

# Rural Domestic Sewage Treatment Model: Case Study Based on Dongying Section of the Yellow River Basin

Shan Zhang, Yu Wang, Xiujuan Wang\*

College of Public Administration, Shandong Agricultural University, Tai'an, China

Email: \*xjwang0709@sda.u.edu.cn

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## Abstract

The 20<sup>th</sup> National Congress of the Communist Party of China proposed to promote the improvement of urban and rural living environment and build livable and workable villages and beautiful villages. The development and challenges of rural domestic sewage treatment coexist. Based on the field investigation of 15 administrative villages in 3 districts and counties of Dongying City, there is a big gap between the development status of rural domestic sewage treatment and expectations. Investigate rural domestic sewage treatment cases in-depth, and condense four modes of primitive, developmental, mature and advanced in a variety of different rural domestic sewage treatment models for discussion, among which, the village sewage treatment work under the mature mode has achieved remarkable results, and is at the forefront of the current rural domestic sewage treatment. Through the multi-case analysis method, the practical dilemma of sewage treatment in different models of villages is summarized, and the feasible improvement path is explored, which contributes to the ecological protection and high-quality development of Dongying and the Yellow River Basin.

## Keywords

Rural Domestic Sewage, Human Settlements, Ecological Protection and High-Quality Development of the Yellow River Basin

## 1. Introduction

Rural sewage treatment is a key link in building beautiful villages in China, which plays an important role in the governance of human settlements environment and the ecological protection and high-quality development of the Yellow River Basin, and is also a prominent shortcoming in ecological protection. The Yellow

River has a total length of 5654 kilometers, runs through the entire territory of Dongying from southwest to northeast, and finally enters the sea in the northeast of Kenli District of Dongying. The environmental pollution accumulation in rural areas of the Yellow River Basin is deep, and the water quality is generally lower than the national average. Therefore, rural sewage treatment in the river basin is inherently insufficient compared with other areas, and the starting point is low. In recent years, through the unremitting efforts of local governments, China's rural sewage treatment rate has increased year by year, but it is still not high, and in 2020, China's rural domestic sewage treatment rate is only 25.5% [1]. By the end of 2021, the rural sewage treatment rate in Dongying City had reached 42.36%, but there was still a gap between it and the provincial target.

Based on the first-hand data of field research in 15 villages of 3 districts in Dongying, this paper classifies and discusses the representative villages with heterogeneity, and analyzes the development shackles and dilemmas of different types of villages in the process of domestic sewage treatment in real situations. In order to have an in-depth understanding of the development characteristics of different domestic sewage treatment modes in rural areas, put forward a targeted improvement path suitable for local sewage treatment, and promote local sewage treatment from individual to whole, which is conducive to gradually approaching the requirements of ecological protection and high-quality development of the Yellow River Basin in the entire Yellow River estuary area.

## 2. Judging Elements and Governance Models

### 2.1. Judging Elements

There are four main ways of collecting domestic sewage in rural areas in China: unified treatment, centralized treatment, decentralized treatment, and direct discharge of urban sewage pipe network [2]. Generally speaking, villages in economically developed and densely populated plain areas are more qualified for sewage treatment, and most of them choose to build centralized sewage treatment units; in villages with sparse population and scattered residences, the amount of domestic sewage generated is small, and the sewage collection of centralized sewage treatment is long, requiring a large number of human, financial, material and time resources [3], and small decentralized facilities are mostly used for sewage treatment.

The survey results show that except for some non-community villages around Kenli District that are close to the municipal pipe network and have carried out double-urn sanitary toilet renovation and are connected to the urban drainage pipe network for treatment, the rural areas of Dongying City rarely treat domestic sewage by connecting to the urban pipe network, most of the rural areas still adopt centralized treatment, and villages with sparse geographical distribution set up small sewage treatment points for decentralized treatment. In order to judge and divide the different levels of rural sewage treatment development in Dongying City, two key evaluation factors were selected for analysis: whether there

are drainage pipes and whether there are centralized sewage treatment facilities (sewage treatment tanks, septic tanks, etc.).

### **2.1.1. Drainage Pipes**

The primary issue of rural water environment governance is sewage collection and treatment [4], regardless of the sewage treatment mode, the distribution of drainage pipes is necessary. Chen Shengzong *et al.* broke the shackles of people's thinking about the economic level of developing countries, pointing out that storage and drainage infrastructure, as an important part of the overall infrastructure, directly determines the quality of people's lives, and local governments still need to increase investment [5]. Chen Tonghui also regarded the construction of water supply and drainage pipe network as an important factor in ensuring the water security of villagers and improving the living environment in rural areas in the research of new rural water supply and drainage construction [6]. Li Zhu and Li Yan believe that drainage pipes can not only complete the collection of effluent from every household, but also ensure the effective collection and concentration of sewage [4]. Not only that, when laying sewage discharge pipes in rural areas, it is necessary to base on the local terrain and actual conditions to ensure that sewage is completely discharged. In summarizing the sewage treatment model, Wang Lei pointed out that if the rural sewage pipeline cuts corners due to various external factors, resulting in a single pipeline and insufficient quantity, then when the discharge is too large, there will be a backflow phenomenon, sewage overflow, and in the long run, the drainage pipeline will become a reservoir of sewage, and a large amount of sewage garbage fermentation [3]. This not only fails to achieve the original intention of rural domestic sewage treatment, but also causes secondary pollution to the rural water environment and causes trouble to the normal life of villagers.

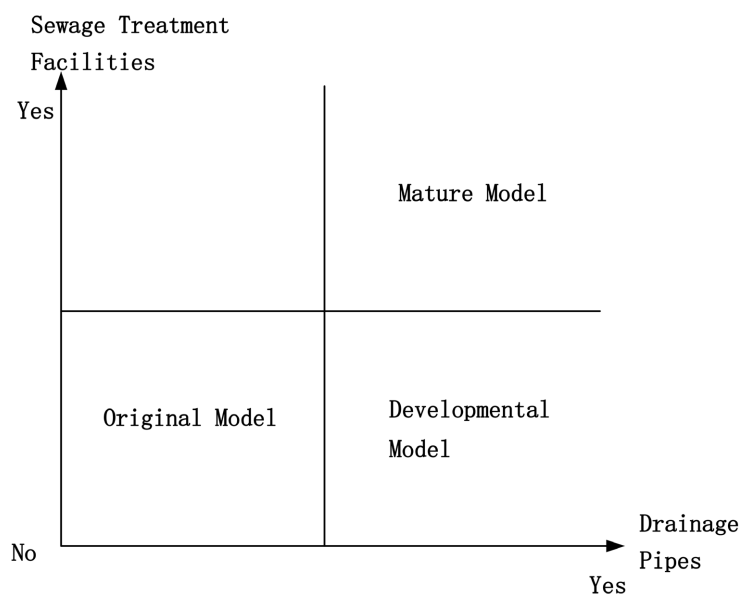
### **2.1.2. Sewage Treatment Facilities**

Both centralized and decentralized sewage treatment methods need to establish sewage treatment stations, and then rural domestic sewage is "concentrated" or "decentralized" according to the actual situation [7]. At this stage, the economic development of rural areas themselves has not yet met the needs of building sewage treatment points, and most rural areas rely on policy funds applied for by governments at or above the district and county levels at the township level. Huang Yue *et al.* emphasized in the study that although the society paid more and more attention to water environment governance, the number of sewage treatment plants in formed towns increased by 2.7 times between 2015 and 2020, the treatment capacity increased by 92.47%, and the construction of facilities has made significant progress, but it is still significantly lower than that of cities and counties [8]. It can be seen that the construction of rural sewage treatment facilities is in a difficult period of development. Rural domestic sewage treatment facilities not only have the characteristics of small scale, large quantity, wide distribution and complex technology, but also have great difficulty in long-term

operation and maintenance management after the completion of the facilities [9]. The construction and operation and maintenance management of sewage treatment facilities are public welfare public undertakings, so Chen Ying *et al.* pointed out that the government is under greater financial pressure, which to a certain extent has led to the slow progress of rural sewage facilities unbuilt projects [10]. Therefore, rural areas in many places choose to adopt the PPP model, which is the main mode of public-private capital cooperation, based on concessions, and third-party social enterprises are introduced by township and district governments to carry out the construction of sewage treatment infrastructure, so as to achieve the purpose of rural domestic sewage treatment standards and discharge.

## 2.2. Classification Models

Based on the above two evaluation factors and the actual situation of rural sewage treatment in Dongying City, a classification framework can be constructed to divide the treatment level of rural domestic sewage in Dongying into three basic modes. The two evaluation elements of drainage pipes and sewage treatment facilities cross in pairs, generating four patterns distributed within the four quadrants of **Figure 1**. In each type of governance model, the construction of drainage pipes and sewage treatment facilities is different. It should be noted that the two factors are not completely independent, and there is no absolute standard in reality. For example, in the second quadrant model, only sewage treatment facilities but no drainage pipes are laid, which is out of practice, and this governance model no longer exists, so this study excludes this model, classifies the villages surveyed in Dongying according to the characteristics of the other three remaining models, and selects representative villages for case analysis.



Source: The author made his own according to the research situation.

**Figure 1.** Quadrant chart of rural sewage treatment model classification in Dongying.

With the rapid development of circular economy, some scholars have introduced the theory of circular economy into the study of water resources, and the circular economy of water resources applies the movement of water in natural ecosystems to economic systems. So as to realize the operation process of “water resources—water resources development and utilization—water resources recycling and treatment—water resources” [11]. The fourth model: Advanced Model is a mode in which sewage treatment pipelines and facilities are complete, and sewage treatment is reusable. Since the advanced type is now idealized for most rural areas in China, Dongying City has not yet appeared villages that meet the above types of levels, and there is a lack of example support, so this type will not be analyzed in depth.

### 3. Cases Analysis

Based on the above-mentioned models of rural domestic sewage treatment in Dongying, one representative village with distinctive characteristics was selected from each model, and two representative villages were selected for analysis as Mature Models appeared more in the research area. Compare the operation results, problems and crux, model optimization of village sewage treatment under different modes (Summary is shown in **Figure 1**). Rural domestic sewage treatment is mainly aimed at underdeveloped and low-income vast rural areas [12]. But do rural areas with low incomes and underdeveloped economies really have the ability and conditions to treat domestic sewage? What is the level of development of this type of sewage treatment in rural areas? What results have rural areas with certain economic conditions achieved in the treatment of domestic sewage?

#### 3.1. Case A: Direct Sewage Treatment Forced to Choose

Original Model: Typical village—Lilin Village (along Yellow River)

Lilin Village, located in Huang Hekou Town, Kenli District, Dongying City, is a village near the mouth of the sea in the lower reaches of the Yellow River. In recent years, Lilin Village has responded to the policy call of the higher-level government to build a beautiful village, and the garbage disposal work has made great progress, but the implementation of sewage treatment in Lilin Village is very different from it: Lilin Village belongs to a typical primitive model village with no drainage pipes and no sewage treatment facilities, where domestic sewage such as kitchen waste or washing is directly poured into the yard or road, and this direct sewage treatment method is not because of Lilin Village’s own geographical conditions and development needs, but the “forced choice” of all villagers in Lilin Village. Lilin Village has a large area, far away from other villages in Huang Hekou Town, the road is damaged, years of disrepair, every rainy season, the direct discharge of sewage can only wait for natural infiltration, sunny days to dry, and sewage evaporation or infiltration after the ground leaves a peculiar smell, bacteria breed, the quality of the living water of the residents in the village is not high. Due to the heavy precipitation in the summer of 2022,

there are no drainage pipes in Lilin Village, coupled with the high cost of agricultural investment, the harvest in the first half of this year in the village is not optimistic, which is undoubtedly worse for the villagers of Lilin Village with poor economic conditions and low economic level. Villager A said: *“The most difficult thing is the peasants, this year it rained a little, the crops drowned, the people are dependent on the sky to eat, let’s urge the officials, they will find the town, if they are not active, they will be a deaf ear, now the people do not reflect, if they want to get money, the public does not care who cares.”* It is understood that the villagers of Lilin Village have repeatedly reported the situation to the village committee, and the village committee will also reflect to the township government when the feedback is frequent, but there is no news about the sewage treatment work, and over time, the villagers of Lilin Village gradually accept the reality and their enthusiasm for sewage treatment is no longer high.

### 3.2. Case B: Lack of Awareness or Loopholes in Development

Development Model: Typical village—Seven Village (along Yellow River)

Seven Village, belonging to Kenli Town, Kenli District, Dongying City. Is a typical agricultural demonstration village, traditional villages protection village, rural revitalization civilization demonstration villages, and have formed a mechanized and efficient rice industry chain, launched the “estuary” organic rice brand. Under the beautiful “business cards” one after another, the domestic sewage treatment of the seven villages has only stagnated in the Development Model. In Seven Village, mosquitoes are infested in summer, and drainage pipes are connected to an abandoned ditch a few hundred meters behind the village, the water is livid brown, there is a small amount of weed garbage, no mobility, no odor. To the north of the ditch is a nearly dry canal next to the Yellow River and to the north of the canal is a contracted cultivation pond and rice planting area.” *The water in the sewer next to our house is discharged into the ‘black water ditch’ behind the village, and there is no sewage treatment plant nearby.”* Villager B said. Because there are few permanent villagers, the development momentum of the village’s economy and culture is good, the strong cultural atmosphere and spacious and beautiful environment in the village have become a new fashion for villagers to relax, entertain and fitness, and dance after tea, and the “sewage collection pond” behind the village has no peculiar smell, mosquitoes only exist in summer, in the long run, the villagers who have lived in the seven villages for decades stay in such a sizable, culturally rich comfort zone, and there is no hard demand for domestic sewage treatment. The focus of the village on the development of green economy industry, party building and cultural development has brought rich feedback to the village and its people, and the need for domestic sewage treatment has gradually been forgotten.

### 3.3. Case C: An Alternative to Lack of Funds

Mature Model: Typical village 1—Tianzhuang Village (not along Yellow River)

Tianzhuang Village is located in Dongcheng Street, Dongying District, Dongying City, and belongs to a typical “cityside village”. As early as 2019, it began to plan the implementation of domestic sewage treatment projects, adhering to the principle of “doing it well”, taking rainwater sewage diversion into account, and learning from the treatment experience of other townships and districts and counties through comparison. For example, in Dongying Xicheng and Kenli County, some oxidation ponds (small sewage treatment facilities), etc., after demonstration, according to the small daily sewage volume and large rainfall in the rainy season, a decentralized sewage treatment mode suitable for the local people was selected: seven or eight sewage collection ponds of 30 cubic meters or more were set up around the village. In the early stage of the project, the funds were insufficient, and the domestic sewage treatment staff of Tianzhuang Village set up a conversion valve at the end of the drainage pipeline and then connected it to the sewage collection tank, and when there was no precipitation, the valve was pulled to make the sewage flow into the sewage treatment tank; close the valve during the rainy season to collect rainwater into a gutter or channel. This can not only eliminate black and odorous water but also collect domestic sewage, solving the problem of insufficient funds.

Tianzhuang Village is also known as a “village of old and dangerous houses” in the vicinity, and when the village first began to lay drainage pipes, it was necessary to make a hole under the homestead to shake the foundation of the house, which caused some villagers to object. The sewage treatment project in Tianzhuang Village adopts the PPP Model, so in order to ensure the villagers’ peace of mind and satisfaction, the village committee coordinates with the villagers and strictly regulates third-party construction. “*We have a professional team, professional service companies, they have commercial supervision departments, the construction does not meet the processing standards, it cannot be opened, the bidding office depends on their qualifications, and the environmental protection departments of our streets and development zones will also conduct regular sample testing.*” The sewage treatment staff said proudly. The sewage treatment staff said proudly. Although the current development level of Tianzhuang Village still cannot support the construction of sewage treatment information platform, the village still attaches great importance to the operation and maintenance of equipment, and has special staff to open and close valves and report water full.

### **3.4. Case D: A Pity of the Town That Is Not along Yellow River**

Mature Model: Typical village 2—Dongdi No. 2 Village (not along Yellow River)

Dongdi No. 2 Village is a community under the jurisdiction of Mingji Township, Lijin County, Dongying City, and is one of only three villages among the 38 administrative villages in Mingji Township to carry out sewage treatment in recent years. Mingji Town is not along Yellow River, the application for funds for domestic sewage treatment in the administrative villages under its jurisdiction is relatively difficult, and the implementation of sewage treatment work is relatively



**Table 1.** Case study summary: various models represent the problems existing in village sewage treatment.

Village	Character	Model	Model Character		Crux
			Drainagepipes	Sewage treatment facilities	
Lilin Village	Along Yellow River	Original Model	No	No	Economic development is limited, and funds for sewage treatment are insufficient. Lack of attention from local governments. Villagers' enthusiasm and satisfaction don't match.
Seven Village	Along Yellow River	Development Model	Yes	No	The level of economic development is relatively high, but there is no substantial progress in domestic sewage treatment. Low awareness of domestic sewage treatment. Lack of publicity and guidance of sewage treatment. The comfort zone of farmers is difficult to break. Sewage treatment policies have not been implemented. Villager participation is low.
Tianzhuang Village	Not along Yellow River	Mature Model	Yes	Yes	For the time being, the recycling of water resources of sewage has not been achieved. Low transparency of sewage treatment data indicators. Low degree of digitalization
Dongdi No. 2 Village	Not along Yellow River	Mature Model	Yes	Yes	Sewage treatment is underfunded and relies on higher authorities The sewage treatment project application has been delayed

Source: The author made his own according to the research situation.

slow. In 2020, Mingji Township invested 3.7 million yuan to build a sewage treatment station for the centralized treatment of domestic sewage in the three administrative villages of Dongdi No. 2 Village, Dongdi No. 1 Village and Xidi East Village with a daily treatment capacity of 1000 cubic meters. Sewage treatment is a process, and the first practice of three administrative villages, including Dongdi No. 2 Village, has set a model for the other 35 primitive villages in Mingji Township.

Dongdi No. 2 Village adopts the simplest way of centralized sewage collection and treatment: through the laying of drainage pipes, the domestic sewage of all users in the village is collected, discharged into the collection tank, and the water in the collection tank is full and then transported out, and finally, the sewage treatment tank is centrally treated until it meets the standard discharge. Mingji Township attaches special importance to this sewage treatment work, specially packaged special debt projects, and plans to invest in 10 administrative villages in 2022 to carry out the transformation of domestic sewage collection. However, due to the relatively insufficient financial resources of the district and county governments, they could not support the simultaneous sewage treatment and transformation of the entire Lijin County, so they temporarily changed the policy and temporarily withdrew the sewage treatment funds originally given to



Mingji Township and transferred them to the sewage treatment work along Yellow River Township. The head said: “*Ecological protection along the yellow is the first priority. Mingji Township is not along Yellow River, and the township’s financial resources are limited, so the fund allocation for governance was changed to next year.*”

## 4. Improving Paths

The above four models are condensed according to the domestic sewage treatment situation in different rural areas of Dongying. The proving paths are targeted, but not comparable.

### 4.1. Original Model

Pay attention to investigation and research, and guard against work formalism. In view of the formalistic problems such as “long-distance” research, fruitless public opinion feedback, and “one-size-fits-all” work in some areas, local governments should turn passive into proactive, randomly check the sewage treatment situation of different villages from time to time, timely understand and grasp the first-hand information of village sewage treatment, and prescribe the right medicine.

Thoroughly implement relevant policies on sewage treatment. Governments at or above the urban level in Dongying should increase policy publicity, bring the requirements of domestic sewage treatment to all departments of township and local governments, make full use of the sewage treatment funds allocated by the state, focus on helping poor and extremely poor villages, and prevent any village from becoming a “fish that slips through the net” in rural domestic sewage treatment.

Lay a solid foundation for rural sewage collection and treatment. Make up for the shortcomings of the sewage collection pipe network and promote the full coverage of the sewage pipe network [13]. Accelerate the construction of domestic sewage collection pipe networks in poor villages and urban villages in county towns, “aging” rural areas, urban-rural junctions and other places, effectively fill the blank areas of the pipe network, fill the gap in sewage treatment capacity, and promote the construction of rural sewage pipe networks in an orderly manner.

Actively strive for subsidy funds such as special funds from higher-level finances and investment within the budget. Establish and improve reward and punishment systems and scheduling mechanisms (weekly scheduling, monthly reporting).

### 4.2. Development Model

Adjust measures to local conditions. Select sewage treatment technology models according to regional applicability and economic conditions. Persist in adapting measures to local conditions, embody rural characteristics, and preserve rural

styles. Research and formulate practical guidelines on land, water and electricity use for sewage treatment facility construction projects, simple approval, tax exemptions, green credits, etc., and open up the “last mile” of policy implementation [14].

Combine sewage treatment with rural toilet reform [15]. According to the survey, nearly 90 per cent of the 15 villages still use open dry latrines, which need to be extracted and transported out every year. Local governments should effectively link rural toilet renovation and domestic sewage treatment, reduce the discharge of rural domestic pollution, and improve the utilization rate of water resources and manure resources. Encourage all localities to combine actual conditions to treat toilet manure and livestock and poultry breeding waste together and use them as resources.

Increase government investment and introduce private capital. Not only Dongying, but also the entire Yellow River Basin ecological environment governance has the problem of uneven or insufficient investment. Therefore, under the premise of continuously increasing government financial investment, we should actively guide private capital to participate in the treatment of rural domestic sewage in the Dongying section of the Yellow River Basin through scientific and theoretical evidence, and allow some enterprises to obtain certain economic benefits through market behavior in the construction of this undertaking [16].

Give full play to the advantages of villages and towns and promote the integration of “government, industry, education and research”. Through the cooperation (PPP) model between local governments and local third-party enterprises, the ecological environment-oriented development (EOD) model, etc., absorb social forces, take environmental protection, conservation and regeneration as the goal, increase the research and development of rural domestic sewage treatment technology and equipment, solve the contradiction between “economic feasibility and operational applicability”, and form a circular operation mechanism jointly promoted by technology research and development and industrial demonstration.

### **4.3. Mature Model**

Improve the assessment and incentive mechanism, and the governance process becomes transparent and open. Improve the quality index system of sewage treatment services, and improve the assessment and incentive mechanism for domestic sewage oriented by pollutant reduction performance [17]. Farmers often do not know in the early stage of treatment, so sewage treatment indicators and data should be disclosed in the treatment process, and farmers’ awareness of sewage treatment should be strengthened in the form of regular disclosure of data or indicators, so as to enhance farmers’ sense of achievement and enthusiasm for participation.

Implement professional operation and maintenance. Improve the normalized and professional operation and maintenance mechanism of urban sewage and garbage treatment facilities, strengthen the level of professional skills, and strict-

ly implement operation and maintenance in accordance with standards and specifications. Encourage the selection of operation and maintenance entities through market-oriented competition. Innovate operation and management methods, encourage the integration and packaging of projects of different scales and different levels of profitability to grant franchises, and promote third-party governance of environmental pollution [18].

Utilization of sewage resources. To improve the level of sewage resource utilization, it is necessary to upgrade existing sewage treatment facilities, and reuse reclaimed water that meets relevant standards for ecological water supplementation, agricultural utilization and rural miscellaneous use, and strive to transform into advanced sewage treatment villages [19]. Promote the transformation of sewage treatment facilities from “single function of pollution control” to “dual function of pollution control and water supply”.

Respect the status of farmers as the main body and ensure that farmers benefit from their interests. The absence of farmers cannot be completely attributed to the ideological concepts formed by rural groups under the economic and social influence of small farmers, and the concept and behavior of habitually being the masters of farmers should be avoided, and the responsibility and responsibility of the local government should be strengthened. It is necessary to strengthen the ideological education and behavioral guidance of farmers, but also pay more attention to allowing farmers to participate in the whole process of domestic sewage treatment, insist on asking the needs of the people, highlight the main body of farmers, and improve the sewage treatment system that is guided by quality and practical results and takes farmers' satisfaction as the starting point.

## 5. Conclusions

Rural domestic sewage treatment has urgent and realistic social needs. As a small research unit, the administrative village is difficult to obtain domestic sewage treatment data, and the longitudinal transmission of information is often prone to distortion, so the previous “digital” assessment method was changed to “speaking with facts”, and the effectiveness of rural sewage treatment in the Dongying section of the Yellow River Basin was examined. The results show that the rural domestic sewage treatment work under the mature mode at this stage is relatively complete, with complete sewage treatment facilities, high environmental awareness of villagers, and mature rainwater diversion technology, which has important reference significance [20]. In addition, this study is of constructive significance for the local government of Dongying City to face up to the current situation of rural sewage treatment stage, solve the “persistent diseases” in different stages of rural sewage treatment development, and promote the development of rural domestic sewage treatment in different districts and counties of Dongying.

It should be noted that the scope of research is difficult to involve every village in each district and county, the research content is not holistic, and the cases in the article cannot represent the overall situation of the entire district and even

Dongying City, but can only provide ideas for the case study of sewage treatment and the development of different models. Farmers are the scales to measure the sense of gain, but also the main body of acceptance of sewage treatment results [21], so the sense of gain and satisfaction is also an indispensable indicator in the study of sewage treatment. And through drainage pipes and sewage treatment facilities to determine the level of village sewage treatment is undoubtedly straightforward and subjective, this paper on Dongying sewage research only stays at the qualitative level, the subsequent use of government public data such as Dongying sewage treatment indicators and water resources statistical yearbook to more convincingly the government's sewage treatment performance acceptance, find problems, solve problems, so as to establish a sound and effective sewage treatment assessment and supervision mechanism [22].

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

### References

- [1] Wang, B., Che, L.L., Dai, C. and Zheng, L.J. (2022) Rural Domestic Sewage Treatment: From Theory, Practice to Decision-Making. *Environmental Protection*, **50**, 13-18.
- [2] Gao, S.W., Huang, Z.P., Xia, X.F., Liu, P., Wang, H.L. and Li, Y. (2022) Investigation and Countermeasures and Suggestions for Rural Domestic Sewage Treatment. *Journal of Agricultural Resources and Environment*, **39**, 276-282.
- [3] Wang, L. (2020) Thinking on the Optimal Selection of Rural Domestic Sewage Treatment Mode under Rural Revitalization Strategy. *Rural Staff Officer*, **21**, 58-59.
- [4] Li, Z. and Li, Y. (2012) Design Ideas and Countermeasures for Rural Direct Sewage Treatment. *China Rural Water Resources and Hydropower*, **1**, 61-62.
- [5] Chen, Z.S. and Zhu, L. (2020) China's Traditional Infrastructure Still Needs to Be Improved Urgently. *International Finance*, **22**, 29-35.
- [6] Chen, T.H. and Liu, Q.Q. (2018) Construction of New Rural Water Supply and Drainage Pipe Network. *Shandong Water Conservancy*, **47**, 7-8.
- [7] Yang, S.P., Wang, Z.P., He, Y.L., Li, P. and Lei, S. (2018) Effects of Different Drainage Modes on Rural Water Environment Quality. *Environmental Engineering*, **36**, 1-5.
- [8] Huang, Y., Liu, G.Q., Tao, X.W., Yu, X. and Yao, Y. (2022) Research on the Status Quo and Development Direction of Sewage Treatment in Organized Towns in China. *China Water & Wastewater*, **38**, 37-41.
- [9] Ye, L.Y., Ye, H.Y. and Liu, R. (2022) Exploration of Provincial Management System

- of Rural Domestic Sewage Treatment Facilities: A Case Study of Zhejiang Province. *Journal of Environmental Engineering*, **16**, 1039-1047.
- [10] Chen, Y. and Zhang, C. (2021) Analysis of Long-Term Management Mode of Rural Domestic Sewage Treatment Facilities in Fujian Province. *Water & Wastewater*, **57**, 61-67.
- [11] Yang, J., Jing, P., Gao, D. and Cao, H.B. (2020) Analysis of Obstacles to the Development of Circular Water Resources Economy in Beijing-Tianjin-Hebei Urban Agglomeration. *China Rural Water Resources and Hydropower*, No. 10, 131-136.
- [12] Zheng, F.H., Wang, J.X. and Huang, L. (2021) Rural Revitalization: Government Performance Goals, Farmers' Sense of Gain and Grassroots Governance Model Selection: A Case Study of Rural Domestic Sewage Treatment in G Province. *China Administrative Management*, **46**, 57-64.
- [13] Mao, X. and Wang, F. (2022) Reconstruction of Rural Environmental Governance System from the Perspective of Urban-Rural Integration. *Journal of Southwest University for Nationalities (Humanities and Social Sciences Edition)*, **43**, 190-196.
- [14] Zheng, F.H. and Zhu, X. (2021) Rural Domestic Sewage Treatment: Why Farmers' Sense of Gain is Not as Expected?—Sampling Survey Based on Province G. *Journal of Guangxi University (Philosophy and Social Sciences)*, **43**, 85-92.
- [15] He, Y., Hu, X., Wang, J. and Xu, H.J. (2015) Current Situation and Treatment Countermeasures of Rural Water Pollution in Shandong Province. *Chinese Kou Resources and Environment*, **25**, 221-223.
- [16] Li, P.F., Sun Y.L., Sui, K.J., Si, S.L., Chen, J.G., Zhang, J.M., Zhou, Z.Y. and Li, J.J. (2021) Analysis of the Current Situation of Rural Sewage Treatment in China and Discussion on Treatment Model. *Water & Wastewater*, **57**, 65-71.
- [17] Su, S.Y., Zhou, Y.X. and Cai, W.X. (2021) Rule-Type Structure of Collaborative Management of Rural Domestic Sewage and Small Watersheds: A Practical Sample Based on Linyi "Lanshan Model". *China Environmental Management*, **13**, 80-87.
- [18] Zhang, W., Liu, W., Xiong, F., Shen, J., Liu, Y., Zhang, H.D. and Zhou, Y.M. (2022) Prospects of Rural Sewage Treatment Technology and Development Mode in China. *Applied Chemical Industry*, **51**, 1396-1402.
- [19] Carneiro, R.B., Gomes, G.M., Zaiat, M. and Santos-Neto, Á.J. (2022) Two-Phase (Acidogenic-Methanogenic) Anaerobic Fixed Bed Biofilm Reactor Enhances the Biological Domestic Sewage Treatment: Perspectives for Recovering Bioenergy and Value-Added By-Products. *Journal of Environmental Management*, **317**, Article ID: 115388. <https://doi.org/10.1016/j.jenvman.2022.115388>
- [20] White, K., Elliott, M. and Barnett, M. (2019) Wastewater Management Issues in the Rural Alabama Black Belt and a Proposed Path Forward. *Abstracts of Papers of the American Chemical Society*, **11**, 258-260.
- [21] Wang, W.H. and Kuan, T.H. (2016) Rural Sewage Treatment Processing in Yongjia County, Zhejiang Province. *IOP Conference Series: Earth and Environmental Science*, **39**, Article ID: 012037. <https://doi.org/10.1088/1755-1315/39/1/012037>
- [22] Makoto, T., Masayoshi, H. and Isao, Y. (2003) A Study on Volatile Organic Compound in Wastewater Treatment Plant in Rural Area. *Journal of Rural Planning Association*, **22**, 19-24.