Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268
e-ISSN: 2395-3454

Vol. 16 | No. 3 | pp. 745-751 | 2017

Original Research Paper | Open Access

Positive Effects of Environmental Management Input on Environmental Pollution and Treatment Measures Taking Shandong Province in China as an Example

Peibiao Liu
Shandong Women's University, Jinan, Shandong 250300, China

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 17-04-2017
Accepted: 19-07-2017

Key Words:
Environmental management
Environmental pollution
Treatment measures
Shandong province

ABSTRACT

Economic development characterized by high consumption, high input and high pollution has aggravated the global environmental pollution. Insufficient input in environmental management has become an important factor that restricts the improvement of environmental pollution. In this study, the current environmental pollution in Shandong province of China is analysed using the provincial environmental panel data of the province from 2005 to 2015. Moreover, the random-effect variable coefficient model is adopted to measure the effect of environmental management input on the improvement of the environmental pollution in Shandong province. Results indicate that the environmental pollution in Shandong province is characterized by the increasingly serious air pollution, the intensification of water pollution and huge amount of urban waste. Improvement resulting from environmental management input on the environmental pollution is quite obvious in the cities of Weihai, Rizhao, Qingdao and Jinan, contrary to the negligible effect observed in Dezhou, Liaocheng and Heze. Policy proposals are presented from the aspects of optimizing economic and industrial structure, increasing environmental input, improving the mechanism for the participation in environmental investment, and the formulating environmental protection legal system, so as to improve the environmental pollution in Shandong province. This paper may be used as reference in the analysis of the relationship between environmental input and environmental pollution, evaluation of environmental input performance, and formulation of scientific approaches for environmental protection and development policies by government departments.

INTRODUCTION

China's economy has been very rapidly growing in recent years. The extensive growth of GDP has not only resulted in considerable wastage of economic resources, but has also led to serious damage to the environment and ecology. Large-scale environmental pollution and frequent pollution events have aroused widespread concern, resulting in the great urgency of environmental management. Additionally, energy consumption in China per GDP is significantly higher than that in international advanced economies. This phenomenon has strengthened the awareness in environmental protection, and expanding environmental management input has been considered as the only approach to achieve sustainable economic development in China. Prioritizing the transformation of economic development, optimization of economic structure, promotion of energy conservation, and development of low-carbon economy should be coordinated with the ecological capacity of resources and environment. Sustaining a steady and rapid economic development implicates a great demand on natural resources and tremendous pressure on ecological environment along with the continuous population growth, further acceleration of urbanization and rapid transition of economic structure.

Environmental pollution has been a key concern in Shandong Province, which is a key industrial province in China. Sustainable development requires that various regions in Shandong Province should further enhance environmental protection input, strictly control environmental pollution, and consider environmental protection input as the focus of public expenditure for low-carbon transformation. However, a large gap still exists between financial input and realistic objective demand in Shandong Province, which cannot be adapted to the current environmental protection needs. Therefore, this paper reports on the evaluation of whether environmental protection could effectively improve environmental pollution as well as on the measurement of the degree of improvement by analysing the current status of environmental pollution with Shandong Province as the case study. This study is expected to have a strong practical significance in increasing financial environmental input, establishing a sound environment financial system, and improving institutions, policies, and innovative systems for environmental protection.

Numerous theoretical and empirical studies have been performed domestically and in foreign countries on the effects of environmental management input on environmental pollution and the various treatment measures. Dinda regarded environmental resources as input factors in the production function, specifically the utility function, and found an inverted U-shaped relationship between environmental quality and economic growth (Dinda 2005). Greuner analysed the impact of public expenditure on environmental pollution (Greuner 2005). Egli established a dynamic model based on Greuner's study and also obtained an inverted environment EKC curve (Egli et al. 2007). Economides analysed the feasibility of the government's use of taxation and other policies to manage pollution (Economides et al. 2008). Pautrel believed that a win-win environmental policy should be established to enhance the economy and reduce environmental pollution (Pautrel 2008). Gupta analysed the roles of productive public expenditure and environmental pollution and calculated the optimal proportion of tax expenditure and productive public expenditure allocated by the government (Gupta et al. 2009). López argued that increasing government spending can reduce water and air pollution (López et al. 2011). Yang analysed the relationship between industrial pollution and pollution control input and showed that the western region in China would face greater pressure on pollution because of the low pollution control input in this area (Yang et al. 2012). Liu analysed the efficiency of the input in environmental pollution control in various cities in Fujian Province and showed that enhancing the input efficiency was the key to improving environmental pollution (Liu 2012). Zhang argued that government intervention could effectively improve the quality of the local environment, and environmental input has distinct control effects in different places (Zhang 2013). Shi believed that China's tolerant environmental policy considerably attracted foreign investment, but this phenomenon had aggravated the local environmental pollution (Shi 2013). Wang inferred that moderate increase in input could effectively control sewage pollution, improve the efficiency of environmental pollution control, and make adjustments in accordance with the characteristics of regional development (Wang et al. 2014). Parisa studied the impact of Iran's foreign direct investment on environmental pollution (Parisa 2014). Hua analysed the input efficiency of the input in environmental pollution control in controlling pollution by adopting the DEA model (Hua et al. 2014). Kun believed that competition among local governments had a significant role on environmental pollution, because this competition could significantly increase pollution in an area and reduce regional environmental quality (Kun et al. 2016). Environmental management input can significantly improve environmental pollution, but variations still exist concerning the specific meaning of this practice among different countries. The selection of environmental pollution indicators also provides opportunity for further expansion. Therefore, this paper reports on the analysis of the internal mechanism between environmental input and improvement in environmental pollution in Shandong Province, China. In addition, the effect of environmental management input on pollution was calculated by analysing the current status of environmental pollution in Shandong Province to propose policy recommendations for environmental input policies and improvement of environmental pollution.

CURRENT STATUS OF ENVIRONMENTAL POLLUTION IN SHANDONG PROVINCE

Seriously intensified air pollution: Shandong Province is a high energy consumer, and its energy consumption has continued to escalate as a result of the social and economic development in recent years. The total energy consumption of this province in 2015 was approximately 4-fold of its consumption in 2000 (Fig. 1). Coal and other energy industries have contributed to high exhaust emissions, and the city skyline has become increasingly polluted. In addition, the growing number of urban motor vehicles has also led to progressively serious pollution caused by vehicle exhaust. The pollutants mainly include solid suspended particles, carbon monoxide, sulphur dioxide, hydrocarbons, aromatics, organic acids, benzene, and other harmful gases, which adversely affect the health of residents. Air pollution has led to an elevated incidence of diseases. Gas combustion pollution, motor vehicle exhaust and industrial waste gas are currently the main sources of air pollution in Shandong Province. Emissions from industrial waste in Shandong Province from 2000 to 2015 are depicted in Fig. 2.

Water pollution aggravation: Improvement in the urbanization rate of Shandong Province resulted in the migration of a high proportion of rural population to the city, resulting in increased urban population and sewage discharge. At present, the low processing capacity for urban sewage has led to the considerable discharge of industrial wastewater. In particular, the total industrial wastewater discharge increased by approximately 2 billion tons from 2005 to 2015 (Fig. 3). The national emission standards remain hardly achieved, although the majority of wastewater has been processed. Additionally, the chemical composition of the sewage is becoming more complex. Given the limited natural purification capacity of water, once the untreated sewage is discharged into the river, groundwater and soil will become polluted, and the natural environment of a water body will also be destroyed. Contaminated groundwater detrimentally affects human health. Therefore, industrial wastewater and do-

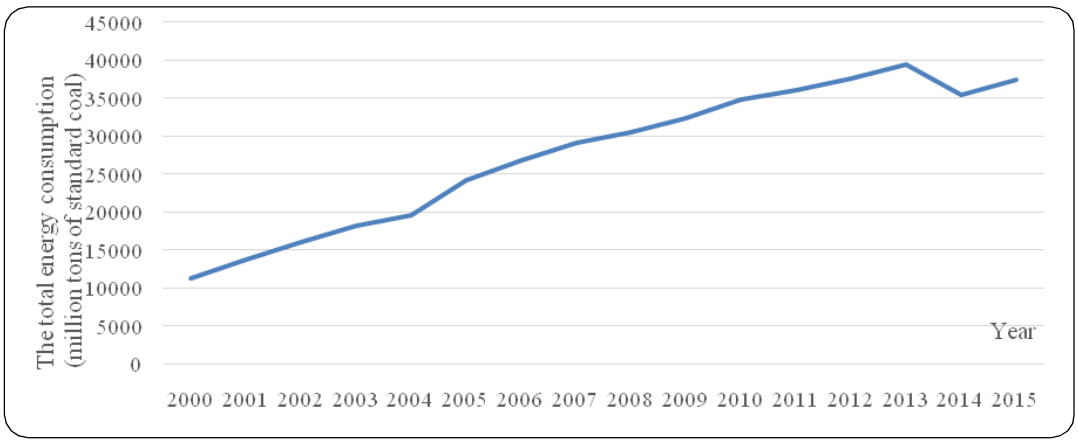

Fig.1: Total energy consumption in Shandong Province from 2000 to 2015.
(Data are sourced from the China Energy Statistical Yearbook)

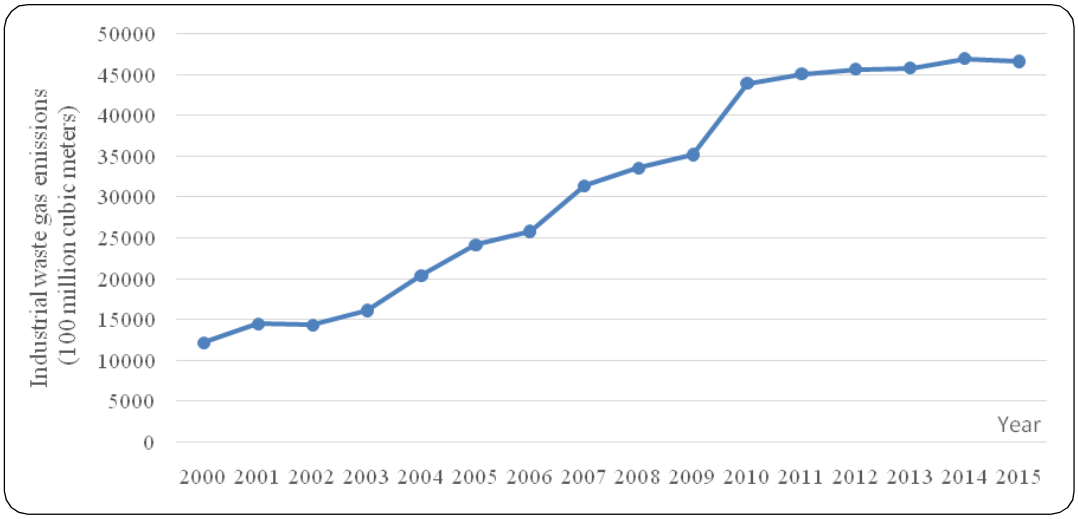

Fig. 2: Emissions from industrial waste in Shandong Province from 2000 to 2015.
(Data are sourced from Shandong Province Statistical Yearbook).

mestic sewage are the main causes of urban water pollution.

Considerable amounts of garbage pollution: Garbage in large cities in Shandong Province is surmounting and has become a public hazard for urban environmental construction and human life. The data on huge amount of urban garbage are shown in Fig. 4. A bulk of this garbage is just piled in open-air, where its harmful components leach to the surrounding interstices of soil and water sources through ground surface and rainwater. This process pollutes the soil, atmosphere, and water. Consequently, harmful wastes in the environment can directly enter the human body through the respiratory and digestive systems. Many cities are surrounded by garbage because of poor waste disposal and utilization capacity. Furthermore, harmful substances in the garbage can easily transform into serious sources of pollution, resulting in extensive hazards to the urban environment, groundwater, air and human health.

MODEL INTRODUCTION AND DATA DESCRIPTION

Introduction to the model: Shandong Province, which is located on the eastern coast of China, covers 17 municipal cities. The influence of environmental management input on the improvement of environmental pollution in different areas was investigated by considering the SO_2 emission from these cities as an indicator for measuring environmental pollution. This emission was also used as an explanatory variable. Moreover, the environmental management input was used as an explanatory variable to establish a panel regression model. The general form of the panel data is as follows:

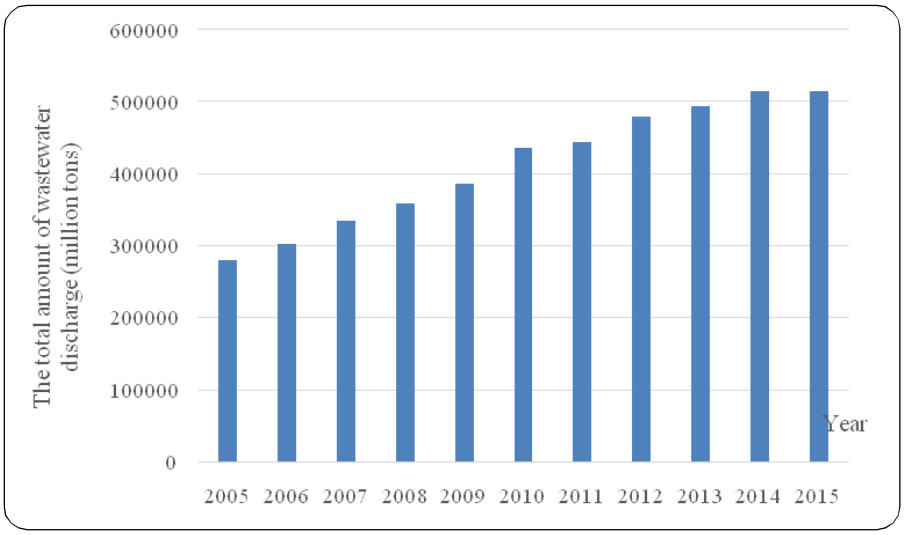

Fig.3: Industrial wastewater discharges in Shandong Province from 2005 to 2015. (Data are sourced from the Shandong Province Statistical Yearbook).

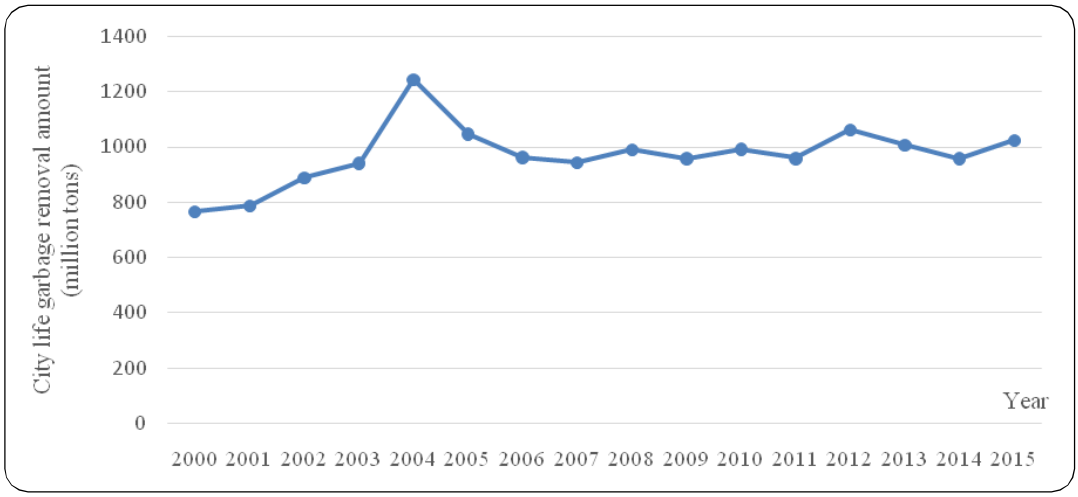

Fig. 4: Transported amount of urban household garbage in Shandong Province from 2000 to 2015. (Data are sourced from the Shandong Province Statistical Yearbook)

$$Y_{it} = a_{it} + X_{it}\beta_{it}\varepsilon_{it}$$
$$X_{it} = (X_{1it}, X_{2it}, \cdots X_{kit})$$
$$\beta = (\beta_{1i}, \beta_{2i} \cdots \beta_{ki}) \quad ...(1)$$
$$i = 1, 2 \cdots N; t = 1, 1 \cdots T$$

Where, α_i indicates the intercept term, β_i indicates the coefficient of explanatory variable, ε_{it} indicates white noise, and K indicates the number of explanatory variables. According to the different assumptions of α_i and β_i, the model is further divided into the following three forms:

Mixed data mode: $\alpha_i = \alpha_j, \beta_i = \beta_j$

Variable intercept model: $\alpha_i \neq \alpha_j, \beta_i = \beta_j$ ...(2)

Variable coefficient model: $\alpha_i \neq \alpha_j, \beta_i \neq \beta_j$

The appropriate model to be adopted should first be determined before performing the panel model regression. In this paper, the widely used covariance analysis test was adopted, and the test was performed mainly through the following two F-statistics to determine which specific model regression shall be used:

$$F_1 = \frac{(S_2 - S_1)/(N-1)K}{S_1/[N(T-K-1)]} \sim F[(N-1)K, N(T-K-1)] \quad ...(3)$$

$$F_2 = \frac{(S_3 - S_1)/(N-1)(K+1)}{S_1/[N(T-K-1)]} \sim F[(N-1)(K+1), N(T-K-1)] \quad ...(4)$$

Where S_1, S_2, and S_3 indicate the residual sum of the squares of the three corresponding equations in the Equation (2), respectively, N indicates the number of cross sections of the data, T indicates the time span of the data, and K indicates the number of independent variables. For general $\alpha = 0.01$ significance level, F_2 -statistic is first used to determine whether the mixed model is appropriate. If F_2 is less than the critical value, the mixed data model shall be used, otherwise, F_1 shall be reused for further test. If F_1 is less than the critical value, the variable intercept model will be used, otherwise, the variable coefficient model will be used.

After the specific model has been selected, fixed and random effects should be applied. The general adopted approach is the Hausman test. The W-statistic is constructed as follows:

$$W = [b - \hat{\beta}]\hat{\sum}^{-1}[b - \hat{\beta}] \quad ...(5)$$

Where b is the estimation result of the fixed effect regression coefficient, $\hat{\beta}$ is the estimation result of the random-effect regression coefficient, and $\hat{\sum}$ is the variance of the differences in the estimated results of the regression coefficients in the two models, i.e. $\hat{\sum}$ = var [b- $\hat{\beta}$]. When the original hypothesis is established, W follows the χ^2 distribution of K freedom, and $\alpha = 0.01$ is chosen at the given significance level. If the value of W is greater than the critical value, the fixed effect model is selected. Otherwise, the random effect model shall be selected.

Data sources: Environmental pollution variable (expressed as POL) is the core explanatory variable in this paper. Among the wide varieties of exhaust gases, SO_2 was considered as the core pollution index in air pollution on the basis of data availability and reference to relevant literature. In this paper, SO_2 emission in the sub-regional i in the year t was used as an indicator to measure environmental pollution, and the unit is 10,000 tons. TPI refers to the ratio of public input in local environmental pollution control to local GNP in the sub-regional i in the year t. TPI was determined as follows: TPI = environmental pollution control input/GDP. All data were sourced from the Shandong Province Statistical Yearbook (2006-2016), and the time span was 2005-2015, for a total period of 11 years.

EMPIRICAL RESEARCH

According to Equation (3), $F_1 = 6.48 > F_{0.01}(16,153) \approx 2.12$. Thus, the mixed data model is not used. Moreover, $F_2 = 4.63 > F_{0.01}(32,153) \approx 1.80$. Thus, the variable coefficient model should be used. The critical value of F was obtained using Stata's display invF command, while the other operations were accomplished using Eviews 7.0. Based on the Housman test, the probability of the cross-section random is 0.99, and the original hypothesis was accepted at 99% confidence. Therefore, the variable coefficient model of the random effect should be adopted. The regression results are presented in Table 1.

Table 1: Regression results.

Name of city	Regression coefficient	T-statistic
C (constant)	1.68	2.48
Jinan	-3.23	2.95
Qingdao	-4.64	4.52
Zibo	-2.12	0.86
Zaozhuang	-0.75	0.64
Dongying	-1.23	2.95
Yantai	-0.24	2.21
Weifang	-1.54	1.56
Jining	-0.47	2.14
Tai'an	-2.69	3.14
Weihai	-5.62	9.92
Rizhao	-6.44	6.54
Binzhou	-0.54	4.56
Dezhou	0.54	6.32
Liaocheng	0.42	0.21
Linyi	-0.21	0.29
Heze	0.47	2.10
Laiwu	-0.63	0.14
R variance	0.93	
Adjusted R variance	0.98	
DW statistic	2.14	
F value	169.64	

The regression results show the following information:

1. The adjusted R variance was 0.98, indicating the good fit of the regression equation. The DW-statistic was 2.14, indicating no linear autocorrelation. F value was 169.64, indicating the significance of the equation regression.
2. The impact of environmental management input on the improvement of environmental pollution in Weihai, Rizhao, Qingdao, and Jinan was significant. The regression coefficient was negative and significant. The original statistical data show the highest regression coefficients in Weihai, Rizhao, Qingdao, and Jinan because of the significant urban growth in these areas. Meanwhile, improvements in pollution investment in these cities were very obvious, because these cities are located in the coastal areas, and the governments have paid great importance to environmental protection in recent years. Taking full advantage of the market mechanism, these cities are suggested to enhance the guidance and supervision, as well as promote efforts, for control-

ling pollution. These efforts include guiding enterprise investment based on strict enforcement of policies, pulling social investment based on government investment, and mobilizing market resources based on economic policies to maximize the full implementation of pollution control funds.

3. The regression coefficients of the three cities of Dezhou, Liaocheng and Heze were positive, indicating that environmental management input did not play an effective role in improving the environment. This phenomenon is probably caused by the location of three cities, which are located inland of Shandong Province. The economic base in this area is poor, and environmental management inputs are also relatively few. Therefore, these cities are suggested to adjust the industrial structure and focus on the development of industries with low pollution. In addition, considering that low environmental investment, local governments are urged to increase the input capacity and strengthen the financial commitment to environmental budget.

COUNTERMEASURES

Optimize the economic industrial structure and complete industrial distribution: The polluting behaviour of high-polluting industries should be strictly controlled to reduce pollutant emission and transform economic growth mode. Industrial restructuring should be prioritized, outdated technologies and devices should be eliminated, according to the law, and resource-wasting enterprises that pollute the environment and destroys ecology should be shut down. High-tech industries should be encouraged and emerging industries with low energy and low pollution output should be promoted. Regional industrial distribution according to regional environment capacity should be adjusted. Circular economy should be developed, and cleaner production should be implemented to enhance the level of clean production, reduce consumption of raw materials, and improve rate of waste recycling. Water conservation, energy-saving technologies, and improvement of repeating utilization factor of industrial wastewater should be vigorously promoted. Moreover, the transformation of pollution control from end treatment to the overall process of production should be supported. Implementation of cleaner production and promotion of the effective use of water resources is recommended to ease the pressure on water resources for economic development. Central heating projects should be expedited, central heating area should be expanded, and heating penetration rate should be improved. Desulphurized heating boiler with long service life and low efficiency of desulphurization should be phased out.

Enhance the strength in environmental investment and guarantee adequate funding for environmental improvement: Environmental investment has a positive role on environmental pollution emissions, because environmental investment is associated with economic development. Unilateral pursuit of economic development has led to the remarkable environmental problems in China, but the requirements and needs for environmental quality are improving constantly along with the enhanced living standards. Environmental protection, as a key element to improve people's livelihood, should be promoted to the same position as agriculture, education and technology. In addition, double linkage mechanisms between environmental expenditure and GDP, as well as between environmental expenditure and fiscal revenue growth, should be constructed to ensure that the amplification of environmental expenditure is higher than the growth rate of GDP and fiscal revenue. Moreover, improving the efficiency of environmental input and reducing the environmental pollution is highly important, because the environment affects the welfare of a community. These goals can be achieved by fully implementing the joint roles of the government and market and correctly handling their jurisdictions.

Improve the participation in environmental investment mechanism and raise environmental funds from multiple channels: Financial deficit still exists despite the enhanced environmental investment and expanded financing channels in environmental protection. Moreover, environmental pollution has not been effectively controlled. To tap the potential of market mechanism in the allocation of environment investment funds, directional and normative policy measures and activities should be formulated and implemented by all levels of government and environmental organizations to support and encourage all kinds of market players to actively participate in environmental pollution control and environmental quality protection. Furthermore, the responsibilities of the government should be clarified and refined. These responsibilities include the environmental policies that should be managed by the government and the environmental protection infrastructure invested by the government. Additionally, the clean development mechanism can be actively used to promote financing and investment, expand the policy-oriented financing support, and improve the green procurement system of the government.

Develop systematic environmental protection legal system and improve the environmental protection system: Standards on environmental pollution and government environmental behaviour should be established to provide the basic guidelines for the conduct and clear obligations of polluting enterprises and administrative departments on envi-

ronmental protection. Legal vacancies in environmental protection should be promptly detected, and relevant legal systems should be effectively implemented. The civil liability for environmental infringement should be clarified, supporting laws and regulations should be formulated, and the types, scope and even specific amount of punishment of administrative penalties should be clarified. Sound environmental protection system, urban ecosystem, and ecological construction system should be established. Moreover, the indicator of total pollutant discharge is considered as the important criterion of measuring the performances of all government units in controlling the total amount of pollutant discharge. Thus, they can be consciously responsible for the environmental conditions in their jurisdictions. Hence, by refining the discharge targets, all governments units can flexibly and dynamically monitor polluting enterprises under their jurisdictions.

CONCLUSIONS

The demand for natural resources has further intensified because of the continuous population growth and acceleration of urbanization. These processes have resulted in considerable pressure to the ecological environment. This phenomenon requires an increase in investment in environmental protection and implementation of strict control of environmental pollution during the low-carbon transformation. In this paper, the status of air, water, and garbage pollution in Shandong Province, China was analysed. Variable coefficient model of random effects was used to measure the effect of environmental management input on environmental pollution. The results showed three major aspects of environmental pollution, namely, seriously intensified air pollution, aggravated water resource pollution, and considerable amount of municipal waste pollution. The environmental management input showed a significant impact on the improvement in the environmental pollution in the coastal cities of Weihai, Rizhao, Qingdao, and Jinan. This result is contrary to the negligible outcome in Dezhou, Liaocheng, and Heze. Countermeasures, such as optimizing the economic and industrial structure, increasing investment in environmental protection, improving the environmental participation system, and formulating a legal system on environmental protection, were discussed to improve environmental pollution. This paper focused on the analysis of the current status of environmental pollution and determination of whether the effect of environmental management input on environmental improvement was obvious and the degree of action. Further studies on the environmental accounting system, efficiency of environmental protection fund, and whether environmental management input disrupts the improvement in environmental pollution should be conducted.

REFERENCES

Dinda, S. 2005. A theoretical basis for the environmental Kuznets curve. Ecological Economics, 53(3): 403-413.

Economides, G. and Philippopoulos, A. 2008. Growth enhancing policy is the means to sustain the environment. Review of Economic Dynamics, 11(1): 207-219.

Egli, H. and Steger, T.M. 2007. A dynamic model of the environmental Kuznets curve: turning point and public policy. Environmental and Resource Economics, 36(1): 15-34.

Greuner, A. 2005. Fiscal policy in an endogenous growth model with public capital and pollution. Japanese Economic Review, 56(1): 67-84.

Gupta, M.R. and Barman, T.R. 2009. Fiscal policies, environmental pollution and economic growth. Economic Modelling, 26(5): 1018-1028.

Hua, Y., Hou, C.X. and Gu, Y.Z. 2014. Investment efficiency DEA analysis of pollution control in China. Applied Mechanics and Materials, 687(11): 4979-4983.

Kun, Xu, Xiaolong, Li and Guanghe, Ran. 2016. An empirical analysis on the impact of local government competition on environmental pollution in China. Journal of Beijing Institute of Technology, 18(1): 18-23+61.

Liu, Tao 2012. The study of technical efficiency evaluation of urban environmental pollution control investment of Fujian Province based on data envelopment analysis. Journal of Heze University, 34(5): 1-6.

López, R., Galinato, G.I. and Islam, A. 2011. Fiscal spending and the environment: Theory and empirics. Journal of Environmental Economics and Management, 62(2): 180-198.

Parisa, Bahloul 2014. An investigation into the impact of foreign direct investment on environmental pollution in Iran. Meteorological Applications, 18(4): 475-482.

Pautrel, X. 2008. Reconsidering the impact of the environment on long-run growth when pollution influences health and agents have a finite-lifetime. Environmental and Resource Economics, 40(1): 37-52.

Shi, Qing 2013. Foreign direct investment, environmental regulation and environmental pollution: from the perspective of government honest degree. Fin. Trade Econ., 34(1): 93-103.

Wang, P. and Xie, L. 2014. Pollution control investment, enterprise technical innovation and pollution control efficiency. China Population Resources and Environment, 25(9): 42-47.

Yang, L. and Gao, X. 2012. Environmental pollution and the deviation of pollution control investment: An analysis based on the gravity model. Journal of Subtropical Resources and Environment, 27(2): 41-47.

Zhang, Gaofu 2013. Government intervention, environmental pollution and corporate environmental protection investment-evidence from listed companies of heavy pollution industries. Research on Economics & Management, 34(09): 38-44.