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An overview of water pollution situation and governance in China's rural areas

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Abstract: Since the reform and opening up, Chinese economy has grown rapidly. However, the environmental pollution is increasingly serious, and rural water pollution has been one of the most important factors that threat the sustainable development of China. Compared with abroad, legal system in China is not perfect, especially in rural water pollution. In terms of rural water pollution governance, there is a huge gap between China and other countries. The current situation and causes of water pollution in China's rural areas are studied in this paper. The paper proposes measures for rural water pollution treatment. Firstly, the paper summarizes the current situation of China's rural water pollution, and then puts forward the proposals that deal with the rural water pollution through the combined efforts of government, enterprises and farmers together based on advanced experience abroad.
Keywords: rural water pollution; rural water policy; sustainable agriculture; chemical fertilizer and pesticide.

INTRODUCTION

Water pollution and water security have been paid attention by many countries in the world. More than 1.1 billion people have not enough water supplies, while over 2.6 billion people lack safe drinking water [2]. Although rapidly growing industrialization in developing countries greatly contributes to economic development, it has caused a significant losses to social welfare when it makes negative effects on human health, agricultural activities, environment and ecosystem at large through air, water and soil pollution [1].

According to Pearce David and Warford's empirical studies that the damage costs caused by water pollution in developing countries are much higher than those in developed countries, which will cost approximately 5% of their GDP to deal with the environmental pollution in developing countries [3]. The rural water pollution is more fearful in developing countries due to unsubstantial economic environment [4] and the poor awareness of environmental protection in rural areas. It reported that, two-thirds of the soil and 60% of the rivers were polluted in a certain degree on account of chemical fertilizer and pesticide used excessively. The sustainability of water resources is becoming more and more challenge in terms of the shrinking water resources caused by contamination, climate change and urbanization [5].

To improve the situation above, many countries have taken various measures, including rationally developing water resources, establishing water quality monitoring system and rural industrial sewage treatment plant, issuing a large number of regulations about rural environment protection and so forth.

China is a traditional agricultural country and a large number of people in rural areas live on agriculture [6]. With the development of society and economy, environmental pollution is more and more severe both in urban and rural areas of China [6,7]. Especially, China's economy has made remarkable achievements since the reform and opening up, while it has also paid a high price for environment pollution, especially water pollution [8,9]. In fact, three major factors, including economic growth, urbanization and industrialization, jointly cause environment pollution in rural areas.

China is a serious water shortage country and regarded as one of the most water-poor economies in the world by UN. The available average water quantity of per people is only 2186m³in 2012 [10]

. A survey about national water quality shows that, 76.8% of water in the groundwater wells, 35.8% of the river water, 41.2% of water in the major lake areas, and 18.9% of water in the major reservoirs are unfair for people to drink, for it cannot meet the drinking water quality criteria (see Table 1) [11,12].

Table-1: The evaluation of river water quality by river valley

River	Evaluate length(km)	Classified river length (%)					
		Grade I	Grade II	Grade III	Grade IV	Grade V	Worse than Grade V
National total River	201216	5.5	39.7	21.8	11.8	5.5	15.7
Songhuajiang River	15410	0.5	16.6	39.8	23.8	7.0	12.3
Liaohe River	5454	2.6	26.4	15.1	18.9	9.8	27.2
Haihe River	14953	3.1	21.1	10.4	6.8	12.5	46.1
Huanghe River	20545	2.9	34.0	18.6	12.4	4.7	27.4
Huaihe River	25904	0.5	9.6	26.7	28.5	10.8	23.9
Changjiang River	57562	4.9	45.3	24.5	8.6	4.6	12.1
Taihu River	6033	0.2	6.1	12.4	21.8	23.0	36.5
Southeastern River	7049	5.7	46.2	27.0	9.9	4.0	7.2
Zhujiang River	20208	3.0	64.3	15.9	6.8	2.9	7.1
Southwestern River	17015	12.5	65.5	19.7	2.0	——	0.3
Northwestern River	17117	22.0	56.5	12.3	4.6	2.1	2.5

Data resource: China Statistical Yearbook, 2013[10].

For example, the Haihe basin, one of the seven major Chinese river systems, crossing the North China Plain from west to east, is lack of water resources and per person has only 305 m^3 compared with 430 m^3 average for China [51]. Pollution sources come from industrial wastewater, domestic wastewater, agricultural fertilizers and agricultural chemical pollutant discharges [13]. The causes resulting in the pollution have many, for example, unfair utility and treatment of fertilizer, pesticides and others, the shortage of environmental protection regulations and policies in rural areas, timely scientific treatment of various wastes in rural areas, and so forth [14,6,7,15].

Rural environmental governance has not still given enough attention by China's local government for the dual structure in urban and rural economy. Because there is a huge discrepancy in life style between urban and rural, it increases the difficulty of environmental governance in rural. For this reason, the paper firstly analyzes the actuality and causes of rural water pollution, and then puts forward the proposals for the rural water pollution governance combining with advanced experience abroad.

The causes and situation of rural water pollution in China

Rural water pollution is resulted from many causes, including industrial waste water that is not treated fairly, the extensive use of chemical fertilizer, pesticide and herbicide, the garbage littering ignorantly, people's and animal's dung without fair treatment, and so forth [13,16].

Rural industry and water pollution

As early as 1980s, rural industries including TVES and SMEs have been promoted with the China's economic transition, and become a significant engine for China's development [17,12]. At the same time, water pollution caused by small enterprises has become a serious problem all over the China, too [18]. However, the growth of rural industries is an extensive pattern of economic growth. Not only the rural industry's production technology with obsolete equipment, scattered geographical location layout and poor management is outmoded, but also energy and resources are highly consumed, which bring serious environment pollution to rural areas [18,19,20]. As a consequence, wherever there are rural industries, water pollution caused by them is much more serious. For example, the industries producing pulp and paper are regarded as one of the most severe sources of water pollution, and discharge 1.8% of national industrial wastewater, 11.2% of NH_4-N emissions, and 28.9% of COD (see Fig. 1) [21].

What's more, the amount of the chemical industry parks (CIPs) is so large in China that more than 1200 CIPs are built in 2010 [22], and they have been regarded as the most severe sources of environmental pollution accidents in spite of a great contributions to China's economy [22,23]. Especially, the total amount of petrochemical and chemical industries was 7555 in 2006 in China and about 4/5 of them were located around lakes, rivers, or populated areas[10], but half of the industries could lead to serious environment contamination [22]. Therefore, many serious environmental events have occurred from 2005 to 2010, causing economical losses and harming downstream water resources and ecosystem [22]. For example, 100 tons of chemicals are released into the Songhua River in 2005, and the Yangzonghai River is polluted by wastewater containing arsenic in 2008, etc. Not only the source of drinking water is polluted, but also it cause severe agricultural and fishery losses. Before 2000, environmental pollution incidents (especially water

pollution) were occurred frequently, but it has been slowed since that.

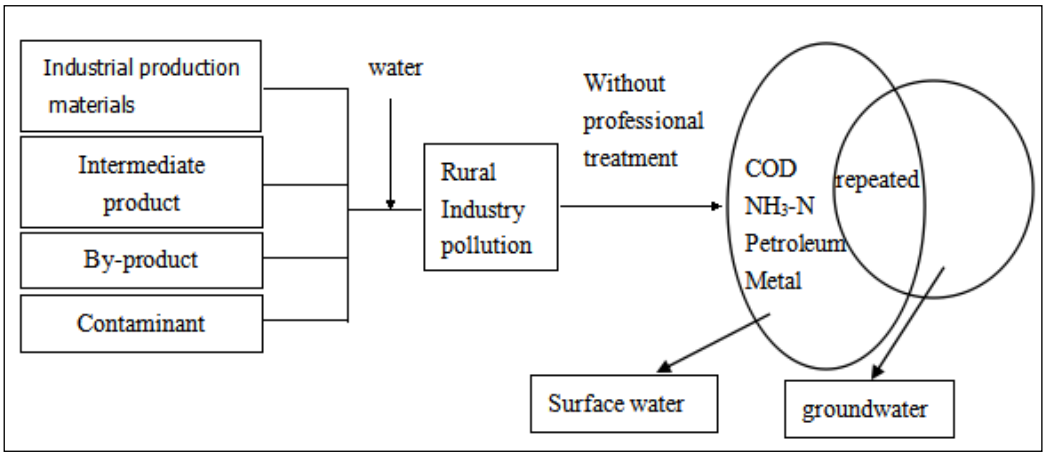

Fig-1: Rural industry pollution mode

Table-2: Environmental accidents in China

Quantity	1997	2000	2003
Total accidents	1992	2411	1843
Water pollution	986	1138	1042
Air pollution	752	864	654
Solid pollution	55	103	56
Noise pollution	119	266	50
Other pollution	80	40	41

Data: China Statistical Yearbook, 2013[10].

In 2012, the total amount of water discharged is 6848 million tons, in which 2216 million tons is industries waste water, accounting for 32.3% [10]. Table3 shows the amount of industrial water, waste water discharge, industrial discharge, COD discharge and ammonia nitrogen discharge from 2000 to 2012, respectively. At the same time, approximately 3.4-4 billion tons of solid waste has been produced every year by reason of 120 to 130 billion tons of natural resources consumption [4]. So much large number of the waste is produced every year that it has leaded to a huge pressure to manage the waste with a better sustainable method for the government in China [24].

Table-3: Waste water discharge from 2000 to 2012

Year	Industrial Water (100 million cu.m)	Waste water discharge (100 million tons)	Industrial discharge	COD discharge (10000 tons)	Ammonia Nitrogen Discharge (10000 tons)
2000	1139.1	415.2	194.2	704.5	-
2001	1141.8	432.9	202.6	607.5	41.3
2002	1142.4	439.5	207.2	584.0	42.1
2003	1177.2	459.3	212.3	511.8	40.4
2004	1228.9	482.4	221.1	509.7	42.2
2005	1285.2	524.5	243.1	554.7	52.5
2006	1343.8	536.8	240.2	541.5	42.5
2007	1403.0	536.8	246.6	511.1	34.1
2008	1397.1	571.7	241.7	457.6	29.7
2009	1390.9	589.1	234.4	439.7	27.4
2010	1447.3	617.3	237.5	434.8	27.3
2011	1461.8	659.2	230.9	354.8	28.1
2012	1380.7	684.8	221.6	338.5	26.4

Data: China Statistical Yearbook, 2013[10]

Agriculture activity and water pollution

The fresh water is mainly used by agriculture, accounting for 93% of the total consumption in the world [24], but agriculture activities has a great effect on water quantity and quality, too [23]. In most of the European catchments a major challenge is how to reduce the diffuse pollution caused by agricultural activities (Wilkinsona, 2014). A major reason that water body fails to achieve good ecological status is that, excess nutrient inputs in agricultural activity and households lead to eutrophication in surface water [16,26]. Approximately 7/10 of the suspended sediment is produced by agriculture in the EU, and 2/10-4/10 of the phosphorus (P) and 4/10-8/10 of the nitrate (NO_3) flow into surface water[16].

In China, recently the non-point source pollution caused by agriculture has been regarded as a major source of aquatic pollution by government [8]. And the proportion of non-point source pollution is increasing annually with the development of agriculture and a large number of chemical fertilizer and pesticides utility in China [27]. It is found that, the total nitrogen generated from non-point pollution consists of 44.5% of the total pollution emissions, while the total phosphorus accounts for 26.7% through the investigation of the entrophication in Dianchi Lake [27,28]. Therefore, agricultural non-point pollution has been regarded as a threat to watershed environment, and has become a key field of water quality management (see Figure 2) [8].

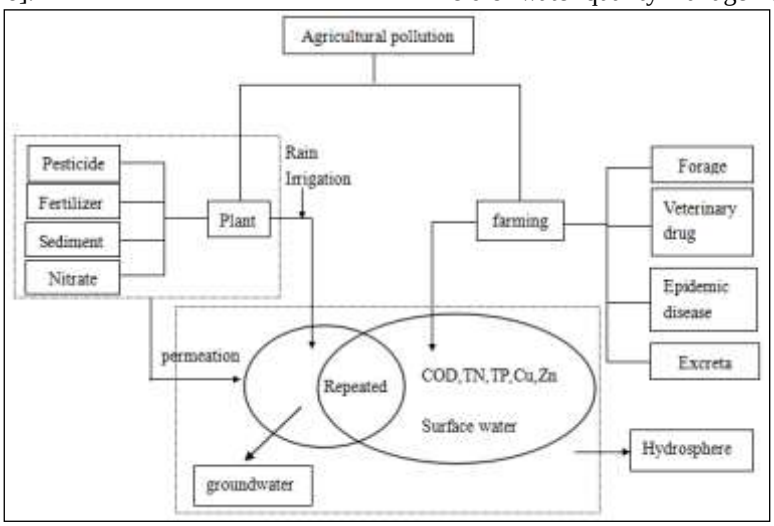

Fig-2: Agricultural pollution mode

It is known that the amount of China's chemical fertilizer and pesticide use in agriculture is the largest in the world [29,30]. 41.46 million tons of chemical fertilizer was used in 2000, while the quantity has reached 58.39 million in 2012 (see Table 4). As is shown in Fig. 3 that both irrigated area and chemical fertilizer consumption show an increasing trend, which cause a great challenge to the environment.

Table-4: Irrigated area and chemical fertilizer consumption

Year	Irrigated Area (1000 hectares)	Consumption of chemical fertilizer (10000 tons)	Nitrogenous fertilizer (10000 tons)	Phosphate fertilizer (10000 tons)	Potash Fertilizer (10000 tons)	Compound fertilizer (10000 tons)
2000	53820	4146	2162	691	377	918
2001	54249	4254	2164	706	400	984
2002	54355	4339	2157	712	422	1040
2003	54014	4411	2150	714	438	1110
2004	54478	4637	2222	736	467	1204
2005	55029	4766	2229	744	490	1303
2006	55751	4928	2263	770	510	1386
2007	56518	5108	2297	773	534	1503
2008	58472	5239	2303	780	545	1609
2009	59261	5404	2330	798	564	1699
2010	60348	5562	2354	806	586	1799
2011	61682	5704	2381	819	605	1895
2012	63036	5839	2400	829	618	1990

Data: China Statistical Yearbook, 2013[10].

Table-5: Livestock quantity (unit: 10000 heads)

Year	Cattle and buffaloes	Horses	Donkeys	Slaughtered fattened hogs	Hogs (year-end)	Sheep and goats
2000	12353	877	923	51862	41634	27948
2001	11809	826	882	53281	41591	27625
2002	11568	809	850	54144	41776	28241
2003	11434	790	821	55702	41382	29307
2004	11235	764	792	57279	42123	30426
2005	10991	740	777	60367	43319	29793
2006	10465	720	731	61207	41850	28370
2007	10595	703	689	56508	43990	28565
2008	10576	682	673	61017	46291	28085
2009	10727	679	648	64539	46996	28452
2010	10626	677	640	66686	46460	28088
2011	10361	671	648	66362	46862	28236
2012	10343	634	636	69790	47592	28504

Data: China Statistical Yearbook, 2013[10].

It was found through the investigation of 141 villages in China that, chemical fertilizers have been commonly used by the farmers from the 1980s, accounting for 36.16% of the farmers. And on average, seven kinds of fertilizer is used in agriculture, while the kinds of fertilizers used in some place have reached 21 [31]. At present, all farmers have to use fertilizer and pesticide in agriculture [31].

In addition, the quantity of the livestock grows fast and has expanded enormously in recent year, especially hogs and goats (see Table 5) [8]. However, livestock waste in rural areas is not treated fairly, and some livestock wastes are flushed into the rivers and nearby water resource through the rain. As is shown in Table 5 that, there were 1531.4 million livestock in China, and they have produced 2664.6 million tons of solid waste every year in 2011 [4].

Rural living and water pollution

The generation of the solid waste has been accelerated increasingly due to the rising of community living standards in China and the pollution caused by the solid waste has become increasingly serious [32]. Living waste pollution to environment has two ways of living sewage and living garbage, and they will seriously pollute to environment if not treated fairly (see Fig. 4). According to Yang's [8] research, although the rural population only account for 75% of the total population in Ninghe, yet the amount of untreated waste water is at least 90% of total waste water [8].

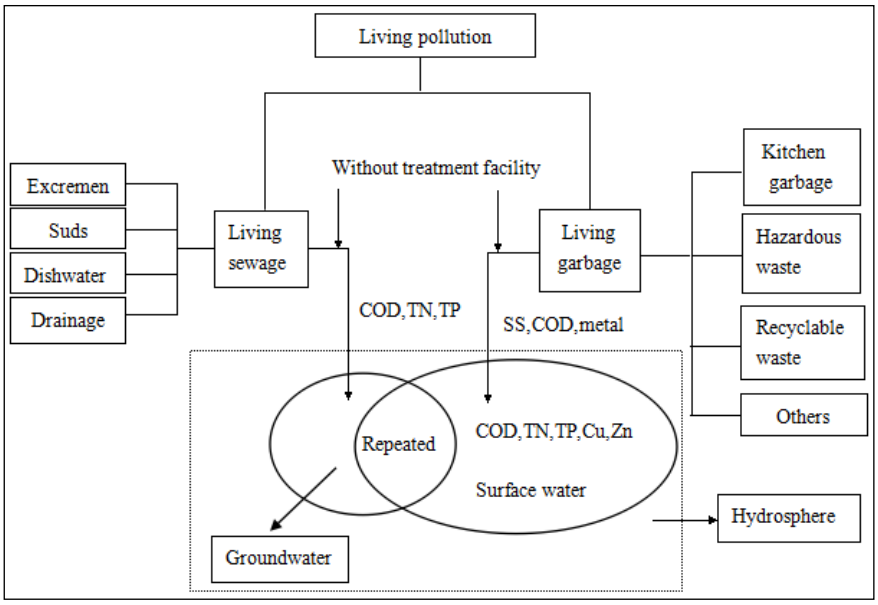

Fig-4: Living waste pollution mode

Water pollution governance in rural areas **Legal measures**

Chinese economy has been increased rapidly since 1978, but at the same time it has caused serious water pollution, too. Especially, surface water quality has been deteriorated because of water pollution. To protect the environment, the first environmental protection law was promulgated in 1979, and China has enacted 130 environment protection regulations and policies after that [33]. Although surface water quality issue has gotten much political attention substantially during the last decades, it is still not enough compared to the EU and the US [34] and environmental sustainability in China is the worst in the world [35].

Improvement of rural water protection laws and regulations

The key to rural water resources protection is to improve associated law and regulations. For example, in the US, the regulations and policies on water resource have been revised many times to attach great attention to the ecological environment of water, to enhance the cooperation between the government, the enterprise and the public, to strengthen the education of water resources, and so forth since the US founded. The US has stipulated the law about the production and utility of the fertilizer and pesticide which can cause water pollution in rural areas to control rural water pollution in America, too. At the same time, the US has made relevant project to protect rural water resource such as clean rural water project and pesticides implementation plan, which play a positive role in water pollution governance [36,37].

Obviously, perfect regulations have an important effect on rural water protection from abroad experience. Although many laws about water resource protection have been published in China, yet associated management system for rural areas has still been set up. Therefore, the situation focusing on urban water pollution but ignoring rural water pollution should be changed [38]. Especially, China should improve rural water protection law and regulation practice to keep pace with the times of development. At the same time, the legal standard for rural water pollution and protection must be perfect, too. In addition, China should greatly prevent the transfers of pollutes to the rural areas from industry and city, and punishment should be enhanced for the industries and cities causing rural water resource pollution. Moreover, the duty should be divided clearly between agriculture, department of environmental protection, ministry of water resources and other departments in rural water pollution prevention [39].

Rural water protection system construction in China

In rural areas, both economic development and people's daily life way are different from that of city. However, rural water pollution management system that is fit for rural characteristics has not still formed, resulting in increasingly serious environmental pollution problems， for example, urban pollution transfers to rural areas， inorganic agriculture input (e.g., fertilizer, pesticide and others) pollution，people and livestock manure pollution, rural living waste pollution, and so forth [12,31,8].

In China, the Law on Prevention and Control of Water Pollution only stipulates the relevant issues of urban water use [40], but there has no system and regulation in rural areas. Most of the rural areas in China have no any necessary water facilities and farmer's water mainly comes from wells [41]. The Law on Prevention and Control of Water Pollution has not stipulated how to prevent the water pollution and to reduce water waste.

To prevent water pollution and waste, it is necessary to establish corresponding law specialized in rural water utilization and management with the difference from the city. At the same time, the utility of fertilizer, pesticide and other chemicals should be decreased during the process of agricultural production [42]. It is necessary to encourage farmers to use lower toxicity and less residual pesticide and to use scientific irrigation methods.

In addition, a corresponding system should be set up for rural living garbage at the same time. It is important to improve the public awareness of environment protection and to give some guidance to peasant on sanitation works actively [9]. Moreover, government can strengthen the thought of garbage classification, for example, perishable rubbish use for agricultural production, waste collection (especially waste paper) for recycling use, scrap metal for sale, harmful waste (e.g., battery, etc.) collection and recycling, etc. Especially, the transferring station of waste collection that is fit for the characteristics of the different rural areas should be established to change traditional pattern of rural garbage treatment.

The enforcement of the law

The environmental protection agency of China mainly for the service of city pays little attention to the rural areas. Therefore, the enforcement agency of environmental protection in rural should be improved [43]. A environmental agency commanded and coordinated by the State Environmental Protection Administration should be established to carry out environmental work independently by provinces and municipalities, and full-time environmental management cadres in villages and towns should be equipped, too [39]. The professional quality of environmental law enforcement team needs to be enhanced as soon as possible to ensure their

professional management. At the same time, the enforcement procedures of environmental protection law should be improved, too [15].

ECONOMIC MEASURES

Increased investment in rural water protection

Due to the dual structure in urban and rural, government always pays more attention to urban water pollution treatment, while investment in rural water protection is rare [44]. Therefore, it is necessary to increase investment in rural water protection. Firstly, government should provide enough funds for rural waste treatment including the construction of garbage disposal sites and facilities in rural areas and the collection, transport, recycling and recovery and harmless treatment of treatment [45].

Government should encourage and support farmers to make the cleaner production of agricultural products through financial subsidies or tax policies, too. If the environment protection and the economic interests are properly combined together, then farmers would have great enthusiasm to consciously carry out water conservation under the guidance of local government [46].

Sustainable agriculture development

It is important to use groundwater and surface water to irrigate agriculture because of rapid population growth and decreasing in water resources [5]. However, because of industry and agriculture itself pollution, some poor quality water cannot be used for agricultural production on account of its bad for soil and people health [5]. Therefore, on the one hand, government should firstly prevent rural water pollution and treat it with a great effort.

On the other hand, government should provide policy support and economic help for modern eco-agriculture to change agricultural production mode, to promote cleaner agricultural production and to help rural areas to achieve social, economic and ecological effects [47]. Of course, it should depend on the recycled economy and reasonable layout of the breeding and planting industries to solve serious rural water pollution caused by the rapid development of the intensive farming in China's agriculture. In fact, for agricultural production, it is much better to realize the cleaner production of material-energy cycles of agriculture-inside materials [48]. Government should promote the development of such an ecological agriculture by the way of promotion, publicity and encouragement.

The improvement of fertilizer utility efficiency

In recent years, the pollution caused by agriculture is becoming increasingly serious, which has been a major reason for rural water pollution [30]. However, it is difficult to control this situation because of a variety of uncertainties with a large number of uncertain factors surrounded it [30]. For example, in the United States, the agricultural activity has caused approximately 60% of total non-point source pollution of surface water (USEPA, 2009). In China, the problems of over-fertilize utility is more severe and the efficiency of fertilizer is lower than that of the world average, while the efficiency of N fertilize utility reaches only 25% to 30% [49].

It is important to enhance the education and extension of farmers to improve the efficiency of fertilizer utility. According to Li Ma [49], key to efficiency improvement is education. It does not just improve the farming skills [49], but also help to train farmers to fairly use fertilizer to reduce its negative effects [50]. In addition, government should encourage and promote farmers to use organic fertilizer.

CONCLUSIONS

Since the 1970s, rural water pollution in China has become more serious. Rural water environment, including the surface water such as the vast rural rivers, lakes, ditches, ponds and reservoir, the soil water and the groundwater, is the basis of rural production and living. Rural water environment pollution will damage the basic conditions of agricultural production and the safety of agricultural products, and make a serious threat to farmers' life safety and health. Therefore, water pollution prevention and control in China's rural areas is imminent.

Rural water pollution is caused by industrial waste water not treated fairly, the extensive use of chemical fertilizer, pesticide and herbicide, the garbage littering ignorantly, people's and animal's dung without fair treatment. Therefore, China should take policies and countermeasures to treat it from different aspects.

Foreign experience has shown that legal are main means to solve the problem of rural water pollution. However, the laws and regulations of rural water environment governance in China is not enough completion. To protect water resources, China must improve the relevant laws and regulations from the experience of foreign, and the government should enhance the development of regulations. At the same time, the government should strengthen the investment in rural water pollution treatment, and provide the policy and finance support for farmers. For farmers, it is important to improve their awareness of environmental protection and the efficiency of fertilizer use, and learn how to classify and treat the waste effectively.

REFERENCES

1. Reddy VR, Behera B; Impact of water pollution on rural communities: An economic analysis.

Ecological Economics, 2006; 58(3): 520-537.
2. Kujinga K, Vanderpost C, Mmopelwa G, Wolski P; An analysis of factors contributing to household water security problems and threats in different settlement categories of Ngamiland, Botswana. Physics and Chemistry of the Earth, 2014; 67: 187-201.
3. Jessoe K; Improved source, improved quality? Demand for drinking water quality in rural India. Journal of Environmental Economics and Management, 2013; 66(3): 460- 475.
4. Song QB, Li JH, Zeng XL; Minimizing the increasing solid waste through zero waste strategy. Journal of Cleaner Production, 2014.
5. Singh, A. (2014) Conjunctive use of water resources for sustainable irrigated agriculture. Journal of Hydrology, 519, 1688-1697.
6. Zhu LD, Li ZH, Ketola T; Biomass accumulations and nutrient uptake of plants cultivated on artificial floating beds in China's rural area. Ecological Engineering, 2011; 37(10): 1460-1466.
7. Yang SS, Qu HJ, Luan SJ, Kroeze C; Environmental implications of rural policies in China: a multi-agent model at the level of agricultural households. Journal of Integrative Environmental Sciences, 2014; 11(1): 17-37.
8. Yang Y, Chen Y, Zhang XL, Ongley E, Zhao L; Methodology for agricultural and rural NPS pollution in a typical county of the North China Plain. Environmental Pollution, 2012; 168: 170-176.
9. Miao X, Tang YH, Christina WYW, Zang HY; The latent causal chain of industrial water pollution in China. Environmental Pollution, 2014.
10. China Statistical Yearbook, 2013.
11. MWR (Ministry of Water Resources), 2012.
12. Hu YA, Cheng HF; Water pollution during China's industrial transition. Environmental Development, 2013; 8: 57-73.
13. Zhao HX, You BS, Duan XJ, Stewart BECKY, Jiang XW; Industrial and Agricultural Effects on Water Environment and Its Optimization in Heavily Polluted Area in Taihu Lake Basin, China.Chin. Geogra, 2013; 23(2): 203-215.
14. Judova P, Jansky B; Water quality in rural areas of the Czech Republic: Key study Slapanka River catchment. Limnologica, 2005; 35(3): 160-168.
15. Zhao Y; The legal problems about the rural water environment pollution, Hebei University of Economics and Business. Master's thesis, 2014.
16. Wilkinsona ME, Quinn PF, Barber NJ, Jonczyk J; A framework for managing runoff and pollution in the rural landscape using a Catchment Systems Engineering approach.Science of the Total Environment, 2014; 468: 1245-1254.
17. He GZ, Zhang L, Arthur PJ, Wang TY, Lu YL; Why small and medium chemical companies continue to pose severe environmental risks in rural China.Journal of Environmental Management, 2008; 86: 648-659.
18. Wang M, Webber M, Finlayson B, Barnett J; Rural industries and water pollution in China. Journal of Environmental Management, 2008; 86: 648-659.
19. WU DY; Water Pollution Problem in Rural Areas and Its control Measures. Journal of Anhui Agri, 2012; 40:6738-6739, 6817.
20. Liu HX; Analysis of the Current Deterioration of Water Environment in Rural Areas Causes and Countermeasures. Science & Technology Information, 2011; 5: 788-790.
21. Zhang C, Chen JN, Wen ZG; Alternative policy assessment for water pollution control in China's pulp and paper industry. Resources, Conservation and Recycling, 2012; 66: 15-26.
22. Peng JF, Song YH, Yuan P, Xiao SH, Han L; An novel identification method of the environmental risk sources for surface water pollution accidents in chemical industrial parks. Journal of Environmental Sciences, 2013; 25(7): 1441-1449.
23. Andersson AS, Tysklind M, Fangmark I; A method to relate chemical accident properties and expert judgments in order to derive useful information for the development of Environment-Accident Index. Journal of Hazardous Mate-rials, 2007; 147(1): 524-533.
24. Cheng H, Hu Y; Municipal solid waste (MSW) as a renewable source of energy: current and future practices in China. Bioresour. Technol, 2010; 101(11): 3816 -3824.
25. Duarte AC; Water pollution induced by rainfed and irrigated agriculture in Mediterranean environment at basin scale. Ecohydrology hydrobiology, 2011; 11(1-2): 35-46.
26. Haygarth PM; Managing soil and water for multiple objectives. In: SAC, editor. SAC and SEPA Biennial Conference -climate, water and soil: science, policy and practice. Edinburgh: SAC and SEPA; 2010.
27. Shen ZY, Liao Q, Hong Q, Gong YW; An overview of research on agricultural non-point source pollution modeling in China. Separation and Purification Technology, 2012; 84: 104-111.
28. Chen JN; Non-point Source Pollution Control—Case Studies in Dianchi Lake Catchments, China Environmental Science Press, Beijing, 2009.
29. Edwin D, Ongley Zhang XL, Yu T; Current status of agricultural and rural non-point source Pollution assessment in China. Environmental Pollution, 2010; 158(5): 1159- 1168.
30. Tan Q, Huang GH, Cai YP; Radial interval chance-constrained programming for agricultural non-point source water pollution control under uncertainty. Water Management, 2011; 98(10): 1595-1606.
31. Tang LX, Zuo T; The investigation and analysis of

rural pollution condition in China. China Rural Survey, 2008; 31-38.
32. Allen C; Hernani, Spain: Door-to-Door Collection as a Strategy to Reduce Waste Disposal, 2012, Available from: http://no-burn.org/downloads/ZW%20Hernani.
33. Shao WY; Effectiveness of water protection policy in China: A case study of Jiaxing. Science of the Total Environment, 2010; 408(4): 690-701.
34. McGechan MB, Lewis DR, Vinten AJA; A river water pollution model for assessment of best management practices for livestock farming. Biosyst Eng, 2008; 99(2): 292-303.
35. Wang CM, Lin ZL; Environmental Policies in China over the Past 10 Years: Progress, Problems and Prospects. Procedia Environmental Sciences, 2010; 2: 1701-1712.
36. Matzdorf B, Meyer C; The relevance of the ecosystem services framework for developed countries' environmental policies: A comparative case study of the US and EU. Land Use Policy, 2014; 38: 509-521.
37. Paul GH, Bush B; Environmental politics and prospects for US climate policy. Energy Policy, 2009; 37(3): 966-971.
38. Wang JY, Da LJ, Song K, Li BL; Temporal variations of surface water quality in urban, suburban and rural areas during rapid urbanization in Shanghai, China. Environmental Pollution, 2008; 152(2): 387-393.
39. Wang CY; The rural water environment pollution and its countermeasures of the water pollution in China. Hebei University. Master's thesis, 2014.
40. Zhang GZ, Mi ZM, Xie XT; Environmental Policy Analysis for Water Management in Lanzhou City. Procedia Environmental Sciences, 2010; 2: 656-664.
41. Yang SB; The research of controling the rural water pollution in Zhejiang province. Zhejiang University of Finance & Economics. Master's thesis, 2014.
42. Li YJ, Kahrl F, Pan JJ, Roland-Holst D, Su YF; Andreas Wilkes, Xu Jianchu. Fertilizer use patterns in Yunnan Province, China: Implications for agricultural and environmental policy. Agricultural Systems, 2012; 110: 78-89.
43. Song GH, Li YF; The Effect of Reinforcing the Concept of Circular Economy in West China Environmental Protection and Economic Development. Procedia Environmental Sciences, 2012; 12: 785-792.
44. Shu Y, Chen Q, Pan JQ; Optimization of Environmental Investment Strategy in Water Resource of Agricultural Production. Energy Procedia, 2011; 5: 1251-1257.
45. Lopez R, Gregmar I, Galinato Islam A; Fiscal spending and the environment: Theory and empirics. Journal of Environmental Economics and Management, 2011; 62: 180-198.
46. Chaturvedi A, Manjeet S, Saluja Banerjee A; Rachna Arora. Environmental fiscal reforms. IIMB Management Review, 2014; 26: 193-205.
47. Cao JJ, Li M, Li SG; Development Strategy Research of Modern Eco-Agriculture on the basis of constructing the Rural Circular Economy-For the Example of Shandong Province. Energy Procedia, 2011; 5: 2504-2508.
48. Buckley C, Carney P; The potential to reduce the risk of diffuse pollution from agriculture while improving economic performance at farm level. Environmental science&policy, 2013; 25: 118-126.
49. Li M, Feng SY, Reidsma P, Qu F, Heerink N; Identifying entry points to improve fertilizer use efficiency in Taihu Basin, China. Land Use Policy, 2014; 37: 52-59.
50. Reidsma P, Feng S, van Loon M, Luo X, Kang C, Lubbers M, Qu F; Integrated assessment of agricultural land use policies on nutrient pollution and sustainable development in Taihu Basin, China. Environmental Science & Policy, 2012; 18: 66-76.
51. He H, WRPB; Introduction of Integrated Water Resources Planning of Hai River Basin. Water Resources Protection Bureau of HaiHe River Basin, Available from: http: // www. hwcc.gov.cn/pub/hwcc/static/3.htm.