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*Original Research Article*

# Study of spatio-temporal dynamic change and mutual influences of river water quality in Liao River basin

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**This paper analyzes the water quality data from an automatic monitoring station in provincial control section and temporal and spatial variation characteristics in Liao River Basin. Variation in river water quality and the key pollution control tributaries (area) in Liao River Basin were analyzed. The relationship among water quality parameters are analyzed using multivariate function method. It shows that there is a linear relationship between water quality indexes of conductivity and ammonia nitrogen in Liao River Basin. The trend of change in year and season of the indicators is forecasted. This study provides the basis for water environment management and monitoring in Liao River basin. The study therefore promotes the application of automatic monitoring stations in the Liao River basin.**

**Key words:** Water quality, automatic monitoring station, Liao River Basin, conductivity, ammonia nitrogen.

## INTRODUCTION

Water quality monitoring is an important component of environmental protection. Accurate, timely and reliable water quality monitoring data is the premise of water quality analysis. Since the implementation of water special project, Liao River Basin has gradually built an automatic water quality monitoring station one after another in State-controlled section. It has thus become an important basis for water environment management in Liao River Basin. Through water quality automatic monitoring stations, real-time and remote control continuous monitoring can be realized in Liao River Basin using the real-time transmission of data from the real-time status of water in Liao River Basin. It is also capable of early warning and forecasting water pollution accidents. Liao River Basin has now built 15 automatic observation stations, with data monitoring taking place every two hours on a daily basis. Indicators include water temperature, pH, conductivity, ammonia nitrogen, dissolved oxygen, total nitrogen, total phosphorus and others. Although many automatic monitoring stations have been built in china, most of them are mainly based on on-going researches in the construction location, monitoring index and monitoring instruments of the automatic station. Few studies have been conducted on the analysis of water quality data using automatic monitoring stations. This paper is based on the conductivity, and ammonia nitrogen water quality data of the automatic monitoring station in Liao River basin. The spatial difference and time difference in conductivity and ammonia nitrogen in Liao River Basin (day, month, quarter, year and year) were analyzed. In addition, correlation among water quality parameters was analyzed and the model between the two parameters was established. Changes in the two indexes in the Liao River Basin are also predicted. The review of related literatures to evaluate the relevance of this study is also carried out.

At present, the water quality automatic monitoring system has been established in succession in the major river sections of China, the real-time and continuous monitoring characteristics of the automatic monitoring station make up for the shortage of laboratory fixed-point and regular monitoring. It provides a new means for water pollution monitoring and water resources management and has increasingly become an important means of water quality management by the State and watershed agencies (Wang et al., 2008). Many scholars have studied problems of constructing water quality automatic station. For

example, Wang and others (2008) discussed the shortcomings of China water quality automatic monitoring station to include lack of professional management personnel and timely maintenance of equipment, however, the monitoring data is relatively stable and reliable. Xu (2011) pointed out that the management of surface water quality automatic monitoring station in China has some problems, such as imperfect management mechanism and unprofessional management personnel [Xu, 2011 ]. Li et al. (2011) put forward a river automatic monitoring station based on a wireless sensor network, aiming at the problems of small monitoring range and poor flexibility of existing automatic monitoring station of a river monitoring system. Peng et al. (2016) discussed the problems and solutions of third party operation and maintenance management of water quality automatic monitoring station in China. Qi et al. (2011) discussed the function of water supply automatic monitoring station in basic data acquisition and storage in the safety management information system for drinking water. The design of automatic monitoring station, working flow chart, operation mode and main functions are also discussed in details. An automatic monitoring station data publishing and inquiry function was introduced into the software for comprehensive information publishing (Qi et al., 2011). Xing (2015) completed the whole design and detailed design of a water quality automatic monitoring system through system analysis, and to achieve the formation of the whole system, built a complete monitoring system whose parameters were accurately tested and compared with the standard of the Environmental Protection Department of water quality monitoring data, to verify the reliability of the system (Xing, 2015). Jiang et al. (2009) shows that in years 2007 and 2008, water quality monitoring data analysis from 5 monitoring stations reflect changes in water quality in Taihu. From the data obtained, , the water quality of the 5 automatic monitoring stations improved generally. At present, researches on the water quality of automatic monitoring stations in China mostly focus on management mechanism, equipment allocation, monitoring items and operation ideas. However, there is little research on the relationship between water quality parameters and large data based on automatic monitoring station.

This paper carried out the analysis of temporal and spatial variation characteristics of water quality in Liao River Basin using an automatic monitoring station. It points out the variations in river water quality in Liao River Basin and finds out the key pollution control tributary (area) by providing support for key pollution source monitoring through the establishment of function relation model. The connotation relation between water quality parameters is determined, and the relation among water quality parameters is found. It can provide reference for water environment management, monitoring and early warning in Liao River Basin. It also provides a basis for the popularization and application of automatic monitoring station in Liao River Basin, in addition to the adjustment of river water quality monitoring index.

**River water quality database of Liao River Basin (automatic monitoring data)**

Liao River Basin has 10 water quality automatic monitoring stations. Every 4 hours, in 2004, data monitoring, on indicators such as water temperature, pH, conductivity, turbidity, ammonia nitrogen, dissolved oxygen, permanganate index and other indicators was carried out. The data obtained by means of hourly means are more objective and accurate than the water monitoring carried out by hand every month.

**Analysis of spatial and temporal changes in river water in Liao River Basin**

The changes in water quality indexes in different water stations at the same time, monthly and annual averages were analyzed, respectively. The variation in characteristics of river water quality in Liao River Basin at different times interval were obtained. 5 time points that is; April 14, June 16th, August 15th, Octobr 14th and December 12th, in 2014, were selected. The water conductivity and ammonia nitrogen water quality parameters of 10 stations in Shenyang Bird Island, Tieling new town No. 1 Bridge, Taian Zhang wasteland, Liaozhong Yujiafang, Kaiyuan Nanhua Tower, Haicheng Xiaojie Temple, Changtu Zahngjia Bridge, Changtu Houyihe Tun, Changtu Fudedian, Benxi Xingan, were analyzed at the same time. Water conductivity parameters in Changtu Houyihe Tun site was found to be the highest, followed by Liaozhong Yujiafang, while Tieling new town No. 1 Bridge produced the least value(Figure 1) . Ammonia nitrogen content of the water is highest in Changtu Houyihe Tun at different time points(Figure 2); the content was much different at other sites; while the content at Changtu Fudedian site was the lowest. The results of this study are consistent with the analysis of water quality pollution in the Liao River Basin. They are also consistent with the results of Ping et al. (2011) who found that the water pollution in the middle and lower reaches of the Liao River Basin was serious.

Monthly average conductivity of 10 sites in Shenyang Bird Island, Tieling new town No. 1 Bridge, Taian Zhang wasteland, Liaozhong Yujiafang, Kaiyuan Nanhua Tower, Haicheng Xiaojie Temple ,Changtu Zahngjia Bridge, Changtu Houyihe Tun, Changtu Fudedian, Benxi Xingan were analyzed for 8 months (from April to December2014) (Figure 3-4), where an increased trend in changes over time in conductivity was observed. In Benxi Xingan, Shenyang Bird Island conductivity Changtu Fudedian, Changtu Zahngjia Bridge Taian Zhang wasteland, Tieling new town No. 1 Bridge, there was a decreased trend in conductivity and then an increase, reaching the lowest point in August and September.

In the study area (from August to December) , changes in ammonia nitrogen content were analysed(Figure 4). It was pointed out that Changtu Houyihe Tun maintained high nitrogen levels.; Changtu Fudedian,aian Zhang wasteland and Tieling new town No. 1 Bridge showed low values for

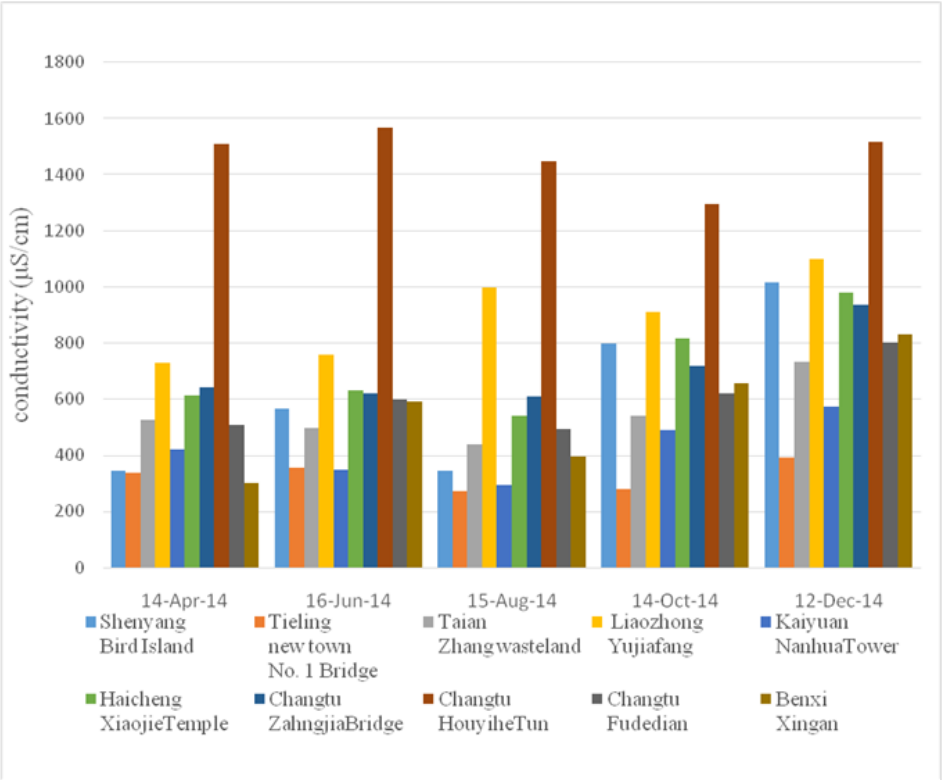


**Figure 1**: Conductivity parameters of each site at the same time

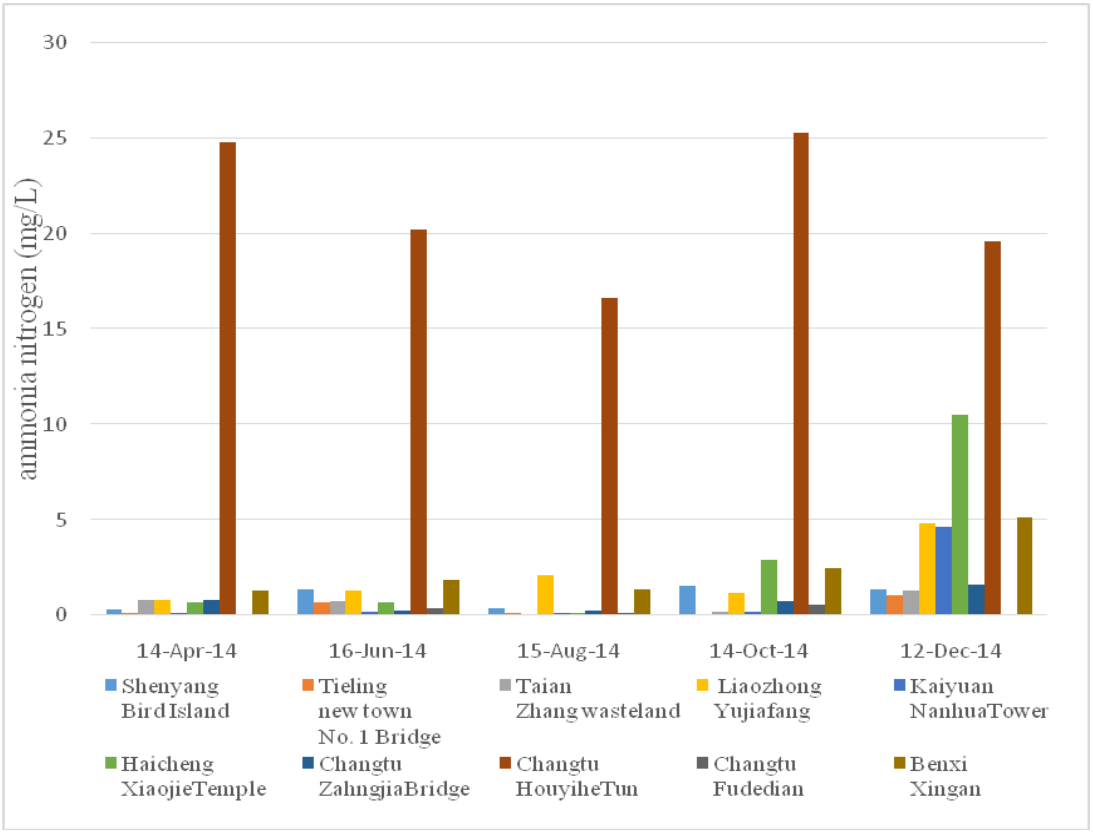


**Figure 2**: Ammonia parameters at the same time at each site

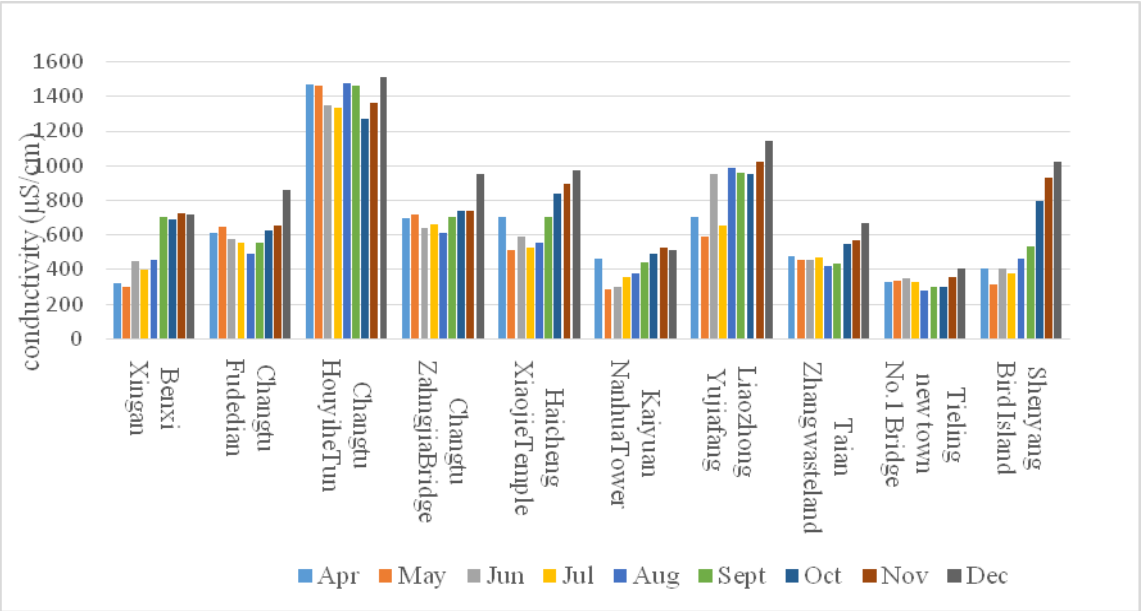


**Figure 3**: Monthly average conductivity of water body

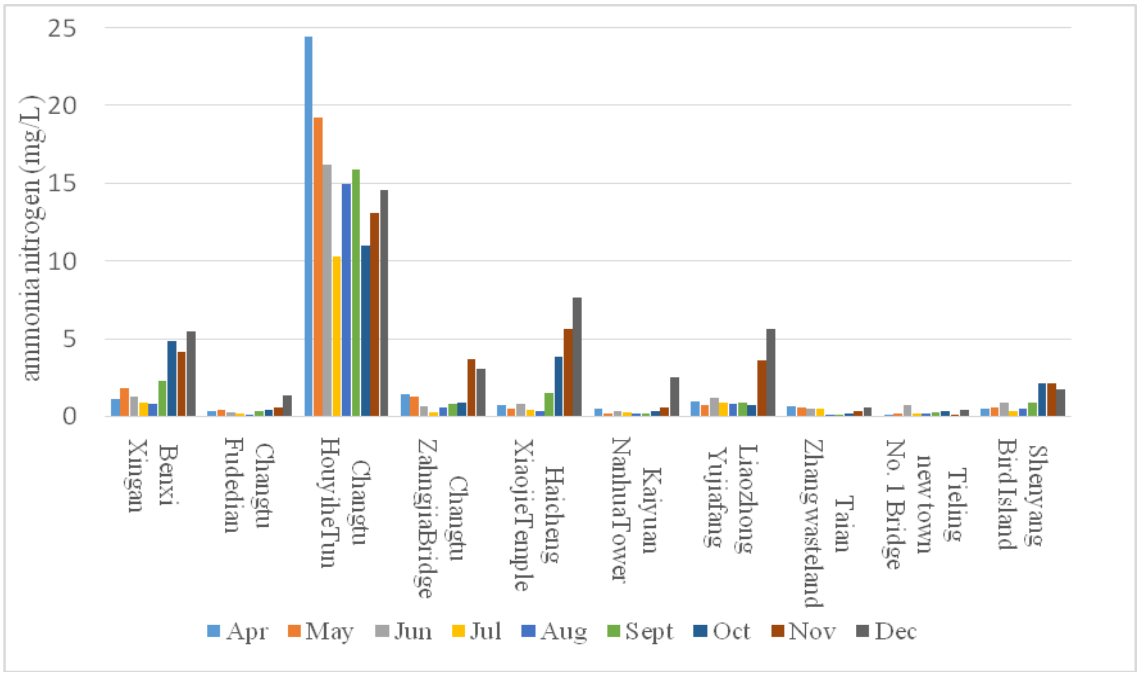


**Figure. 4**: Monthly average change of ammonia in water body

monthly average of ammonia nitrogen content; monthly variation in content fluctuation is not obvious as the change in average ammonia nitrogen content in Benxi Xingan and Liaozhong Yujiafang with time. This is similar to the results of Wang (2016).

The average conductivity and ammonia nitrogen content of the 10 sites in 2014 were analyzed(Figure 3). Changtu Houyihe Tun is far superior to other sites. Its conductivity is generally between 400~800 μS/cm(Figure 5). Ammonia nitrogen content was generally about 2mg/L, and the minimum was 0.292mg/L(Figure 6).

**Analysis of function relationship between water quality factors**

SPSS software or MATLAB softwares were used to analyze the correlation analysis of conductivity and ammonia nitrogen of two water quality parameters. The result is

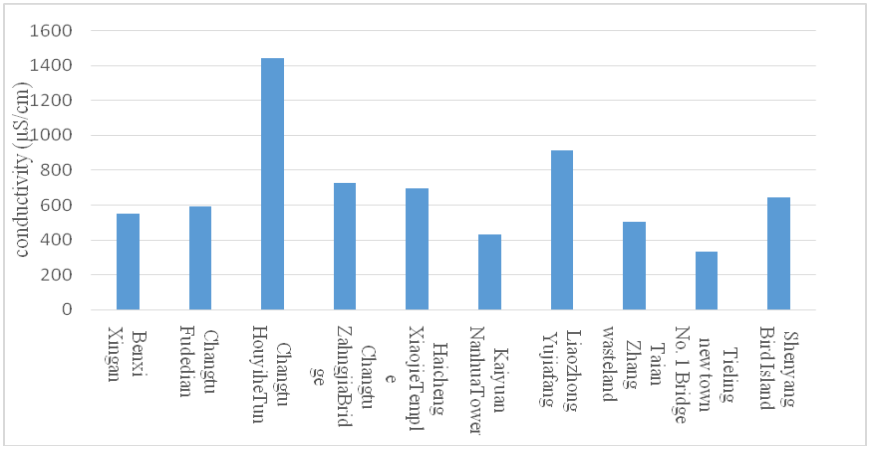


**Figure 5**: Annual average conductivity of water body

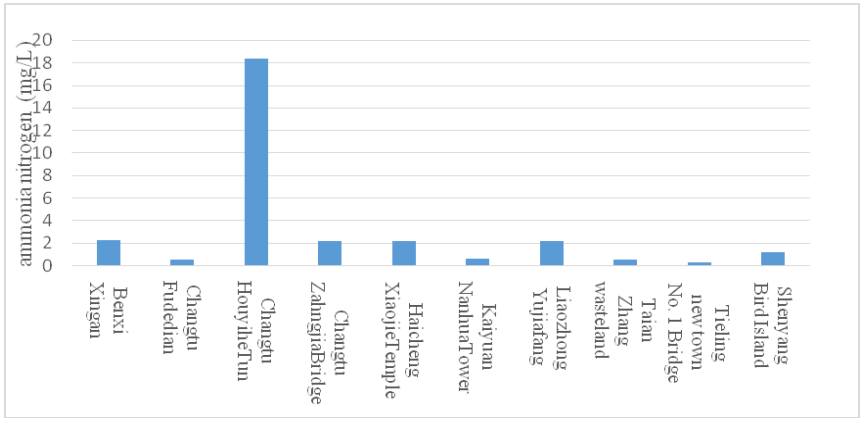


**Figure 6**: Ammonia change map of average water body

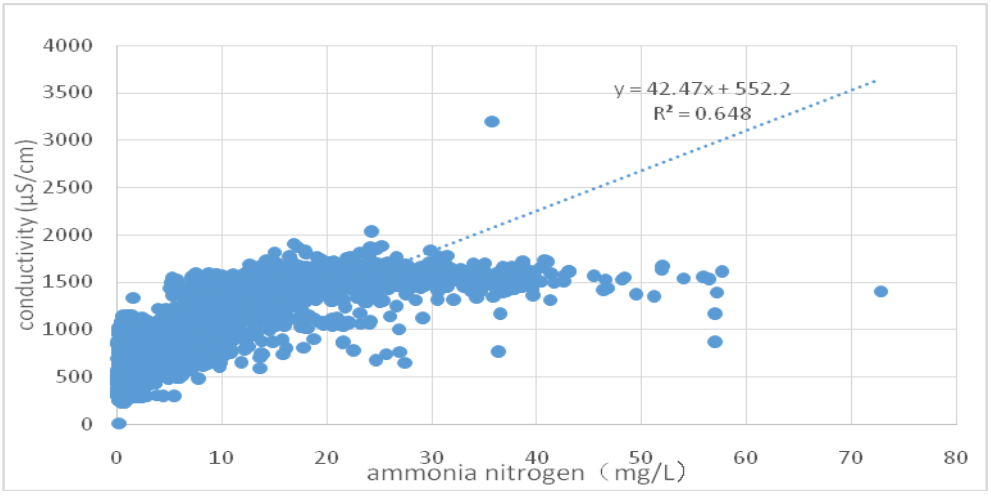


**Figure 7**: Conductivity and ammonia nitrogen correlation diagram

0.8054, indicating that the two parameters are positively correlated, but the dependence is low (Figure 7). This is consistent with the results of Yuan and others who reported that conductivity is the main cause of the disappearance of large benthic animals, and pointed out that the increase in the proportion of agricultural and

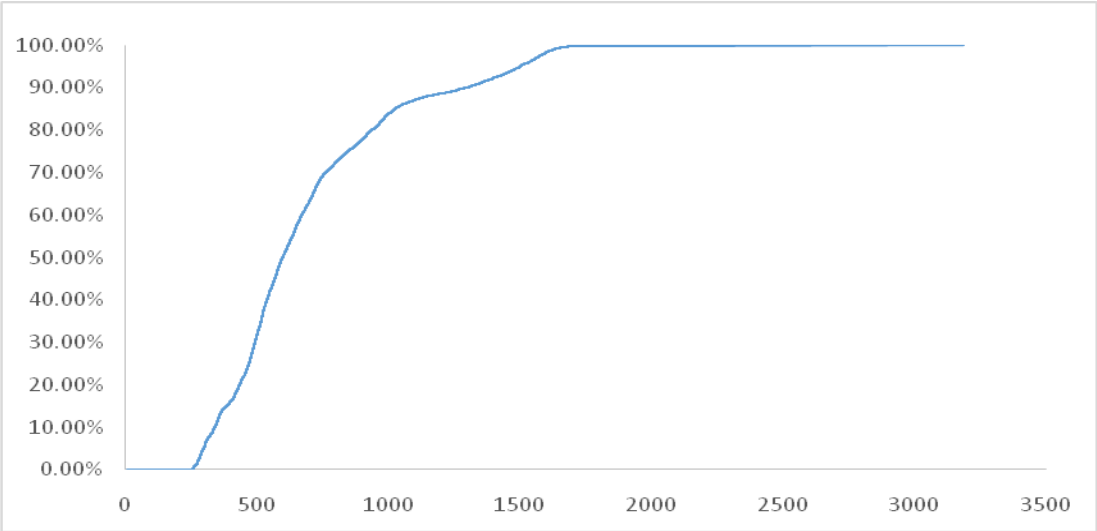


**Figure 8**: cumulative probability distribution curve of conductivity

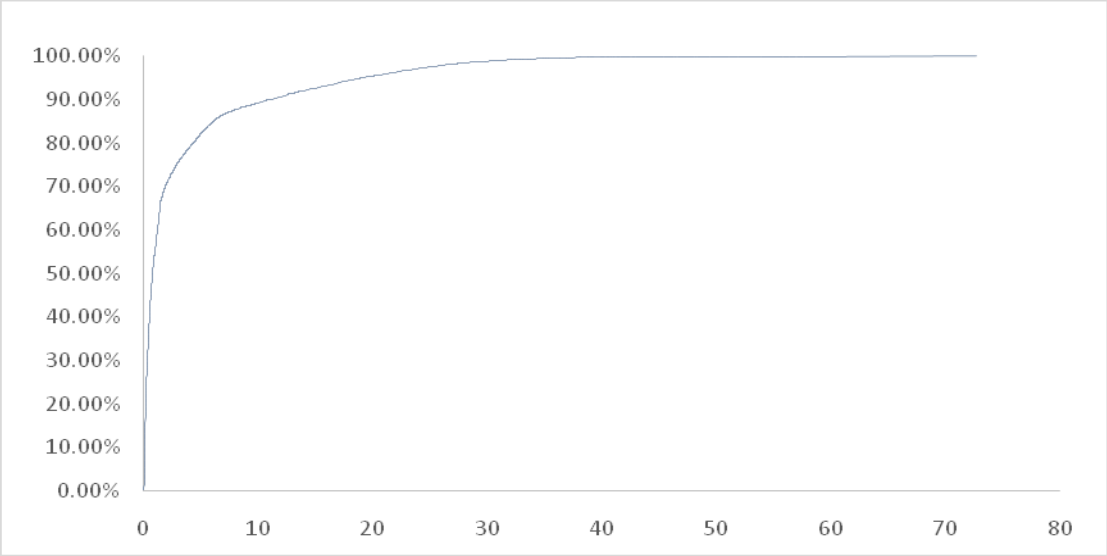


**Figure 9**: cumulative probability distribution curve of ammonia nitrogen

urban construction land significantly increased the value of water conductivity, and industrial and agricultural activities will cause an increase in ammonia concentration (Yuan et al., 2015).

**Prediction and analysis of river water quality in Liao River Basin**

According to the linear relationship(Figure 8-9), the average ammonia nitrogen content of 10 water stations in 2018 were predicted thus: April- ammonia nitrogen 2.2083 mg/L, conductivity 616.4954 μS/cm; July- ammonia nitrogen 1.4041mg/L, conductivity 563.9315μS/cm; October- ammonia nitrogen 3.8 227mg/L, conductivity 722.0157μS/cm. Average water quality in 2018 is therefore: ammonia nitrogen, 3.2076mg/L, conductivity 681. 8136μS/cm.

**RESULTS AND DISCUSSION**

In this paper, the time and spatial characteristics of water conductivity and ammonia nitrogen in the Liao River Basin were analyzed using monitoring data of the automatic monitoring station. The water quality characteristics of the rivers in the Liao River Basin were pointed out. The middle and lower reaches of the Liao River Basin were heavier, more than IV standard; conductivity in upstream

concentration was higher, but not excessive.

The mathematical function analysis shows that there is a clear linear relationship between conductivity and ammonia nitrogen in Liao River Basin, and it is pointed out that industrial and agricultural activities are the main reason for conductivity and ammonia nitrogen rise.

Based on the analysis of a large number of monitoring data of water quality automatic monitoring stations, this paper analyzes changes in conductivity and ammonia nitrogen in the Liao River Basin. Because there are only 10 automatic monitoring stations, tributary pollution analysis in the Liao River Basin was not thorough. In addition and ammonia nitrogen, it should be further analyzed for other water quality factors as a function of the relationship.

**Conflict of Interests**

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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