

## Research Article

# Dynamic Combination Evaluation Method of Rural Environmental Pollution Control Effect

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In recent years, the problem of environmental pollution has become more and more serious, and environmental pollution has become a topic of concern. PM2.5, PM10, hazy weather, and other words about environmental pollution have become hot words and topics for the media and the public to talk about, and environmental pollution control is called for by the media and the public. This reflects the rapid development of economy and the obvious changes in people's living standards, and people have higher requirements and aspirations for their lives and the environment they live in, and their awareness of environmental protection is getting stronger and stronger; however, it also reflects that the rapid development of the economy comes at the cost of damaging the environment. This paper analyzes the current situation and governance dilemma of rural environment by means of field research from dynamic portfolio evaluation theory, explains the problems and causes of environmental pollution management under the requirement of polycentric governance, and proposes countermeasures to solve the problem of environmental pollution management in county. The paper aims to analyze the current state of environmental pollution in rural areas through literature review, villagers' field interviews, and field research and to explain the application of polycentric governance to rural environmental pollution management in county in the region.

## 1. Introduction

In the traditional human labor-based farming era, productivity levels were low, materials were scarce, and thus environmental pollution rarely occurred. However, with the advent of industrialization, machinery has replaced human labor in agricultural production, more and more technologies and goods have entered the countryside, and farmers' income has increased rapidly, and their living standard has become higher and higher, but the environment on which they depend for survival is deteriorating. In order to increase the mu yield, excessive use of chemical fertilizers, pesticides, plastic films, and so forth over time, the soil pH imbalance, plate, fertility reduction, water bodies are polluted, plastic films are not degraded, randomly discarded is white waste, buried in situ pollution of the soil, open burning pollution of the atmosphere [1]. With the governance of urban environmental protection, many high-energy-consuming and high-polluting enterprises gradually moved into rural areas

with weak environmental protection supervision; the relocation of enterprises temporarily brings about economic benefits to the local area, but large amounts of wastewater and exhaust gases are discharged recklessly, which seriously damage the local environment and harm the physical and mental health of local villagers. In the new era, researchers put forward the development concept of "green water and green mountains are golden mountains," and various environmental pollution control works have been carried out in various places, and the construction of beautiful countryside is indispensable for building a beautiful city [2].

Environment is the combination of various material requirements for human life and development and is the external carrier of human life. The rural environment is related to the urban environment and is the sum of natural and social conditions centered on the rural settlement within a certain area. The rural environment is divided into rural environment and rural living environment, both of which focus on the production as well as the life of villagers, but

there is no absolute boundary between the two and they are often closely related. In general, rural environmental pollution refers to the pollution generated by the daily production and life of villagers living in the village [3]. Rural environmental pollution management is a process in which the government and private organizations use large numbers of measures and methods to manage and change the rural environment to achieve a stable and sustainable socioeconomic development in rural areas. It includes not only the management of industrial, domestic, and agricultural pollution in rural areas but also the establishment of a sound governmental environmental pollution management mechanism, the introduction of some market management mechanisms, and the improvement of people's awareness of environmental protection and their participation in environmental pollution management [4–10]. Therefore, the only way to protect the rural environment that is closely related to our survival is to take effective measures to deal with the rural environmental pollution problems that have emerged, are now widespread, and can be expected. Polycentric governance theory advocates autonomous governance based on allowing multiple power actors to coexist, as shown in Figure 1. It allows the subjects to cooperate and negotiate, giving the public more choices and services in the management of public affairs and social governance, reducing "free-rider" behavior, avoiding "the tragedy of the commons" and "the dilemma of collective action," and extending the public nature of governance [11]. The Ostroms conceived the model of multiple governance subjects, advocating allowing multiple centers of power to coexist and strengthening the synergy between government, markets, and social organizations. By breaking the single governance model of government as advocated by traditional public management in the past and adding social organizations and market subjects and the public, a form of governance in which multiple subjects jointly govern social public affairs is formed. People's interests and demands are changing dramatically with the development and progress of society [12]. In the past, the traditional "single center" governance model has been far from meeting the needs of economic and social development, and "government failure" and "market failure" are common in the management of public affairs and social governance [13–16]. Since 1990, with the acceleration of globalization, informationization, and marketization, governance theories have entered a new round of development, mainly including the following typical theories: learning organization theory [17], enterprise core competency theory [18], enterprise process reengineering theory [19], balanced scorecard theory [20], and theories on the development of the "single center" governance model, and scorecard theory [21]. The contemporary governance theories show many trends, which can be summarized as follows: people management, change management, innovation management, knowledge management, team building, cross-cultural management, green management, and decentralization of organizational structure; all of these have led the contemporary governance theories to the "innovation-led" Era.

After research, rural environmental pollution has been deteriorating due to various factors such as geographical

location, living habits, unilateral government management, and transfer of urban pollution to rural areas. The overall situation of rural environmental pollution in the region is still severe, and environmental pollution shows an expanding trend. The main reasons are attributed to the lack of local government responsibilities, the serious lack of investment funds for rural environmental pollution control, the lack of participation of social organizations, the seriousness of illegal production by local enterprises, and the lack of villagers' awareness and ability to participate. Therefore, this paper constructs a multicentered governance concept of rural environmental pollution management from the perspective of polycentric governance. The power of government, market, social organizations, and the public are brought into play to jointly work on the management of rural environmental pollution. On the one hand, it is necessary to transform the government's function of single-centered environmental governance, form the concept of environmental pluralistic cogovernance, and accelerate the cooperative relationship of multiple subjects in rural environmental pollution governance. On the other hand, the advantages of each subject in environmental pollution management should be brought into play to better solve the dilemmas and problems faced by rural environmental pollution management at this stage.

## 2. Related Work

Environmental pollution is a general term for the phenomenon where human beings produce toxic substances in the process of production and life which exceed the purification capacity of nature itself, thus causing ecological imbalance and environmental degradation and endangering the survival and development of people and other natural organisms. Environmental pollution is mainly the pollution of the atmosphere, water bodies, soil, and food by harmful substances contained in the three wastes produced by industrial production, and it reaches a serious degree of harm. This can lead to air pollution in the atmosphere, poor quality of water environment, garbage and waste accumulation, noise pollution, and so forth. An Introduction to Environmental Safety, edited by Mingjun Jiang, points out that the so-called rural environment is relative to the urban environment, and he shows that the urban environment is mainly artificial, while the rural environment contains both artificial and natural environments. The natural environment of the rural area, also known as the agricultural environment, is a complex consisting of the demand for natural factors in nature during the production of agriculture, forestry, livestock, pasture, and fishery, which includes soil, water, forest, grassland, air, and sunlight. The artificial environment of rural areas refers to the surrounding environment of rural people's production and living process, gathering and production, and living places.

In summary, rural environment can be summarized as a general term for the natural and artificial environment within the scope of rural areas, including the atmosphere, water, land, flora and fauna, and buildings, centered on rural residents. Rural environmental pollution management refers

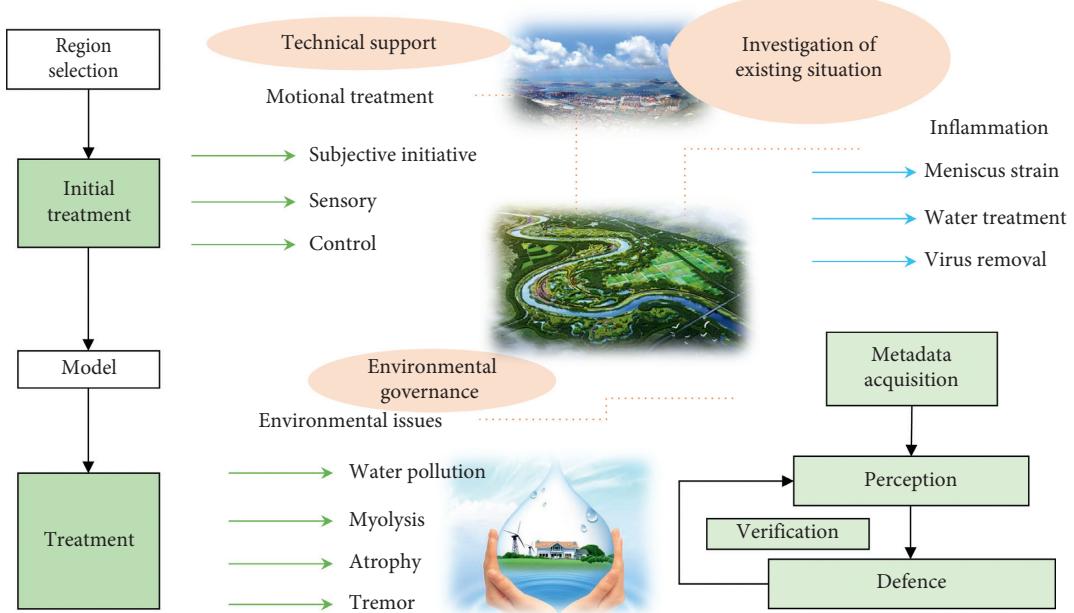


FIGURE 1: Dynamic assessment of polycentric governance.

to the sum of all activities where people take various measures to improve rural production and living conditions, to improve and repair the existing natural environment, living environment, and agricultural production environment in rural areas, and to protect them from the source. Specifically, it includes the treatment of symptoms, that is, the integrated treatment of rural sewage and garbage, the containment of agricultural surface pollution, the proper treatment of industrial pollution, and the improvement of pollution control facilities, as well as the treatment of the root cause, that is, the design of the system, the strengthening of management tools, the role of the market, the awakening of environmental awareness, and so forth [22]. Roughly, according to the different pollutants, they are broadly divided into the three following types. The first type is rural surface source pollution. In the process of rural production, with the excessive use and improper treatment of organic or inorganic substances such as agrochemicals, domestic sewage, or garbage, and in the process of atmospheric circulation and surface runoff, so that a large number of pollutants flow freely into rivers, lakes, reservoirs, and other water bodies, resulting in the pollution of the rural ecological environment, we can call rural surface source pollution.

The main causes of rural surface environmental pollution at this stage are large-scale field pollution caused by the excessive use of agrochemicals, pollution generated by livestock and poultry farming, and straw burning. Due to the change of agricultural production methods and the improvement of farmers' living standards, fertilization methods have changed from organic fertilizers to excessive or inappropriate use of pesticides and chemical fertilizers. The resulting soil acidification, nitrogen, and phosphorus in chemical fertilizers with rain or irrigation into the water body affect domestic water. Rural autumn straw burning

causes large areas of environmental pollution. The second type is rural life pollution. With the reform and opening up, the strategy of vigorously building new rural areas must be carried out unswervingly [23]. Life in rural areas has undergone radical changes, but the infrastructure in rural areas is not perfect, and farmers' awareness of environmental protection is not high enough together with a series of problems resulting in an expanding trend of pollution caused by rural production and life. The main manifestations are the following: the imperfect infrastructure in rural areas leads to the random piling or disposal of domestic waste, and the imperfect treatment of domestic sewage and manure causes serious harm to the ecological environment of the region. The third type is local enterprises pollution. Local enterprises, while driving the development of rural society, can also have an impact on the rural environment of the region. Due to the weak supervision of local enterprises, the large number of enterprises, chaotic layout, rudimentary equipment, backward technology, and other characteristics, the production process generates a large amount of industrial waste discharged without treatment, and the damage to the rural environment in the region is becoming increasingly serious. The number of villagers suffering from cancer is increasing year by year due to these pollutions, and many cancer villages have been created. Therefore, the impact of this pollution on the rural environment cannot be underestimated.

### 3. Dynamic Portfolio Evaluation of Pollution Management

*3.1. Polycentric Governance Theory.* Polycentric governance theory is one of the most popular theories in Western academia today, and the term "polycentric" was first mentioned and explained by British scholar Michael Polanyi in

his book titled “The Logic of Freedom.” The first perspective is the history of human scientific and technological development, and the other perspective is the superiority of market economy over highly centralized planned economy, summarizing two ways of arranging freedom, namely, “spontaneous order” and “centralized guidance.” He argues that the former is freedom in the true sense of the word. In his further explanation of spontaneous order, he saw the incentive of profit in commodity economic activities and thus gained insight into the existence of “polycentric” choices. Although Polanyi’s discovery of the existence of “polycentricity” initiated the study of this theory, whether polycentric governance and services are beneficial to the public management of society and the provision of social services needs to be tested empirically.

Subsequent prominent contributions to the study and development of the theory were made by Ellie Ostrom and Vincent Ostrom (Institute for Political Theory and Policy Analysis, Indiana University) who cofounded the theory of polycentric governance based on theoretical and empirical analyses. Polycentric governance theory advocates autonomous governance as the basis for allowing multiple subjects of power to coexist. The theory of polycentric governance is based on autonomous governance, allowing multiple power actors to coexist, giving the public more choices and services in the management of public affairs and social governance based on cooperation and consultation, reducing “free-rider” behavior, avoiding “tragedy of the commons” and “collective action dilemma,” and expanding the public nature of governance. The Ostroms envisioned a number of ways to expand the public nature of governance. The Ostroms conceptualize a model of multiple governance subjects, advocating the coexistence of multiple centers of power and the strengthening of synergistic governance among government, markets, and social organizations. By breaking the traditional public management model of single governance by the government and adding social organizations, market actors, and the public, they have formed a form of governance in which multiple subjects jointly govern social public affairs. People’s interests have changed dramatically with the development and progress of society. In the past, the traditional “single center” governance model has been far from meeting the needs of economic and social development, and, in the management of public affairs and its social governance, “government failure” and “market failure” are common. The phenomenon of “government failure” and “market failure” in the management of public affairs and social governance is commonplace.

Since 1990, with the acceleration of globalization, informationization, and marketization, governance theories have entered a new round of development, mainly including the following typical theories: learning organization theory, enterprise core competence theory, enterprise process reengineering theory, and balanced scorecard theory. Contemporary governance theories show many development trends, which can be summarized as follows: people management, change management, innovation management, knowledge management, team building, cross-cultural management, green management, and decentralization

of organizational structure; all these make contemporary governance theories enter the “innovation-led” era. First is Learning Organization (LO), Peter Sage (a scholar at MIT Sloan School of Management) put forward this management concept in his book titled “The Fifth Discipline.” He believed that enterprises should strive for streamlining, lifelong learning, and continuous self-organizational reengineering to maintain their competitiveness under any circumstances. Peter St. J. also believes that the most important means of a learning organization is to achieve knowledge management. Second is the theory of core competence of enterprises. Core competence is also called “core competitiveness.”

The concept of core competencies was first introduced in the famous magazine “Harvard Business Review” by the famous American scholar C.K. Prahalad and his student Gary Hamel. They believe that core competencies are the source of sustainable competitiveness. Core competency theory elevates the competitive strategy to a higher level, and it is shown that core competency theory belongs to the strategic management school of management theory. Since the 1990s, a revolution of enterprise reengineering has emerged in the corporate world of western developed countries, which is described as “the transformation of caterpillars into butterflies,” and the theory of enterprise process reengineering (BPR) is regarded as the second management revolution after the movement of total quality management. According to BPR theory, the reengineering activity is a major mutational reform, not a simple modification of the original organization. Third is the Balanced Scorecard Theory; a new approach to organizational performance management was developed by Robert Kaplan and David Norton in the 1990s. As a result of the New Public Management movement, these management theories emphasize cooperation and interdependence among equal actors in the provision of public goods. With more emphasis on the innovative development of enterprises, contemporary governance theories focus on the cooperation between government and market and social organizations. A pluralistic concept of shared governance is formed among the various actors to jointly address the social and public affairs that exist in today’s society and to provide better social services through competition and collaboration.

**3.2. Basic Requirements of Multicenter Dynamic Evaluation.** Based on British sociologist Polanyi’s “Social Order Theory”, the Ostroms have extensively investigated various types of organizational models in social life and proposed the theory of “polycentric governance” through theoretical and empirical analyses. The basic requirements of polycentric governance are mainly reflected in the following aspects: First, polycentricity as a governance concept implies the existence of multiple production, supply, and service subjects in the whole process of public goods production, public service provision, and public affairs handling. Second, polycentric governance specifies that the governance subjects should be diversified, breaking the original pattern of single governance by the government and forming a multigovernance concept led by the government with the

participation of the market, social organizations, and the public. The polycentric governance model is a new paradigm of public affairs governance, as shown in Figure 2, which gives full play to the advantages of each governing body and focuses on solving public affairs and social problems. In a public affairs governance model, the treatment of water pollution should first follow the policy from a perspective of safety index. A later forecast would obtain the data and condition from the index. Then, a specific expectant treatment could be realized. Finally, through different view images, a comprehensive assessment could be obtained.

Polycentric governance refers to the decentralization of the original monolithic implementation to multiple governance subjects, the establishment of multiple jurisdictional units for some public affairs. However, the premise is that, within the constraints of the law, no individual or group can act above the law, and all public authorities have an independent and limited official status. Polycentric governance emphasizes that the public sector, social organizations, and the market can all become suppliers of public goods, so as to achieve a pluralistic supply structure of public goods and form a pluralistic competition mechanism. Polycentric governance requires that, in the process of governance of public affairs, the government should not only take the lead as a main body but also guide various private institutions, various nongovernmental social organizations, the market, and individual citizens to participate in the management of public affairs, and, at the same time, they should do their respective responsibilities and obligations under certain rules to provide better quality social services. The term “polycentric governance” can be summarized into two core elements: one is “polycentric” and the other is “cooperative.” “Polycentricity” refers to the presence of multiple governance actors. “Cooperation” refers to the concept of cooperation and joint governance based on the participation and consultation of multiple subjects. Through the cooperation and resource integration among the subjects, we are committed to solving social conflicts and problems and meeting the needs of public services. The conditions for the realization of “polycentric” governance include the following aspects: First, the government changes its role and builds a service-oriented government. The purpose is to serve the people wholeheartedly and to provide maintenance public services through decentralization, so as to maximize the public interest of the society. Second, enterprises and social organizations have good space for development. The government should provide policy support for social organizations and enterprises. Social organization development and enterprises can only work together to solve social problems and meet public service needs if they are well developed and growing. Third is relatively perfect legal norms for diversified cooperation only under the support of perfect laws and regulations to provide a legal basis for the subjects. Fourth is smooth channels of participation of the good public. Smooth participation channels, mentioning the ability of farmers to participate, can make the public as the main force of social governance and can mobilize farmers to participate in the process of social governance to ensure the democratization of scientific decision-making. Fifth is to

establish mutual trust between the subjects. Trust is the basis and premise of cooperation, and without trust it is difficult to form a real cooperation between the subjects of governance.

## 4. Spatiotemporal Dynamic Evaluation

*4.1. Indicator Selection and Evaluation Methods.* In order to better understand the pollution level, based on the data collection, groundwater from 2010 to 2021 was selected for specific evaluation in this study, and dive quality evaluation maps were made separately, so that the changes in the distribution of dive pollution over these years could be well reflected. Total solids, total hardness, ammonia nitrogen, chloride, sulfate, nitrate, nitrite, volatile phenols, fluoride, arsenic, chromium, lead, oxygen consumption, value, mercury, fluorine, and cyanide, which have a great influence on the groundwater quality, were taken into the evaluation.

According to the actual test results of each individual component evaluation, the quality of the component is divided into categories. The evaluation scores of individual components are determined separately for each category according to the regulations  $F_i$ .

The comprehensive evaluation score  $F$  can be obtained according to the following formula:

$$F = \frac{\sqrt{\sum_{i=1}^n F_i}}{F_{\max}},$$

$$F_q = \frac{\sqrt{\sum_{i=1}^n F_i}}{F_{\max}} + \sum_{i=1}^n (F_i + F_{i+1})^2. \quad (1)$$

From Figure 3, it can be seen that the regional distribution of diving quality in city has a clear horizontal zoning, that is, the northern suburban sewage irrigation area and the urban area are extremely poor water areas, and the diving quality gradually becomes better with this area as the center and outward. This reflects the anthropogenic pollution in city. In the suburban sewage irrigation area, the industrial area, and the urban area, the quality of diving is poor and very poor, and, from this area to the outside, the quality of diving gradually becomes better as the discharge of three wastes and man-made pollution are gradually reduced. The content of pollutants in the water in the excellent area is basically within the background value, with one pollutant at individual points being critical to the standard value. It is harmless and suitable for drinking. It is distributed in the suburban areas and the river area on the periphery of the good area, and the main water supply sources of city are the surface water and ground water.

In the long run, the process of rural environmental pollution control is an extremely complex system project. It is very difficult to achieve a good result if we rely on the government to solve this complex project unilaterally. Therefore, it is necessary to build a “multigovernance” concept of rural environmental pollution management based on Ostrom’s polycentric governance theory. It ensures that the government, enterprises, social organizations, farmers, and the public can become the basic leaders and

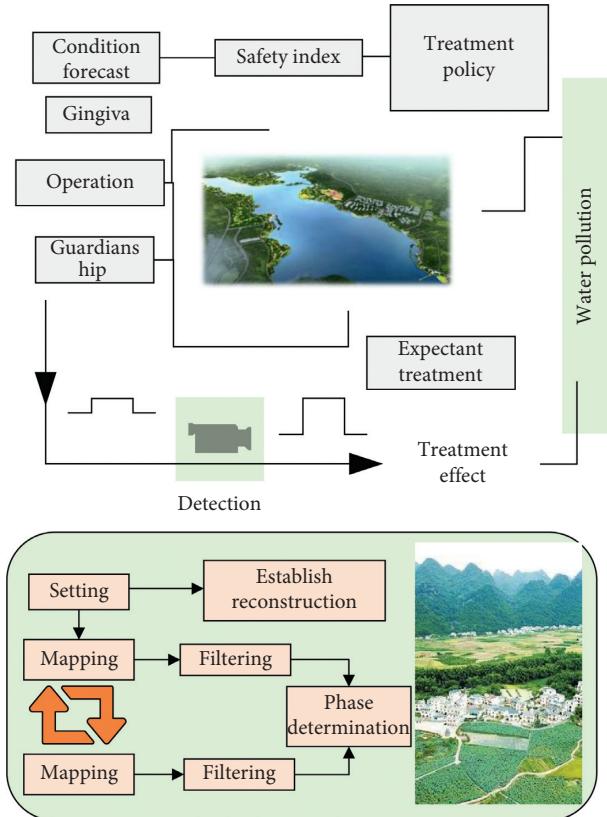


FIGURE 2: Public affairs governance model.

participants in the management of rural environmental pollution and forms a framework for rural environmental governance with extensive participation and cooperation among multiple actors. The core of this governance framework is that the government plays a central leading role in guiding enterprises, social organizations, farmers, and the public to participate in rural environmental governance. Through this framework, we can integrate various resources for environmental governance, improve the laws and regulations of rural environmental governance, and build a platform for consultation and common governance among various subjects.

**4.2. Major Issues in Environmental Governance.** The lack of environmental knowledge available in rural areas compared to urban areas, coupled with long-standing habits and economic pressures, makes it difficult for people to actively participate in environmental protection. They often see environmental protection and pollution control as the government's responsibility, rely on the government to solve problems, and are only concerned when their own interests are at stake. In most cases, people are only concerned with their own personal interests and ignore the common good. Inevitably, environmental pollution is caused by the pursuit of individual interests. The level of public awareness of environmental protection is also a major impediment to its proper development. Without the encouragement and support of these social forces, the government alone cannot adequately deepen our efforts to prevent environmental

pollution. With this pressure for development and the government's lack of understanding of the importance of environmental protection, in order to promote rapid economic development, the government has relaxed the environmental conditions of companies in order to attract projects, resulting in the pollution of the local environment. Even if economic growth is achieved in a short period of time, this "pollute first, treat later" approach will hinder the sustainable development of the economy in the long run. Putting aside the indicators of economic development, the township also faces a variety of checks and assessments. Among them, the letter and stability and production safety are subject to a one-vote veto system, so township governments and grassroots cadres have to devote a lot of energy to such work. Since the 18th National Congress of the Communist Party, the focus of work has shifted toward the construction of ecological civilization, and the proportion of the assessment of grassroots township governments has increased, but it still has not been able to shake the status of economic assessment. Under the premise that the Macon township government has relatively limited human and material resources, it can only cope with the inspection and assessment of the higher government through temporary governance work.

According to the environmental Kuznets curve, the groundwater pollution in city has gone through a process of "getting worse first and then getting better" in recent years. Taking the 2010s as the boundary, the data in the first period are missing and the continuity is poor, while the data in the later period are complete and continuous, so the next 20 years are used as an example. The measured data were selected to produce a time-series graph of nitrate exceedance rate, and the following widely used equation was used as the trend term to simulate:

$$Q(t) = at^2 + bt + c. \quad (2)$$

From the equations and simulations, it can be seen that the groundwater nitrate pollution in city is in the post-declining phase of the normal curve of the environmental Kuznets curve in the past 20 years, and the exceedance rate of groundwater nitrate samples decreases to a level below 30%. Due to the cyclical nature of economic construction and environmental protection enforcement, the groundwater pollution in city over the past 20 years not only has shown a gradual decline in the overall trend but also had secondary cyclical fluctuations, so that the simulation of the trend term of the simple equation cannot be used for accurate prediction.

By removing the trend term on the basis of the original series  $Y(t)$ , it can be found that there are obvious periodic fluctuations in the deviation. Considering the short time series, the mathematical model for data simulation should be relatively simple, and the sine function with single amplitude and single period is used in this study as follows:

$$T(t) = A \cos(\omega t + \varphi). \quad (3)$$

The periodic term simulation is performed, and the periodic term equation for the first-level residuals is as follows:

$$T(t) = 4.2 \cos(0.68t + 3.4). \quad (4)$$

From the equation, we can see that the nitrate pollution in groundwater of city has a fluctuation cycle of one year, and the amplitude of the exceedance rate of the samples is between  $-1.2\%$  and  $1.2\%$ . By adding the trend term simulation equation and the residual cycle term simulation equation, a more accurate simulation equation can be obtained as follows:

$$Q(t) = 1.96 + 2.2t^2 + t + 4.2 \cos(0.68t + 3.4). \quad (5)$$

In fact, the time-series variation of environmental pollution is far more complex than the deterministic theoretical analysis. In addition to the trend and period terms mentioned above, there are obvious stochastic time-series variations, as shown in Figure 4. In order to understand this stochastic variation, a more detailed simulation is needed.

The trend and period terms are removed from the original data series and can be found to be stochastic time series, which may be caused by more secondary fluctuations or stochastic ups and downs factors. Following the idea that the future is an extrapolation of the past to the present and that forecasting is a projection of the unknown from the known, this study uses an autoregressive model for simulation, smoothing the autoregressive period to no more than years and maximizing the autocorrelation coefficient, and the stochastic time-series equation for the secondary residuals is as follows:

$$S(t) = \frac{1.96 + 2.2t^2 + t}{4.2 \cos(0.68t + 3.4)} + S(t-1) + 0.5S(t-2). \quad (6)$$

From the equation, it can be seen that the secondary residual time-series change of groundwater nitrate exceedance rate is negatively correlated with the previous two years and positively correlated with the previous year. Finally, the trend term, the periodic term, and the stochastic term were combined, forming the requested time-domain combination model shown in Figure 5. Compared to 2010, in the same pollution index, the secondary residual time would be much wider in 2020, which can be seen in the black and grey bars. When the index is located in 4, the data from 2020 would reach 6 stages compared to the 4 stages in 2010; and using the similar calculation method, a relative result also can be obtained in red/yellow bars.

## 5. Results and Discussion

Polycentric governance theory requires that, in the management process of rural environmental pollution, multiple subjects give full play to their own roles, and the government, the market, social organizations, and citizens must take on certain responsibilities. In the process of governance, each subject should follow the principle of sustainable development, based on the concept of polycentric governance, meet the strategic overall situation of the harmonious economic and social development of rural areas, take effective environmental protection improvement measures, and increase the strength of rural environmental pollution

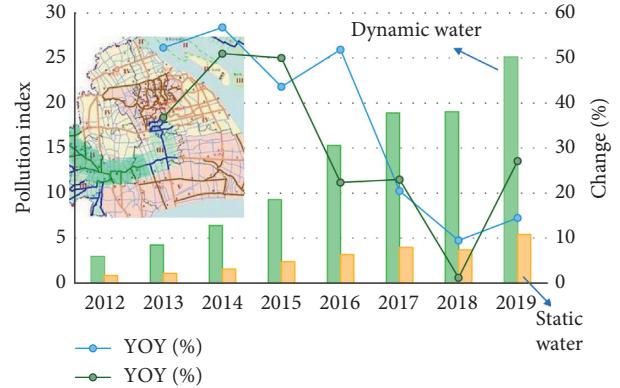


FIGURE 3: Dynamic water quality evaluation.

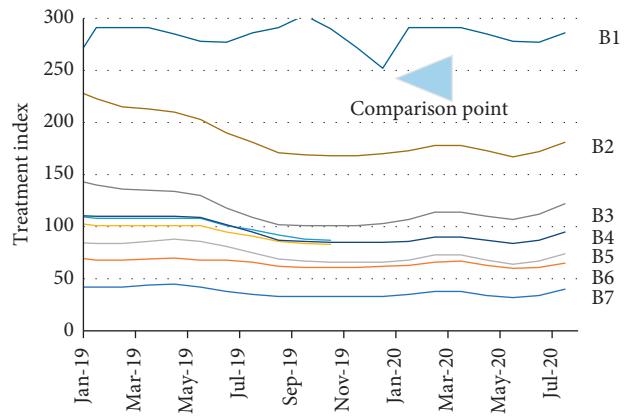


FIGURE 4: Final linkage and evaluation results by year.

management through mutual cooperation and consultation among multiple governance subjects, whose reference orientation can be shown in Figure 6. This requires the government, enterprises, and citizens to do the following requirements: First, the government actively changes its concept of development, listens to the different demands of social organizations, enterprises, and citizens in the process of formulating rural environmental pollution management programs, and strengthens communication efforts. Second, to clarify the responsibilities of enterprises and citizens, farmers should have the intention to defend their rights and supervise the illegal production behavior of enterprises, and enterprises should improve their own environmental awareness. Third is to improve citizen participation and enhance the farmers' own environmental protection meaning. Fourth, social organizations should raise people's awareness of environmental protection through relevant publicity activities. Fifth is to accelerate local laws and regulations on environmental protection in rural areas and continuously improve the government's supervision mechanism on environmental pollution control.

The complex diversity of environmental pollution causes determines that the spatiotemporal variation of environmental quality indexes which is nonlinear, as shown in Figure 7, on a large spatiotemporal scale is not possible to

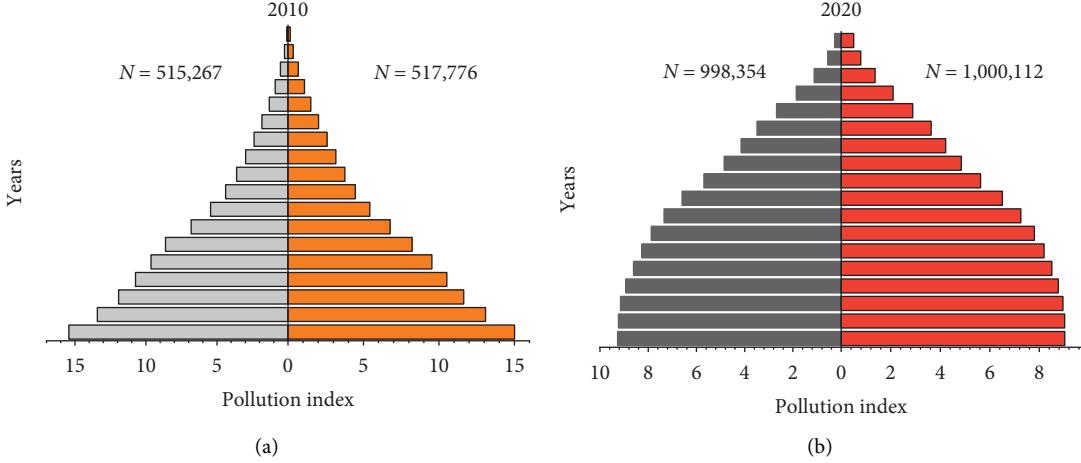


FIGURE 5: Three-level simulation of exceedance rate and comparison of results.

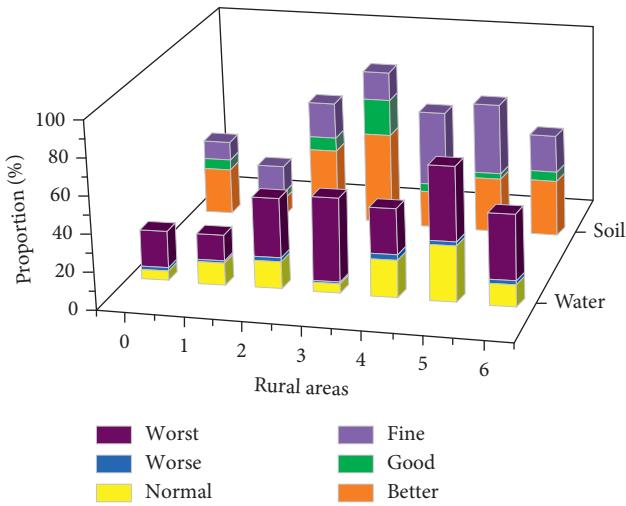


FIGURE 6: Pollution governance dynamics in a polycentric perspective.

simulate accurately with a simple mathematical model but must be treated as a complex problem; the time-domain combined model uses a model system and multilevel numerical simulation, which provides a more reasonable simulation and prediction of spatiotemporal variation of environmental quality. This study provides a reasonable method for the simulation and prediction of spatial and temporal changes in environmental quality. Through this study, the following conclusions can be drawn:

- (1) The time variation of an environmental indicator can be decomposed into three scales, the trend term reflects the overall variation of the series, which can be simulated by a simple linear function or exponential function, the periodic term is a regular periodic fluctuation after filtering the trend term, and the random term can be simulated by a simple or complex periodic function, which is a random series after filtering the trend term and the periodic term, and the autoregressive function of the time series can be used.

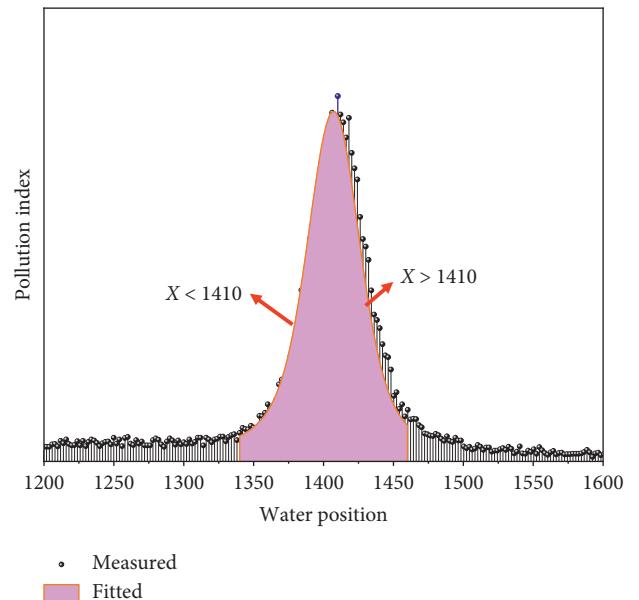


FIGURE 7: Spatial and temporal variation of environmental quality indicators.

- (2) Compared with the widely used pure time-series analysis, gray prediction model, and neural network prediction methods, the most important advantage of the time-domain combination model is that it is not only quantitative and accurate but also qualitative and in line with the laws of environmental change, in which the trend term reflects the general law of environmental quality change with economic development, while the period term is related to the small and medium cycles of economic development and environmental protection enforcement. The stochastic term is a random fluctuation based on the abovementioned identifiable pattern, which is a more subordinate change caused by microrising and falling factors.

(3) Through the simulation practice of groundwater pollution in city in recent years, it is shown that the time-domain combination model is scientifically feasible for the medium- and long-term prediction of regional environmental quality, and the correlation test, posterior difference ratio test, and small error probability test of the prediction model all achieve good results. The model can provide a scientific basis for future groundwater pollution prediction in city. Since the groundwater pollution monitoring in city is conducted on an annual basis, the time series of monitoring data for each month of the year is short, so a single-period function is used for the prediction of the periodic term.

## 6. Conclusion

Based on extensive field observation and investigation, this study systematically collected urban groundwater pollution monitoring data and hydrogeological data in recent years and conducted a systematic analysis and research on the vulnerability and spatial and temporal dynamics of urban groundwater pollution by using GIS and numerical modeling techniques and obtained the following conclusions. First, with the rapid population growth and urbanization as well as social and economic development, urban industrial wastewater and domestic wastewater discharges have been increasing over the past years. The discharge of domestic wastewater has been increasing, and the annual discharge of various types of wastewater and sewage is as high as 10,000 tons. The generalized vulnerability analysis combining land use, functional zoning, and sewage and irrigation canal system shows that the groundwater vulnerability of the western suburban industrial area and central business district with high sewage discharge is the highest, and the groundwater vulnerability of the eastern suburban textile city, the mechanical industrial area and the high-tech development zone, the northern suburban sewage and irrigation district, and the governmental locations of county is medium to high.

In the future, based on the dynamic combination evaluation method, contemporary governance theories should focus more on the cooperation between government and market and social organizations. In the process of rural production, there is excessive use and improper treatment of organic or inorganic substances such as agrochemicals, domestic sewage, or garbage and in the process of atmospheric circulation and surface runoff, so that a large number of pollutants flow freely into rivers.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The author declares that there are no conflicts of interest.

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