Energy, Economy, Population, and Climate's Influences on Environment in Anhui Province, China

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Abstract. Energy consumption, economic development level, population growth, and climate change and so on all have close relations with environment pollution. Based on the statistical data of Anhui province in China from 1987 to 2004, this paper analyzes the direct and indirect influences of energy consumption, total output value of industry, population, temperature and precipitation on environment pollution. The results show production pattern of industry and consumption of electric power are main reasons of environmental pollution.

Keywords: Energy consumption, Environment pollution, Multi-path analysis model, Anhui province.

1 Introduction

With society and economy developing, environment pollution becomes more and more serious, and, in some degree, begins to threaten economic development, human healthy and social security. Most of existing studies are about the influences of single social or economic factor on environment, and emphasize on the relationship between economic growth and environment pollution level, i.e. different expressive forms of Environmental Kuznets Curve, rarely relating to multi-factor influences on environment or direct and indirect influences on environment through effect factors. Since there are various factors which affect environment, such as the increase of energy consumption, the enhancement of industrialization, the growth of population, and the change of climate and so on, environment is a systematic engineering. Treating energy, economy, population, climate and environment as a whole, the multi-path analysis model is used in this paper to make a case study of Anhui province, China, analyzing direct and indirect influences of energy consumption, total output value of industry, population, temperature and precipitation on environment pollution as well as the interaction among each factor. The result of this paper can provide scientific foundation for coordination between regional economy and environment and policy-making of regional environment.

2 Methods

When there are many variables, one independent variable can act on dependent variable not only through direct effect, but also through indirect effect by acting on other dependent variables. Path analysis is combinational analysis of regression equation which is the supplement and development of correlation analysis [1]. It can reduce coefficients of simple correlation into many parts, and show both direct and indirect influences of independents on dependent [2].

Based on data coming from "Anhui statistics yearbook", "Anhui energy statistics yearbook" of 1988-2005 and other references [3], this paper will use path analysis model to analyze the direct and indirect influences on environment pollution in Anhui province from 1987 to 2004. Detailed processes and formulas which can be consulted in reference [4] are omitted.

In our calculation, dependent variables including total waste water discharge, industrial solid waste discharge and total waste gas discharge are used to show environment pollution situation. The following 7 indexes are used as independent variables which affected environment: quantity of population(X_1), consumption of electric power(X_2), consumption of petroleum(X_3), consumption of coal(X_4), total output value of industry(X_5), temperature(X_6) and precipitation(X_7).

3 Results

The main results can be observed from Table 1, Table 2 and Table 3, in which TII represents total indirect influence and PII represents proportion of indirect influence.

Table 1. Direct and indirect influence coefficient of influence factors acting on total wastewater discharge

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	TII
X_1	-0.7575	0.5406	0.0332	0.2191	-0.8649	-0.0574	-0.0007	-0.1301
X_2	-0.7349	0.5572	0.0338	0.2300	-0.8892	-0.0537	-0.0003	-1.4143
X_3	-0.6771	0.5069	0.0371	0.2198	-0.8152	-0.0390	-0.0001	-0.8047
X_4	-0.6726	0.5912	0.0330	0.2468	-0.8564	-0.0491	0	-1.0259
X_5	-0.7166	0.5419	0.0331	0.2312	-0.9143	-0.0598	-0.0005	0.0293
X_6	-0.5105	0.3514	0.0170	0.1422	-0.6413	-0.0852	-0.0020	-0.6432
X_7	0.1159	-0.0382	-0.0006	0.0010	0.0969	0.0376	0.0046	0.2180

From our calculation, we find that consumption of three kinds of energy has a great influence on the pollution situation of atmosphere environment. Table 1 shows that the direct influence of total output value of industrial on waste water discharge is relatively high, and its path coefficient is -0.9143, very close to its correlation coefficients. The following is the quantity of population. Consumption of electric power and consumption of coal have the greatest indirect influences on waste water discharge through industry production and population quantity.

Table 2. Direct and indirect influence coefficient of influence factors acting on industrial solid waste discharge

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	TII
X_1	0.0074	0.6776	-0.6091	0.4363	0.1943	0.1333	-0.0280	0.8044
X_2	0.0072	0.6984	-0.6200	0.4579	0.1998	0.1247	-0.0108	0.1588
X_3	0.0066	0.6354	-0.6815	0.4375	0.1831	0.0906	-0.0027	1.3505
X_4	0.0066	0.6508	-0.6068	0.4914	0.1924	0.1140	0.0008	0.3578
X_5	0.0070	0.6793	-0.6076	0.4603	0.2054	0.1387	-0.0194	0.6603
X_6	0.0050	0.4404	-0.3122	0.2831	0.1441	0.1978	-0.0808	0.4796
X_7	-0.0011	-0.0411	0.0102	0.0020	-0.0218	-0.0872	0.1832	-0.1390

Population quantity, consumption of electric power, consumption of petroleum, consumption of coal and total output value of industry all have great influences on industrial solid waste discharge, the coefficients are 0.8117, 0.8571, 0.6690, 0.8490 and 0.8636 respectively, all positive. Since quantity of population, consumption of petroleum and total output value of industry all have small direct influences on industrial solid waste discharge, with path coefficients 0.0074, -0.6815 and 0.2054 respectively (Table 2), their indirect influences on industrial solid waste discharge are great. The reason is that industrial solid waste discharge increases as the demand of electric power goes up which is caused by population growth, consumption of petroleum and industry production.

Table 3. Direct and indirect influence coefficient of influence factors acting on total waste gas discharge

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	PII
X_1	-1.3508	1.4192	-0.1286	0.6557	0.0738	0.0815	0.0109	2.1125
X_2	-1.3105	1.4628	-0.1309	0.6881	0.0759	0.0763	0.0042	-0.5969
X_3	-1.2073	1.3309	-0.1439	0.6576	0.0695	0.0554	0.0011	0.9072
X_4	-1.1994	1.3630	-0.1281	0.7385	0.0731	0.0697	-0.0003	0.1830
X_5	-1.2779	1.4227	-0.1283	0.6918	0.0780	0.0849	0.0075	0.8007
X_6	-0.9103	0.9224	-0.0659	0.4255	0.0541	0.1210	0.0314	0.4578
X_7	0.2067	-0.0862	0.0022	0.0030	-0.0083	-0.0534	-0.0712	0.0640

In Table 3, the indirect influence of quantity of population and consumption of petroleum on waste gas discharge is high. Their correlation coefficients are all positive, and path coefficients are -1.3508 and -0.1439 respectively. Consumption of electric power has a great indirect influence on waste gas discharge, followed by consumption of coal. Coal is the main energy for economic development. Industry production, fire power station and daily life of residents all request large amount of coal, so consumption of coal is the main reason of air pollution in our country. Enhancing efficiency of energy utilization, developing clean coal technology, improving the process of waste gas treatment, exploring and adopting efficient waste gas treatment and comprehensive resource utilization technique is the fundamental solution for air pollution.

4 Conclusions

In this paper, multi-path analysis model is used to analyze direct and indirect influences of population, energy consumption, gross industrial output value, temperature and precipitation on environment pollution in Anhui province, China, from 1987 to 2004. The results show that production pattern of industry and electric power consumption are main reasons of environmental pollution in Anhui province.

As far as Anhui is concerned, quantity of population and total output value of industry all have high correlation degrees with waste water discharge and the direct influence of the later on waste water discharge is larger than the former. While population grows and industry develops, industry structure should be improved to enhance the technology of waste water disposal, and thereby boosts harmonious development.

While consumption of electric power has great direct influences on industrial solid waste discharge and waste gas discharge, quantity of population and consumption of petroleum all have great indirect influences on industrial solid waste discharge and waste gas discharge through consumption of electric power. With population growing, consumption of electric power will surely increase, leading to large amount discharge of waste gas and waste residue. Controlling population quantity, improving energy for generating electricity, exploring clean coal technology and increasing the rate of energy utilization, all can to some extent reduce environment pollution.

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