provides information for the study of water quality changes and pollution accidents. At the same time, the construction of the system leads a demonstration role, which can be extended to other areas.

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