Scholar Publishing Group
Water Pollution Prevention and Control Project
https://doi.org/10.38007/WPPCP.2021.020106
ISSN 2790-2730 Vol. 2, Issue 1: 53-62

Evaluation on Water Pollution Prevention and Control of Wireless Sensor Ecosystem

Pecka Michael*

Univ Zagreb, Zagreb, Croatia

**corresponding author*

Keywords: Wireless Sensing, Ecosystems, Water pollution, Prevention and Treatment

Abstract: Wireless sensor network technology is a new application field, which has been widely concerned in recent years, and has also made good progress in water environment monitoring. With the change of the times and the continuous improvement of the scientific level, the wireless sensor technology was studied. This paper mainly carried out a series of analysis and discussion on the problem of water pollution. The wireless sensor network technology realized the real-time monitoring of pollutants in the water environment and can transmit its data to the user. However, the existing problem is that in the process of practical application, the effect of traditional ecosystem water pollution prevention and control mode is not satisfactory due to high cost and low efficiency. At the same time, due to unreasonable and incomplete network node layout and other factors, a lot of resources were wasted, but still cannot solve the water pollution problem well. Therefore, people need to constantly study and improve wireless sensor network technology to improve the reliability of the whole system, and solve the problems such as the untimely detection of water pollution hidden dangers and the unsatisfactory monitoring and prediction effect of water pollution problems in the traditional ecosystem water pollution prevention and control scheme. This paper proposed an ecosystem water pollution governance model based on wireless sensor technology and combined with local coverage algorithm. Through the comparative analysis of experimental results, it can be seen that the innovative ecosystem water pollution governance model had an average improvement of 14.9% in four performance aspects compared with the traditional ecosystem water pollution governance model.

1. Introduction

Water environment is a dynamic ecosystem, which includes air, soil and water. There are many

different kinds of substances in this system. Among them, the most important is the deterioration of water quality or even paralysis caused by ecological factors such as water resources and biodiversity, and the second is air pollution. Because air pollution has a great impact on human life, the third is that the destruction of water biological cycle function and the extinction of other species would seriously threaten the structure and composition of the ecosystem. Therefore, people must pay attention to and strengthen the prevention and control of water pollution in the ecosystem.

Some scholars have studied the water quality status in the ecosystem, summarized the water pollution problems, and hoped to determine the main classification of pollution sources by analyzing the forms of water pollution today. By studying the impact of local industrial discharge on the water system and combining the component analysis of water pollution problems, Wu Gaojie determined the main body of pollution sources in water pollution problems, providing a theoretical basis for establishing and improving local water pollution management [1]. Singh Upma analyzed the composition of industrial wastewater, combined with the local industrial discharge standards, studied the local water system pollution level, put forward valuable prevention and control suggestions for industrial pollution on the ecosystem, and opened up a new development direction for the water pollution prevention and control of the local ecosystem [2]. Under the background of extreme shortage of local water resources, Hanif M. A carried out case analysis on four surrounding waters, analyzed the water pollution problems occurred in the four waters and explored the composition of pollution sources, obtained the degree of harm of various pollution sources to human health, and emphasized the severity of water pollution problems in the ecosystem [3].

Wang Qian put forward an efficient theoretical framework for resource recovery and utilization by studying purification methods for local water pollution problems and combining with emerging pretreatment technologies. The reliability of this technology in water pollution purification problems has been proved through experiments, and the prevention and control field of local water pollution problems has been expanded [4]. Fongaro Gislaine combined monitoring tools to carry out comparative analysis on the water quality status of local waters. Through test and analysis, it can be concluded that the water quality monitoring combined with monitoring tools is more real-time and accurate, opening up a new development direction for local water pollution prevention and control programs [5]. Chaoua Sana studied the level of insect egg pollution in local waters. Combining the two kinds of sewage treatment systems, the pollution purification capacity of the two types of samples was evaluated, and the sewage treatment system with more purification capacity can be obtained through comparative analysis, which enriched the local water pollution prevention measures [6].

Nkhoma Peter R emphasized that the water pollution problem should be solved strictly and quickly by studying the cognition survey of local residents and various social subjects on the problem of water shortage and combining with the background of the local water pollution problem, which has given survival significance to the development of water pollution prevention plan [7]. Oral Hasan Volkan studied the consumption and recovery of water resources in local cities. Based on the urban water resources management system, he has put forward valuable suggestions for the prevention and control of urban water pollution and optimized the local water resources management system [8]. Greenaway Tameika studied the emotional information of local residents on the water circulation system, proposed the impact of emotional emotion on the construction process of the local water circulation system, determined the role of negative and positive emotional output on the local water resources management plan, and discussed the impact of this result in the construction of water pollution prevention and control [9]. The above studies have provided a theoretical basis for the construction of local water pollution prevention and control projects.

In addition, some experts and scholars in the construction of water pollution prevention and control projects have conducted in-depth research on the single and ineffective local water pollution

prevention and control measures, hoping to open up a new development direction for the local water pollution prevention and control construction. Through the case analysis of local water pollution problems, combined with the investigation of the physical health of local residents, Ahmed Shahid analyzed the results of the investigation to obtain the harm of water pollution problems to the health of residents [10]. Sarker Bijoyee investigated the pollution level of local water pollution problems. Combined with the local urbanization and industrialization process, he fundamentally discussed the internal relationship between the local modernization degree and the water pollution problem, which provided a theoretical basis for promoting the local water pollution prevention and construction process [11]. Pichura Vitalii studied the deterioration process of water quality in local waters, analyzed the composition of pollution sources in detail, and put forward new water pollution prevention measures for urban ecosystem, which improved the severity of water pollution at that time [12]. None of the above studies has put forward a relatively complete plan, and further research is needed.

In order to solve the problems of the traditional ecosystem water pollution prevention and control plan, such as the untimely detection of water pollution hidden dangers, the relatively weak measures to deal with sudden water pollution problems, and the unsatisfactory monitoring and prediction results of water pollution problems, this paper summarizes and analyzes the traditional ecosystem water pollution prevention and control plan, and shows its advantages and disadvantages. Combining with wireless sensor technology, a new ecosystem water pollution prevention and control model is proposed. This model can timely discover the hidden dangers of water pollution, and the monitoring and prediction of water pollution problems would also have a more significant effect. In the face of sudden water pollution problems, there are more efficient countermeasures.

2. Technical Evaluation of Wireless Sensor Network

With the development of science and technology and the progress of society, the optimal use of water resources in the ecosystem is of great significance to the sustainable development strategies of all regions. It is a long-term task to strengthen the monitoring of water quality status of water resources in the ecosystem. This paper tentatively introduces the wireless sensor network technology to distribute the network structure of sensors and monitor the water quality in the ecosystem for a long time. The purpose of monitoring is to collect and process the water body information that needs to be sensed in the water covered by the network structure in a collaborative way, and transmit the information to the monitor and predict whether there is a trend of water pollution potential.

The wireless sensor network is based on the principle of electromagnetic induction. It converts the analog quantity into digital quantity by collecting the water samples in the water area through the sensing equipment, and then transmits and stores the data through information communication, so as to realize the automatic recognition and sensing of the monitored water samples [13]. The network system is composed of multiple signal transmitting terminals and signal receiving terminals. When it is necessary to detect the water quality of the water samples, it can receive the digital signals generated by the conversion of the analog quantity collected from the measured water samples over a period of time, and send the signal to the surrounding environment at the same time. The sensor at the receiving terminal can receive the monitoring information collected from the measurement point.

The water environment monitoring system built by the sensor distribution network can automatically and continuously monitor the water environment parameters, and the monitoring data can be automatically transmitted remotely. It can not only query the water quality status in the monitored water samples in real time, but also avoid a lot of labor consumption due to the

characteristics of long water quality monitoring cycle, high labor intensity, and difficult data collection, and can more accurately reflect the dynamic change of water quality status and predict the change trend [14]. Due to the diversity and variability of the monitoring environment, in the wireless sensor network constructed in this paper, sensor nodes are not required to conduct full coverage monitoring of ecosystem water samples. In future research, the optimization of communication performance in wireless sensor networks would be strengthened. The structure of wireless sensor network is shown in Figure 1.

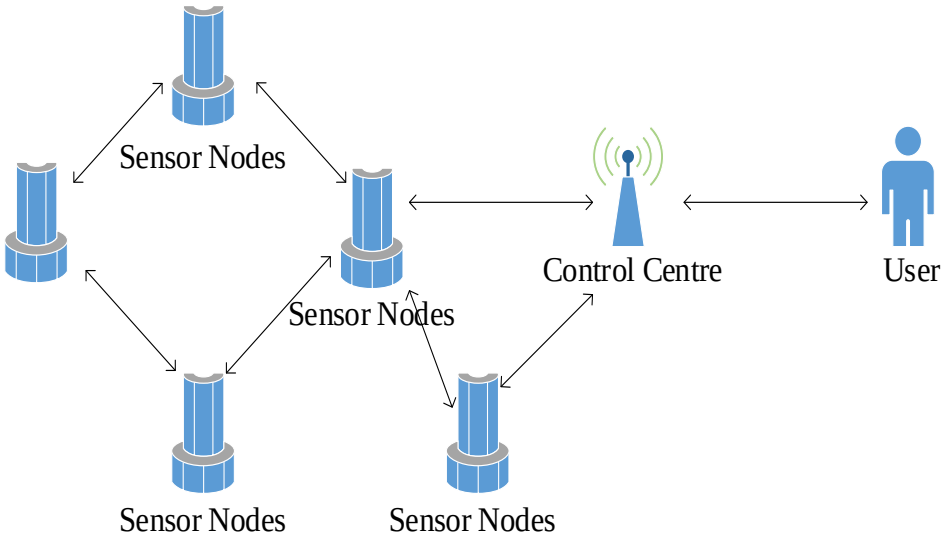


Figure 1. Wireless sensor network architecture

3. Development Evaluation of Water Pollution Control Plan

With the continuous progress of society, people's living standards have been improved, and the sustainable development of the ecosystem has been concerned by more and more social subjects. In the context of rapid economic development, environmental problems are becoming increasingly serious everywhere. Various natural disasters caused by water pollution occur frequently, which is an impact on people's quality of life and the process of socialization, and seriously restricts the healthy and stable development of society. Therefore, taking preventive measures in advance, and strangling the hidden dangers caused by water pollution problems in the cradle can greatly reduce the losses caused to people.

Water pollution in the ecosystem is the loss of water resources caused by the change of activities or natural environment, which is embodied in the reduction of water quality and quantity in the ecosystem water environment, thus affecting human life. Domestic sewage and industrial wastewater contain a large number of harmful substances and toxic gases. Urban construction waste and other by-products of production activities would cause irreversible damage to the water environment in the ecosystem. In this regard, there is also a general argument that if people can solve the outbreak of water pollution by using the current technology and means, people can control the harmful substances well and prevent them from entering the human body and threatening life and health. If people want to save human beings from the impact of water pollution, people must prevent and treat the water pollution problem, or people would treat the symptoms without the root cause.

The current water pollution prevention and treatment plan is basically to strengthen the control of surface pollution, improve the sensitivity of the sewage system, put adsorptive substances into

the sewage system to purify the polluted wastewater, and enhance the utilization efficiency. Such a water pollution control model requires a lot of manpower, material resources, professional knowledge and subjective judgment of experts and scholars, as well as high purification costs. Under the condition that the collation and utilization rate of resources is too low, the prevention and control measures for water pollution are also too backward. In order to solve some problems under the traditional ecosystem water pollution control model, this paper proposes an ecosystem water pollution control model based on wireless sensor network and combined with coverage algorithm. In addition to inheriting the pollution prevention measures of the traditional ecosystem water pollution control model, it also combines water pollution control with ecological restoration, and uses advanced technology to replace human resources to achieve the goal of controlling water pollution more efficiently. The classification of water pollution problems is shown in Figure 2.

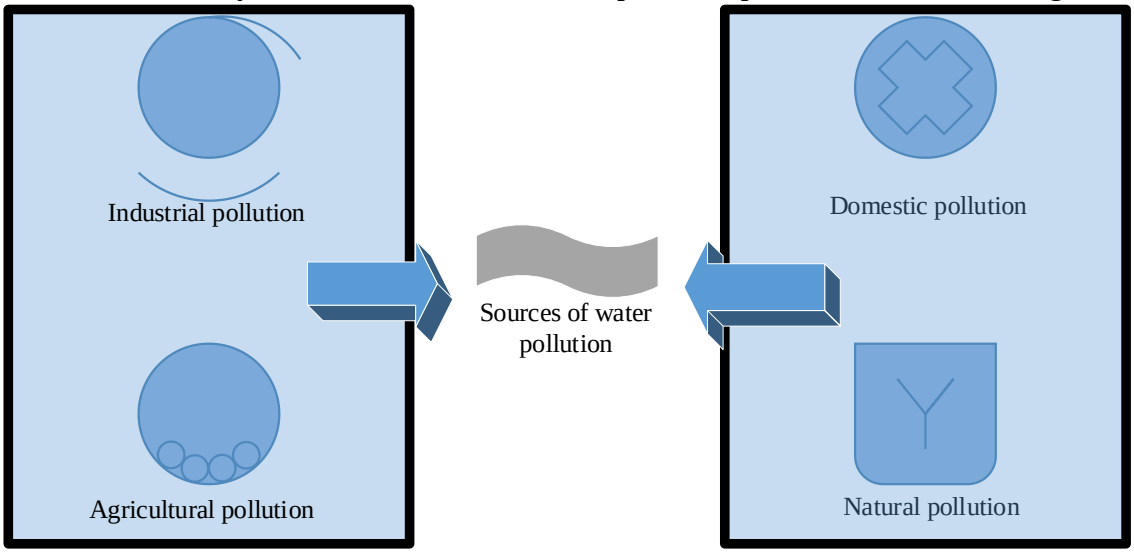


Figure 2. Classification of water pollution pollution sources

4. Evaluation of Coverage Algorithm

Because the monitoring environment of water samples in the ecosystem is relatively diverse, it is not necessary to conduct full coverage monitoring of water samples. Therefore, the local coverage algorithm is used to cover the largest monitoring area of water samples with the minimum number of sensor nodes in the wireless sensor network [15]. The ecosystem water samples covered by the wireless sensor network are processed in a two-dimensional plane, and the communication radius and sensing radius of the x sensor node Q_x are set to L_x and D_x respectively. It is assumed that the communication area and sensing area of the sensor node are circular, the sensing area of node Q_x is expressed as $W(Q_x, D_x)$, and the communication area of similar node Q_x can be expressed as $W(Q_x, L_x)$. For any two nodes Q_x and Q_y, the Euclidean distance between sensor nodes is obtained by Formula (1).

$$d_{xy} = \sqrt{(a_x - a_y)^2 + (b_x - b_y)^2} \tag{1}$$

If the distance between two nodes meets the Euclidean distance, the two nodes can directly communicate with each other, and the effective communication area between sensor nodes Q_x and Q_y can be determined by Formula (2).

$$d_{xy} \le \min(L_x, L_y) \tag{2}$$

If an area in the sensing area of a sensor node is covered by more than one sensor node, the sensor node is said to have local redundancy. The degree of redundancy η_x is equal to the ratio of the area covered by the adjacent nodes of the sensor node S_y to the area covered by itself S_x, which can be calculated by Formula (3).

$$\eta_x = \frac{S_y}{S_x} \tag{3}$$

The redundancy degree of the sensor node can determine whether the local coverage requirements are met. If it does not meet the requirements, it is necessary to add sensor nodes around the sensor node. If it meets the requirements, it is necessary to stop adding sensor nodes around the node to maintain the connectivity of the sensor network. The above are some algorithm formulas used in the water pollution control model of wireless sensor ecosystem built in this paper. This algorithm makes the operation of the model more convenient and efficient, and is more efficient in the water pollution response measures. The algorithm flow is shown in Figure 3.

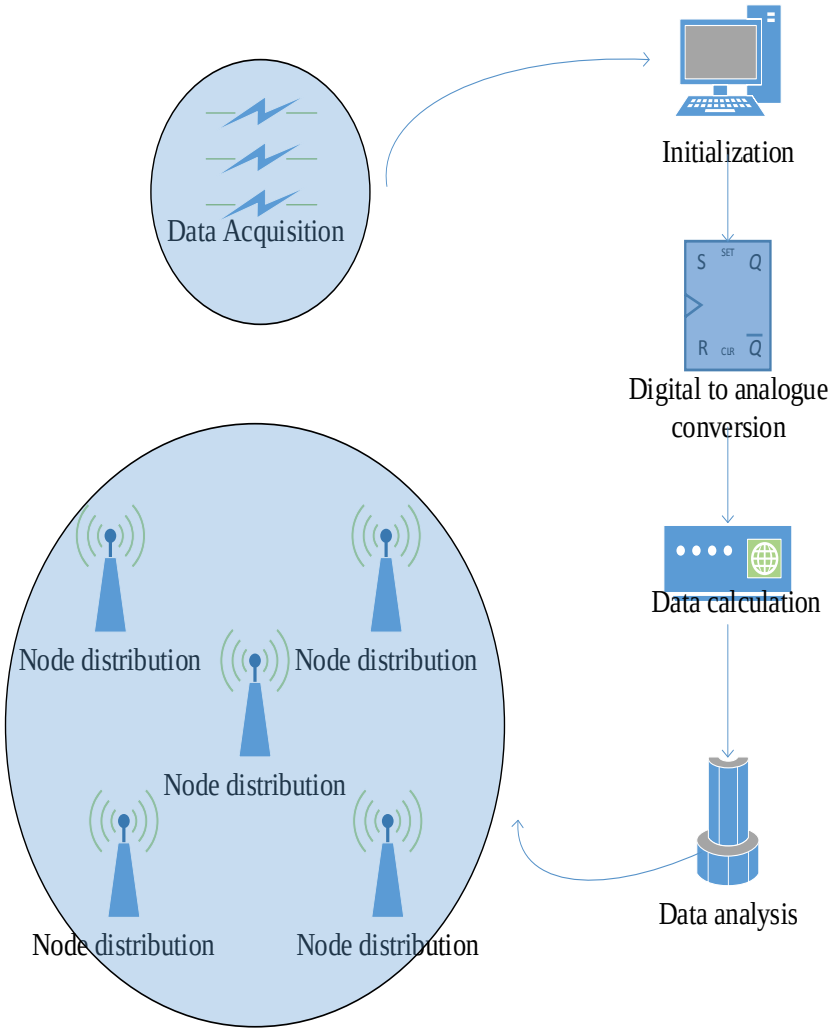


Figure 3. Overlay algorithm structure flow

5. Experimental Evaluation of Contemporary Water Pollution Control Planning Model Based on Neural Network

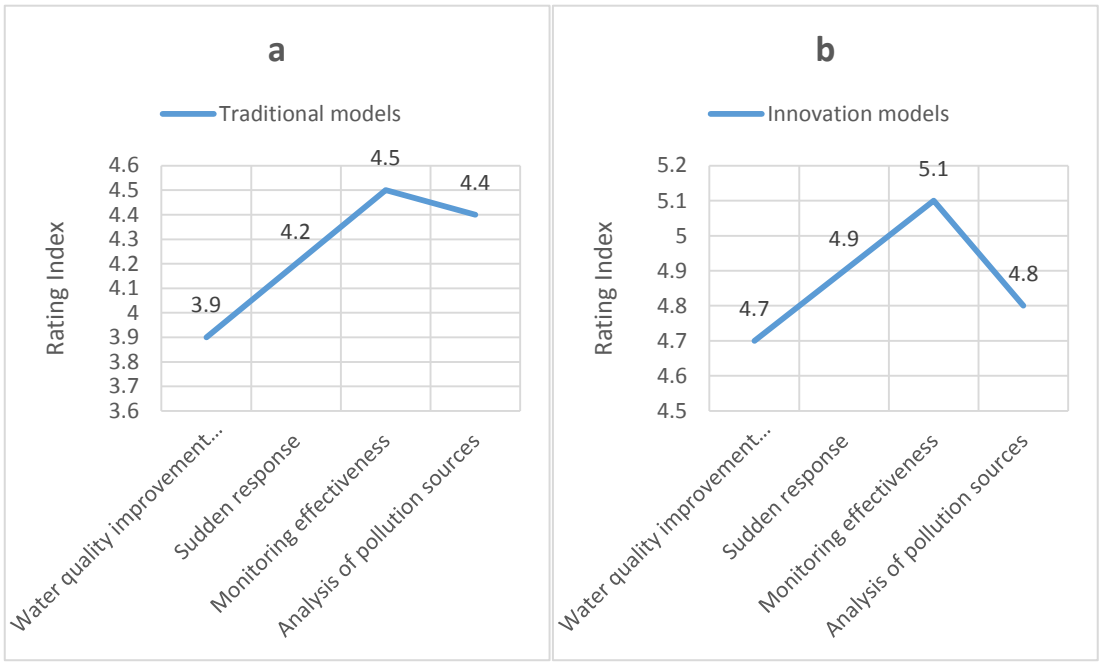
Water pollution is a complex ecosystem. Under different environmental effects, pollutants would also change to different degrees. The harm of water pollution has quite a wide range of influencing factors, which is a very major concern in the treatment of ecosystem pollution. Water pollution would pose a huge threat to people's health, and also cause immeasurable economic losses. Therefore, people need to find problems through research and take corresponding measures to achieve the important goal of harmonious coexistence between human and nature and improving the ecosystem. In order to study the specific application effect of the ecosystem water pollution governance model based on wireless sensor network technology, it is very important to establish the evaluation criteria of the ecosystem water pollution governance model. Table 1 shows the classification of some evaluation criteria and their detailed rules of conduct.

Table 1. Evaluation criteria and their evaluation rules

Evaluation indicators	Rules of Conduct
Water quality improvement effect	Past water quality levels Current water quality levels
Sudden response	Predicted effects Predicted speed

In order to optimize the existing water pollution control model of the ecosystem, so that the ecosystem can be restored, first of all, a sample interval is divided for some waters in the local ecosystem to collect water samples for a period of time for pollution control experiments. Each distributed sensor is a water sample sampling point, which converts the collected water analog parameters into digital signals through digital analog conversion, and then communicates with each other through wireless sensor nodes to transmit the data to the general control monitoring point. In the process of wireless sensor distribution in the sample interval, the local coverage algorithm is used to calculate the optimal wireless sensor distribution scheme, which is used to achieve the maximum coverage, ensure the data transmission efficiency and communication speed, evaluate and predict the final monitoring information, and discover the hidden danger of water pollution in the ecosystem in a timely manner. Such an ecosystem water pollution governance model can fundamentally solve the problems of the traditional ecosystem water pollution governance model in the process of governance. The human and material costs are too high; the hidden dangers of water pollution are not found in time; the measures to deal with sudden water pollution problems are also relatively thin; the monitoring and prediction effects of water pollution problems are not satisfactory. However, some experiments are still needed to verify the effectiveness of the model.

Firstly, the water area in the local ecosystem is divided into sections, and then the local coverage algorithm is used to calculate the distribution scheme of wireless sensors. Each wireless sensor node jointly forms a wireless sensor network. The analog quantity of the water environment collected by the wireless sensor node is converted into digital signals through analog-digital conversion, and the collected wireless sensor interacts with the surrounding wireless sensors for data exchange and information transmission, and finally feeds back to the general control monitoring node for monitoring situation analysis and hidden danger prediction. After a period of experiments, the satisfaction of the relevant staff and system controller is evaluated according to the results. The performance of the wireless sensor based ecosystem water pollution governance model and the traditional ecosystem water pollution governance model proposed in this paper are compared and analyzed according to the evaluation rules, as shown in Figure 4.



a. Performance analysis of traditional models

b. Performance analysis of innovative models

Figure 4. A comparative analysis of traditional and innovative models for managing water pollution problems in ecosystems

As shown in Figure 4, Figure a shows the performance analysis of the traditional ecosystem water pollution treatment model. The four performance indicators are water quality improvement, emergency response, monitoring effect, and pollution source analysis. The performance indexes of the four performance indicators were 3.9, 4.2, 4.5, and 4.4 respectively. Figure b shows the performance analysis of the innovative ecosystem water pollution treatment model. The four performance indicators are water quality improvement, emergency response, monitoring effect, and pollution source analysis. The performance indexes of the four performance indicators were 4.7, 4.9, 5.1, and 4.8, respectively. According to the comparative analysis of the four performance index data, the innovative ecosystem water pollution governance model was better than the traditional ecosystem water pollution governance model. Through the comparison of the two, the innovative ecosystem water pollution governance model proposed in this paper had an average improvement of 14.9% in four performance aspects compared with the traditional ecosystem water pollution governance model.

6. Conclusion

Under the influence of the gradual progress of urbanization in the ecological environment, the endless water pollution problems have caused a huge impact on people's lives, and people have gradually attached importance to the construction of water pollution treatment programs. In order to solve the problems of the traditional ecosystem water pollution prevention and control plan, such as the untimely detection of water pollution hidden dangers, the relatively weak measures to deal with sudden water pollution problems, and the unsatisfactory monitoring and prediction results of water pollution problems, this paper proposed an ecosystem water pollution governance model based on

wireless sensor technology and combined with local coverage algorithm. Finally, the reliability of the model was verified by experiments. Compared with the traditional ecosystem water pollution governance model, it had better ability to deal with sudden pollution problems.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Gaojie Wu. Water pollution management in China: recent incidents and proposed improvements. Water Science and Technology: Water Supply. (2018) 18(2): 603-611. https://doi.org/10.2166/ws.2017.139

[2] Singh Upma. Water Pollution due to Discharge of Industrial Effluents with special reference to Uttar Pradesh, India-A review. International Archive of Applied Sciences and Technology. (2018) 9(4): 111-121.

[3] Hanif M. A. Impact of Kapotaksha river water pollution on human health and environment. Progressive agriculture. (2020) 31(1): 1-9. https://doi.org/10.3329/pa.v31i1.48300

[4] Qian Wang. Coevolution of iron, phosphorus, and sulfur speciation during anaerobic digestion with hydrothermal pretreatment of sewage sludge. Environmental Science & Technology. (2020) 54(13): 8362-8372. https://doi.org/10.1021/acs.est.0c00501

[5] Fongaro Gislaine. SARS-CoV-2 in human sewage and river water from a remote and vulnerable area as a surveillance tool in Brazil. Food and Environmental Virology. (2021) 14(4): 417-420. https://doi.org/10.1007/s12560-021-09487-9

[6] Chaoua Sana. Efficiency of two sewage treatment systems (activated sludge and natural lagoons) for helminth egg removal in Morocco. Journal of infection and public health. (2018) 11(2): 197-202. https://doi.org/10.1016/j.jiph.2017.07.026

[7] Nkhoma Peter R. Recycled water reuse: what factors affect public acceptance? Environmental Conservation. (2021) 48(4): 278-286. https://doi.org/10.1017/S037689292100031X

[8] Oral Hasan Volkan. A review of nature-based solutions for urban water management in European circular cities: a critical assessment based on case studies and literature. Blue-Green Systems. (2020) 2(1): 112-136. https://doi.org/10.2166/bgs.2020.932

[9] Greenaway Tameika, Kelly S. Fielding. Positive affective framing of information reduces risk perceptions and increases acceptance of recycled water. Environmental Communication. (2020) 14(3): 391-402. https://doi.org/10.1080/17524032.2019.1680408

[10] Ahmed Shahid, Saba Ismail. Water pollution and its sources, effects & management: a case study of Delhi. Shahid Ahmed and Saba Ismail (2018)'Water Pollution and its Sources, Effects & Management: A Case Study of Delhi'. International Journal of Current Advanced Research. (2018) 7(2): 10436-10442.

[11] Sarker Bijoyee. Surface and ground water pollution: causes and effects of urbanization and industrialization in South Asia. Scientific Review. (2021) 7(3): 32-41. https://doi.org/10.32861/sr.73.32.41

[12] Pichura Vitalii. Causal regularities of effect of urban systems on condition of hydro ecosystem of Dnieper River. Indian Journal of Ecology. (2020) 47(2): 273-280.

[13] Abdulkarem Mohammed. Wireless sensor network for structural health monitoring: A contemporary review of technologies, challenges, and future direction. Structural Health Monitoring. (2020) 19(3): 693-735. https://doi.org/10.1177/1475921719854528

[14] Khalaf Osamah Ibrahim, Bayan Mahdi Sabbar. An overview on wireless sensor networks and finding optimal location of nodes. Periodicals of Engineering and Natural Sciences. (2019) 7(3): 1096-1101. https://doi.org/10.21533/pen.v7i3.645

[15] Nouri Nabil Abdelkader, et al. Accelerated PSO algorithm applied to clients coverage and routers connectivity in wireless mesh networks. Journal of Ambient Intelligence and Humanized Computing. (2021) 14(1): 207-221. https://doi.org/10.1007/s12652-021-03283-w