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Evaluation of China's Resource and Environmental Performance in 2005-2015

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Abstract: ***The restriction of resources and environment is still the main challenge economic development in for China. In this paper, the resources and environmental c performance index is used to evaluate the 30 provinces of China from 2005 to 2015. The results show that: (1) China's resource and Environmental performance index shows "N" type, the ecological carrying capacity is overloaded, and the ecological fragility is obvious. The higher emission intensity of waste gas and industrial solid waste is the main restricting factor of resource and environmental performance in China. (2) The resources and environmental performance has significant spatial characteristics. The eastern region is superior to the central region, the central region is superior to the western region, and the difference between the western region and other regions became larger after 2010. (3) According to the evaluation of resources and environmental performance of 30 provinces, it can be divided into four gradients, in which the provinces with excellent resource and environmental performance are concentrated in the eastern region, and the provinces with poor resources and environment performance are concentrated in the western region, which is the core area for future attention and improvement. (4) There is a strong correlation between industrial structure, resource environmental policy and regional resource environmental performance. Finally, this paper puts forward some countermeasures to improve our country's resources and environmental performance from the aspects of strengthening the management, promoting the industrial transformation and upgrading, and accelerating the scientific and technological innovation, and so on.***

Keywords: Resource and Environmental Performance; Evaluation; sustainable development.

1. Introduction

There is an intrinsic linkage between the resources, environment and the regional development. In recent years, with the rapid growth of economy, urbanization, industrialization and several related factors are responsible for the rapid consumption of the resources and the degradation of the environment in Chin. China remained the world's largest energy consumer, accounting for 23% of global energy consumption in 2016, and its Environmental Performance Index only ranked 120 in 180 countries with a score of 50.74 in 2018. Especially for air quality which is only 14.39 score, reflecting the strain rapid economic growth imposes on the environment. Today, it's very important for the coordinated development of the economic - resource - environment(ERE) system in China.

2. Literature Review

With the rapid development of economy in China, the problem of heavy consumption of resources and the environmental pollution has become more and more serious, which in turn mainly restricted the development of economy. Rapid economic growth, industrialization and urbanization have put enormous pressure on the environment. Accordingly, the Resource and Environmental Performance Index (REPI) was proposed, and resources or environment are used in the analysis of efficiency and productivity of regional economic behavior [1].

REPI is widely used in the international performance evaluation of resource consumption and pollutant emission in the country or region[2]. The relative index reflects the level of economy at the cost of resource utilization and pollutant emission intensity.

The comparative analysis of the international resource consumption made by Qiao Qong (2008) shows that: the utilization efficiency of resources in developed countries is generally higher than that of developing countries, and we should transform from the traditional economic growth mode of resource consumption-oriented to the recycling economy with the core of resource saving[3]. Studies of Chen Shaofeng (2007), Li Hongli and Zhi Yingbiao (2010), Wen Hongjian and Zhaoxia (2013) suggest that the performance of China's resources and environment has been improved since 2000, and it has obvious spatial differentiation characteristics: the east to the middle and to the west, followed by decreasing, and this gap is expanding continuously[4, 5]. The research made by Yu Zhonghua, Liu Haibin, Xie Fangjian (2013) shows that the REPI of the deputy provincial cities is excellent, the REPI is lower than national average level, and it is closely related to the level of urban development, showing that the REPI of coastal areas is higher than that of inland cities[6]. Huang Heping et al. (2010) systematically analyzed the strength and performance of resource and environment in Jiangxi Province with an improved REPI. [7] The results show that: The energy consumption increases synchronously with the economic growth, water resource consumption growth was slow; COD and SO_2 emissions showed a downward trend, and the REPI had a relatively downward trend in 2002-2008; The ecological vulnerability index and REPI were used to study the resource and environmental performance by Lu Zhanyuan, Zhi Yingbiao et (2010) in guangxi. It shows that the performance of resources and environment is increasing, but the national rank is unchanged[8]. Comprehensive performance index, SO_2 emission performance index, industrial solid waste emission performance Index and biological resources index showed "N" shape, water

pollution index showed "∧" shape, air pollution index showed "W" shape, ecological carrying capacity is overload, and the trend of ecological fragility did not change obviously. The decline in resource consumption and pollutant emissions is not stable. In addition, Liang Xing and Liu Yangdong evaluate the ecological performance of resources in 17 cities of Shandong Province. Zhi Yingbiao and Wang Zailan(2013) analyzed the evolution characteristics of resource environment performance in Inner Mongolia in the arid and semi-arid ecological fragile region of western China of 2000-2010, and indicated that the comprehensive performance has the promotion trend[9]. The relationship between technological innovation and environmental performance is analyzed empirically by Liu Surong, Li Chan, Yang Huimiao (2016) by multivariate linear regression analysis, and it is concluded that R&D funds and regional effective patents play a significant role in promoting environmental performance, while the promotion effect of enterprise-related income on environmental performance is not significant[10].

On the whole, the research on China's resources and environmental performance is gradually enriched, but more research focused on a province or region, few on all the provinces in China; More research focused on a certain time, few on the dynamic analysis and the reason exploration about the value change of REPI. According to the panel data of 30 provinces in China of 2005-2015, this paper integrated the resources, environment and economy, and made a dynamic analysis and spatial evolution analysis of comprehensive resources and environmental performance. Then explore the reasons of the change and gives some countermeasures which supplementing previous studies.

3. Evaluation on the resources and environmental performance in China

3.1 Definition of resource and environmental performance index

Performance of resources or environment can be evaluated by ratio of the resource consumption or pollution emissions unit GDP in one area relative to the national value, and the comprehensive environmental performance index of resources and environment is the weighted average of that of each resources or pollutants in the region. That:

$$REPI_{ij} = \frac{x_{ij} / g_j}{X_{i0} / G_0} \quad (1)$$

In formula (1), $REPI_{ii}$ is the performance index of i resource consumption or pollutant emission in j region. X_{ii} is the total value of i resource consumption or pollutant emission in j region. g_j is the GDP of j area. X_{i0} is the total value of i resource consumption or pollutant emission in the whole country, G_0 is the national GDP. x/g and X/G are used to describe a region and the national resource consumption intensity or pollution emission intensity. That is, the amount of resource consumption or pollutant emissions of the production unit GDP. The division of the two represents the ratio between the region and the National Unit GDP resource consumption or pollution emissions. If the $REPI_{ii}$ is less than 1, the resource and environmental performance of a region is better than the national average level, the lower the $REPI_{ii}$ index is, the higher the resource saving degree or the lower environmental pollution, the higher the performance level. If the $REPI_{ii}$ is greater than 1, the resource and environmental performance of a region is inferior to the national average level, the higher the $REPI_{ii}$ index, the lower the resource saving degree or the higher environmental pollution, the lower the performance level [3].

$$REPI_j = \frac{1}{n}\sum_i^n w_{ij} \frac{x_{ij} / g_j}{X_{i0} / G_0} \quad (2)$$

In equation (2), $REPI_i$, a weighted average of several resources or pollutant performance indicators, is the resource and environmental comprehensive performance index of the j region considering several resource consumption and pollutant emission. w_{ii} is the weight of the i resource consumption or pollutant in area j. In this empirical study, we adopt the idea of determining the weight in "Resource and Environmental Performance Assessment" of Zhi-Yuan Biao, and take same weight of various resource consumption and pollutant discharge [2]. i is the i resource consumption or pollutant discharge, n is the number of indicators. In the formula (2), the x_{ij}, g_i, X_{io}, G_0 meaning is the same as formula (1).

3.2 Determination of Evaluation Index

In this paper, REPI is applied to comprehensively analyze the performance of resources and environment in China's provinces and regions. The comprehensive performance index of resource and environment includes resource performance index and environmental performance index. The resource performance index is measured by energy consumption intensity Index, and the environmental performance index is measured by the emission intensity index of waste water, exhaust gas and solid waste. Chemical Oxygen Demand (COD) is an important indicator of wastewater. Smaller the performance index of COD emission, the lighter the water pollution. SO_2 is an indicator of gas emissions, the smaller the SO_2 emission intensity index, the smaller the air pollution. For industrial solid waste pollution, the smaller the index, the less pollution degree of solid waste. The main indicators are as follows:

Table 1: Evaluation indexes of resources and environmental performance

First level indicators	Second-level indicators	Third-level indicators
Resource and environmental performance	Wastewater discharge intensity	COD emission intensity
	Exhaust gas emission intensity	SO2 emission intensity
	Solid waste emission intensity	Industrial solid waste emission intensity
	Resource consumption intensity	Energy consumption intensity

3.3 Empirical analysis

In this paper, we select 30 provinces except Tibet for comparative study due to the availability of data acquisition. In order to ensure the reliability, all data were collected from the China Statistical Yearbook, China Environmental Statistical Yearbook, and China Energy Statistical Yearbook from 2006 to 2016. According to the indexes in Table 1 and Formulas (1) and (2), we can calculate the performance value of each index of each province in our country. In order to understand the spatial difference, this paper analyses the resource and environmental performance of the eastern, central and western regions, in which the value is calculated based on the average value of the provinces it contains.

3.3.1 Time series analysis of resources and environmental performance in China

The index of resource and environmental performance is a relative index, which reflects the social saving level through resource utilization and reduction of pollutant emission intensity. The average level of China's 30 provinces can be obtained by averaging the resource and environmental performance indices. The results of the Resource and environmental performance index in 2005-2015 are shown in table 2 and Figure 1. We can see, during the 2005-2015, the comprehensive performance index of China's resources and environment showed the trend of "N" shape, in which it increased gradually in 2005-2010, which meaning that the rapid economic growth accompanied with large resource consumption and environmental pollution leading to the further deterioration of the resource and environment. With the implementation of National policy of Energy Conservation and Environmental protection, the comprehensive performance index of China's resources and environment decreased slightly in 2011-2012, and the performance of resources and environment were improved at a certain extent, which worsened in 2014 and 2015. On the whole, China's rapid economic growth, industrialization and urbanization have brought great pressure on the resource and environment, the ecological environment is still relatively fragile, the dual constraints of resources and environment is still a serious challenge to China economic development.

Table 2: China's resource and environmental performance in 2005-2015

Indicators	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Annual change rate
Comprehensive performance of resource and environment	1.239	1.262	1.286	1.293	1.287	1.313	1.309	1.279	1.275	1.283	1.331	0.007318
Performance of COD	1.213	1.219	1.246	1.220	1.224	1.198	1.120	1.111	1.121	1.126	1.151	-0.00492
Performance of SO2	1.335	1.359	1.382	1.338	1.343	1.321	1.329	1.315	1.325	1.328	1.360	0.001991
Performance of solid waste	1.235	1.249	1.270	1.236	1.248	1.243	1.477	1.458	1.478	1.486	1.584	0.026755
Performance of Energy consumption	1.175	1.220	1.246	1.378	1.334	1.488	1.311	1.232	1.177	1.191	1.231	0.007069

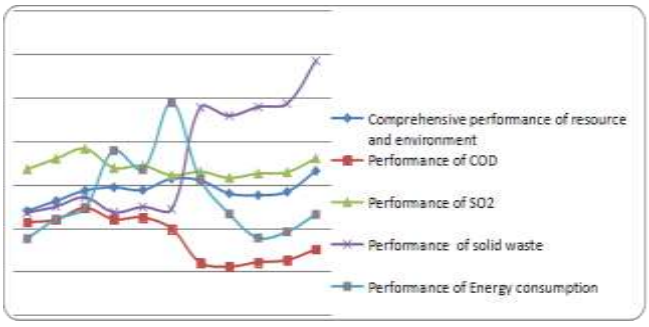

Figure 1: The trend of China's resource and environmental performance index in the 2005-2015

For the reason, poor resources and environmental performance in China is mainly due to the high emission intensity of waste gas and industrial solid waste, especially the rapid rise of industrial solid waste emission intensity since 2011, which is worthy of concern; the intensity of SO_2 emission in 2010-2014 has not changed much, but it has increased significantly in 2015; The intensity of COD emission was unstable before 2010. In 2011, the performance of waste water discharge has been greatly improved, and then slightly worse. For energy consumption, due to the rapid development of resource-oriented industry, the energy consumption unit GDP was rapidly increased before 2010, and then significantly improved under the policy of National Energy Saving Festival and platoon, but the energy consumption indices increased in 2014 and 2015.

3.3.2 Regional Comparison of Resource and environmental performance

In order to clarify the spatial difference of resource and environmental performance in China, we analyze from the eastern, central and western regions, as shown in table 3. It can be seen that the comprehensive performance of

resources and environment has obvious spatial difference, and the eastern region is obviously lower than the central and western region. In the past 11 years, the comprehensive performance index of resources and environment in the eastern region has been around 0.7, the central region fluctuating at 1.3, while the western region fluctuates at 1.9 and has a growing trend. The comprehensive performance index of resources and environment in the central and western regions was significantly greater than 1, indicating that the relative pollution and energy consumption of unit GDP are higher, the lower resource saving degree and the higher environmental pollution, the lower of performance. Especially in the western region, the proportion of heavy industry or energy industry is large, which in turn leads to high energy consumption and heavy pollution. In addition, in 2005-2015, the spatial differences between the central and eastern regions were basically stable, but the differences in the western region have become larger after 2010.

Table 3: Regional resource and environmental performance indicators for 2005-2015

Region	Indicators	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
East	Comprehensive performance of resource and environment	0.689	0.694	0.714	0.743	0.734	0.742	0.721	0.709	0.700	0.700	0.708
	Performance of COD	0.703	0.705	0.733	0.728	0.725	0.700	0.731	0.732	0.737	0.736	0.740
	Performance of SO_2	0.566	0.566	0.586	0.570	0.561	0.557	0.562	0.564	0.566	0.563	0.576
	Performance of solid waste	0.686	0.676	0.690	0.688	0.691	0.691	0.658	0.663	0.665	0.666	0.661
	Performance of Energy consumption	0.798	0.829	0.847	0.985	0.960	1.022	0.934	0.878	0.834	0.834	0.854
Central	Comprehensive performance of resource and environment	1.238	1.252	1.265	1.312	1.306	1.278	1.237	1.214	1.231	1.251	1.307
	Performance of COD	1.305	1.327	1.357	1.336	1.334	1.297	1.348	1.336	1.361	1.376	1.418
	Performance of SO_2	1.117	1.126	1.148	1.131	1.159	1.119	1.129	1.126	1.157	1.180	1.233
	Performance of solid waste	1.405	1.396	1.383	1.403	1.398	1.292	1.236	1.239	1.314	1.338	1.445
	Performance of Energy consumption	1.124	1.161	1.174	1.376	1.333	1.406	1.238	1.157	1.094	1.111	1.133
West	Comprehensive performance of resource and environment	1.792	1.836	1.873	1.830	1.826	1.907	1.949	1.895	1.882	1.888	1.973
	Performance of COD	1.656	1.655	1.679	1.629	1.644	1.624	1.345	1.326	1.331	1.333	1.368
	Performance of SO2	2.262	2.321	2.349	2.256	2.259	2.231	2.241	2.202	2.206	2.201	2.236
	Performance of solid waste	1.660	1.715	1.767	1.664	1.694	1.759	2.472	2.411	2.409	2.414	2.609
	Performance of Energy consumption	1.588	1.653	1.696	1.771	1.707	2.015	1.740	1.642	1.581	1.605	1.679

For the eastern region, energy consumption and pollution emissions are lower, especially the SO2 and the solid waste performance index, indicating that there is a significant advantage in waste and solid waste emissions, while the energy consumption intensity is relatively high. For central region, performance index of COD and solid waste is high, and the high discharge intensity of waste water and solid waste are the main restricting factor to its resource and environmental performance. For western region, the energy consumption and pollutant emission intensity are greatly higher, the comprehensive performance of the resource environment is so poor, especially the SO2 emission intensity, which will be the core monitoring and governance field for sustainable development in the future.

3.3.3 A comparative study on the resource and environmental performance of 30 provinces

The resource and environmental performance indices of 30 provinces in China are shown in the following table.

The provinces with a comprehensive performance value of less than 0.5 are Beijing, Shanghai, Tianjin, Guangdong, Zhejiang, Jiangsu, these provinces all belong to the eastern region, the resource environment is higher, and performance is excellent.

The provinces with comprehensive performance index value of 0.5-1.0 are Fujian, Hainan, Hubei, Chongqing, Shandong, Hunan respectively. The resources and environment performance of these regions is good. The comprehensive performance index value is 1.0-2.0 in the provinces of Sichuan, Guangxi, Henan, Anhui, Jilin, Shaanxi, Jiangxi, Liaoning, Yunnan, Heilongjiang, Hebei and Guizhou, all of which belong to the central and western regions, and the performance is general, which needs further improvement. The provinces with comprehensive performance index value greater than 2.0 are Gansu, Inner Mongolia, Xinjiang, Shanxi, Ningxia and Qinghai, except Shanxi in the central region, all of which belong to the western region, the resource consumption and pollutant emission intensity are generally higher, and the performance is poor, which belongs to the area that the future development needs to focus and strengthen.

Table 4: Resources and environmental performance index in 30 provinces of China in 2005-2015

Provinces	Indicators	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Beijing	Comprehensive performance of resource and environment	0.309	0.300	0.281	0.302	0.295	0.298	0.263	0.252	0.238	0.230	0.217
	Performance of COD	0.220	0.208	0.212	0.220	0.222	0.217	0.233	0.233	0.232	0.222	0.216
	Performanceof SO2	0.200	0.184	0.169	0.153	0.154	0.154	0.133	0.134	0.130	0.121	0.114
	Performance of solid waste	0.247	0.242	0.199	0.175	0.175	0.154	0.105	0.101	0.097	0.095	0.065
	Performance of Energy consumption	0.568	0.564	0.546	0.660	0.629	0.667	0.580	0.539	0.492	0.484	0.475
Tianjin	Comprehensive performance of resource and environment	0.537	0.549	0.555	0.571	0.548	0.563	0.497	0.482	0.453	0.454	0.449
	Performance of COD	0.496	0.493	0.511	0.479	0.483	0.477	0.408	0.397	0.390	0.382	0.390
	Performance of SO2	0.499	0.483	0.510	0.492	0.496	0.482	0.451	0.444	0.439	0.434	0.414
	Performance of solid waste	0.401	0.419	0.410	0.370	0.345	0.346	0.235	0.232	0.201	0.218	0.196
	Performance of Energy consumption	0.755	0.800	0.790	0.944	0.868	0.946	0.895	0.855	0.783	0.783	0.796
Hebei	Comprehensive performance of resource and environment	1.413	1.335	1.446	1.467	1.484	1.628	1.703	1.691	1.692	1.714	1.670
	Performance of COD	0.874	0.922	0.959	0.914	0.904	0.893	1.109	1.132	1.171	1.210	1.250
	Performance of SO2	1.097	1.144	1.201	1.156	1.146	1.143	1.271	1.288	1.322	1.319	1.371
	Performance of solid waste	2.265	1.797	2.113	2.075	2.182	2.664	2.791	2.816	2.778	2.818	2.487
	Performance of Energy consumption	1.416	1.476	1.510	1.721	1.703	1.813	1.643	1.530	1.496	1.507	1.573
Shanxi	Comprehensive performance of resource and environment	2.403	2.363	2.343	2.480	2.470	2.434	2.386	2.425	2.616	2.773	2.964
	Performance of COD	1.211	1.220	1.215	1.187	1.279	1.208	0.853	0.878	0.926	0.971	0.978
	Performance of SO2	2.633	2.570	2.520	2.462	2.717	2.566	2.747	2.742	2.901	3.088	3.237
	Performance of solid waste	3.683	3.507	3.529	3.725	3.429	3.404	3.717	3.936	4.399	4.680	5.220
	Performance of Energy consumption	2.086	2.155	2.109	2.545	2.455	2.560	2.228	2.145	2.239	2.354	2.421
Inner Mongolia	Comprehensive performance of resource and environment	2.036	1.985	1.941	1.842	1.815	1.933	1.921	1.911	1.829	1.972	2.204
	Performance of COD	1.008	0.927	0.876	0.798	0.781	0.786	1.253	1.241	1.297	1.339	1.445
	Performance of SO2	2.740	2.671	2.482	2.319	2.264	2.258	2.165	2.225	2.351	2.409	2.545
	Performance of solid waste	2.627	2.551	2.629	2.101	2.128	2.496	2.490	2.505	2.167	2.581	3.135
	Performance of Energy consumption	1.770	1.791	1.776	2.152	2.086	2.193	1.776	1.674	1.500	1.558	1.693
Liaoning	Comprehensive performance of resource and environment	1.309	1.396	1.418	1.433	1.383	1.303	1.404	1.334	1.304	1.365	1.519
	Performance of COD	1.061	1.059	1.100	1.034	1.011	0.979	1.183	1.172	1.170	1.193	1.255
	Performance of SO2	1.093	1.148	1.210	1.139	1.090	1.047	1.118	1.087	1.105	1.133	1.246
	Performance of solid waste	1.773	2.025	1.977	1.948	1.938	1.604	1.928	1.803	1.795	1.980	2.371
	Performance of Energy consumption	1.308	1.352	1.385	1.611	1.494	1.580	1.386	1.272	1.145	1.152	1.205
Jilin	Comprehensive performance of resource and environment	1.098	1.120	1.117	1.137	1.081	1.090	1.082	1.012	0.983	1.009	1.066
	Performance of COD	1.488	1.499	1.480	1.409	1.354	1.355	1.527	1.471	1.484	1.511	1.588
	Performance of SO2	0.777	0.812	0.827	0.809	0.786	0.777	0.862	0.862	0.856	0.880	0.951
	Performance of solid waste	0.946	0.949	0.906	0.893	0.927	0.918	0.771	0.651	0.642	0.708	0.803
	Performance of Energy consumption	1.179	1.219	1.253	1.439	1.256	1.311	1.167	1.063	0.951	0.938	0.923
Heilong jiang	Comprehensive performance of resource and environment	0.935	0.983	1.036	1.103	1.171	1.135	1.352	1.352	1.371	1.428	1.571
	Performance of COD	1.210	1.233	1.344	1.386	1.470	1.430	2.453	2.441	2.546	2.657	2.847
	Performance of SO2	0.677	0.707	0.794	0.838	0.900	0.894	0.915	0.959	0.990	1.024	1.115
	Performance of solid waste	0.811	0.912	0.895	0.904	1.051	0.894	0.725	0.757	0.770	0.830	1.041
	Performance of Energy consumption	1.043	1.078	1.113	1.286	1.261	1.324	1.317	1.252	1.177	1.202	1.282
Shanghai	Comprehensive performance of resource and environment	0.441	0.446	0.460	0.493	0.463	0.470	0.376	0.373	0.372	0.350	0.343
	Performance of COD	0.436	0.439	0.461	0.459	0.442	0.427	0.254	0.268	0.276	0.267	0.244
	Performance of SO2	0.408	0.408	0.436	0.436	0.397	0.394	0.276	0.289	0.291	0.260	0.251
	Performance of solid waste	0.296	0.283	0.267	0.280	0.256	0.244	0.193	0.179	0.173	0.162	0.156
	Performance of Energy consumption	0.625	0.656	0.678	0.798	0.755	0.815	0.781	0.757	0.750	0.711	0.723
Jiangsu	Comprehensive performance of resource and environment	0.578	0.581	0.577	0.597	0.583	0.582	0.513	0.497	0.498	0.488	0.478
	Performance of COD	0.688	0.658	0.670	0.665	0.652	0.635	0.497	0.494	0.491	0.474	0.464
	Performance of SO2	0.542	0.508	0.513	0.502	0.491	0.479	0.473	0.468	0.464	0.453	0.439
	Performance of solid waste	0.431	0.479	0.435	0.419	0.399	0.375	0.323	0.311	0.333	0.332	0.320
	Performance of Energy consumption	0.651	0.679	0.689	0.800	0.790	0.841	0.759	0.717	0.705	0.694	0.688
Zhejiang	Comprehensive performance of resource and environment	0.490	0.498	0.507	0.539	0.538	0.533	0.475	0.470	0.471	0.476	0.475
	Performance of COD	0.587	0.580	0.588	0.607	0.611	0.586	0.496	0.506	0.509	0.507	0.491
	Performance of SO2	0.471	0.464	0.465	0.475	0.481	0.463	0.452	0.461	0.460	0.466	0.462
	Performance of solid waste	0.261	0.285	0.296	0.296	0.291	0.264	0.209	0.211	0.208	0.224	0.219
	Performance of Energy consumption	0.643	0.663	0.679	0.779	0.770	0.821	0.746	0.701	0.708	0.709	0.729
Anhui	Comprehensive performance of resource and environment	0.962	1.013	1.057	1.139	1.123	1.076	1.018	1.000	0.996	0.993	1.041
	Performance of COD	1.099	1.148	1.198	1.183	1.152	1.110	1.220	1.197	1.200	1.192	1.220
	Performance of SO2	0.784	0.810	0.850	0.864	0.843	0.814	0.763	0.770	0.767	0.771	0.804
	Performance of solid waste	1.093	1.191	1.246	1.437	1.441	1.270	1.137	1.147	1.139	1.138	1.244
	Performance of Energy consumption	0.873	0.902	0.933	1.071	1.056	1.110	0.953	0.887	0.877	0.871	0.894
Fukjian	Comprehensive performance of resource and environment	0.698	0.708	0.718	0.766	0.777	0.784	0.610	0.659	0.668	0.594	0.588
	Performance of COD	0.796	0.801	0.810	0.845	0.839	0.844	0.757	0.747	0.743	0.735	0.723
	Performance of SO2	0.517	0.523	0.528	0.545	0.541	0.525	0.489	0.481	0.483	0.483	0.480
	Performance of solid waste	0.802	0.809	0.801	0.834	0.888	0.871	0.381	0.643	0.712	0.397	0.400
	Performance of Energy consumption	0.675	0.698	0.732	0.840	0.842	0.897	0.814	0.763	0.734	0.761	0.748
Jiangxi	Comprehensive performance of resource and environment	1.442	1.402	1.395	1.399	1.405	1.327	1.170	1.142	1.161	1.133	1.160
	Performance of COD	1.493	1.513	1.581	1.545	1.553	1.522	1.284	1.288	1.296	1.286	1.319
	Performance of SO2	1.110	1.116	1.172	1.151	1.162	1.114	1.101	1.119	1.133	1.109	1.164
	Performance of solid waste	2.406	2.221	2.063	1.974	1.990	1.706	1.473	1.412	1.459	1.362	1.351
	Performance of Energy consumption	0.757	0.759	0.764	0.925	0.914	0.968	0.823	0.751	0.755	0.775	0.805
Shandong	Comprehensive performance of resource and environment	0.743	0.743	0.748	0.771	0.772	0.787	0.869	0.849	0.814	0.820	0.843
	Performance of COD	0.555	0.532	0.546	0.531	0.522	0.529	0.855	0.856	0.854	0.841	0.860
	Performance of SO2	0.801	0.760	0.774	0.753	0.740	0.742	0.889	0.892	0.876	0.873	0.893
	Performance of solid waste	0.696	0.728	0.712	0.706	0.714	0.702	0.653	0.602	0.604	0.639	0.659
	Performance of Energy consumption	0.921	0.951	0.961	1.096	1.113	1.174	1.081	1.045	0.923	0.929	0.960
Henan	Comprehensive performance of resource and environment	0.958	0.981	1.002	1.022	1.031	1.016	1.030	1.017	1.023	1.017	1.011

	Performance of COD	0.902	0.897	0.904	0.874	0.878	0.895	1.044	1.050	1.066	1.059	1.072
	Performance of SO2	1.127	1.114	1.141	1.109	1.097	1.096	1.123	1.100	1.136	1.119	1.140
	Performance of solid waste	0.813	0.874	0.907	0.891	0.948	0.795	0.820	0.846	0.919	0.901	0.834
	Performance of Energy consumption	0.990	1.038	1.058	1.215	1.201	1.277	1.131	1.074	0.973	0.991	0.998
Hubei	Comprehensive performance of resource and environment	0.973	1.011	0.997	1.029	1.002	1.008	0.897	0.858	0.826	0.809	0.788
	Performance of COD	1.239	1.263	1.260	1.251	1.214	1.196	1.101	1.089	1.085	1.059	1.029
	Performance of SO2	0.801	0.847	0.830	0.814	0.783	0.749	0.748	0.714	0.708	0.695	0.688
	Performance of solid waste	0.781	0.820	0.772	0.744	0.734	0.731	0.587	0.562	0.602	0.578	0.550
	Performance of Energy consumption	1.071	1.115	1.128	1.310	1.277	1.355	1.153	1.067	0.909	0.901	0.885
Hunan	Comprehensive performance of resource and environment	1.130	1.147	1.175	1.183	1.168	1.140	0.963	0.908	0.875	0.848	0.855
	Performance of COD	1.796	1.845	1.872	1.852	1.775	1.660	1.299	1.271	1.290	1.276	1.288
	Performance of SO2	1.024	1.030	1.049	1.001	0.980	0.944	0.769	0.743	0.762	0.752	0.760
	Performance of solid waste	0.711	0.695	0.743	0.657	0.667	0.617	0.654	0.602	0.579	0.507	0.517
	Performance of Energy consumption	0.990	1.020	1.036	1.221	1.248	1.340	1.130	1.016	0.869	0.857	0.853
Guangdong	Comprehensive performance of resource and environment	0.447	0.440	0.458	0.498	0.493	0.504	0.481	0.480	0.472	0.467	0.461
	Performance of COD	0.621	0.607	0.626	0.634	0.631	0.622	0.693	0.704	0.706	0.691	0.680
	Performance of SO2	0.422	0.405	0.415	0.425	0.427	0.432	0.351	0.357	0.357	0.351	0.343
	Performance of solid waste	0.179	0.166	0.187	0.221	0.206	0.203	0.167	0.172	0.173	0.165	0.161
	Performance of Energy consumption	0.565	0.582	0.607	0.713	0.710	0.760	0.712	0.686	0.654	0.660	0.660
Guangxi	Comprehensive performance of resource and environment	1.890	1.880	1.896	1.925	1.900	1.838	1.070	1.067	1.041	1.059	1.006
	Performance of COD	3.557	3.626	3.570	3.489	3.438	3.266	1.325	1.335	1.336	1.332	1.305
	Performance of SO2	1.889	1.777	1.831	1.813	1.809	1.785	0.981	0.987	0.956	0.971	0.924
	Performance of solid waste	1.220	1.188	1.201	1.297	1.256	1.116	0.962	1.003	0.970	1.014	0.870
	Performance of Energy consumption	0.896	0.928	0.981	1.102	1.098	1.186	1.011	0.944	0.904	0.918	0.926
Hainan	Comprehensive performance of resource and environment	0.608	0.639	0.685	0.734	0.739	0.714	0.741	0.716	0.721	0.738	0.740
	Performance of COD	1.403	1.457	1.581	1.620	1.656	1.492	1.551	1.541	1.563	1.571	1.564
	Performance of SO2	0.180	0.195	0.223	0.199	0.210	0.264	0.285	0.305	0.300	0.304	0.322
	Performance of solid waste	0.197	0.204	0.194	0.246	0.208	0.176	0.253	0.222	0.240	0.291	0.239
	Performance of Energy consumption	0.654	0.699	0.741	0.872	0.883	0.925	0.875	0.794	0.780	0.786	0.835
Chongqing	Comprehensive performance of resource and environment	1.104	1.125	1.160	1.200	1.175	1.152	0.953	0.898	0.851	0.825	0.798
	Performance of COD	1.028	1.039	1.051	1.009	1.003	0.987	0.815	0.787	0.783	0.760	0.745
	Performance of SO2	1.774	1.867	1.935	1.859	1.801	1.716	1.293	1.263	1.260	1.205	1.163
	Performance of solid waste	0.714	0.654	0.687	0.670	0.669	0.614	0.500	0.448	0.454	0.425	0.377
	Performance of Energy consumption	0.901	0.938	0.969	1.263	1.227	1.291	1.205	1.093	0.908	0.911	0.906
Sichuan	Comprehensive performance of resource and environment	1.252	1.271	1.312	1.325	1.284	1.316	1.083	1.044	1.026	1.037	1.003
	Performance of COD	1.405	1.426	1.427	1.438	1.444	1.438	1.212	1.185	1.187	1.196	1.217
	Performance of SO2	1.293	1.250	1.222	1.254	1.265	1.244	0.946	0.924	0.906	0.910	0.880
	Performance of solid waste	1.211	1.266	1.406	1.232	1.040	1.121	0.914	0.907	0.969	0.987	0.859
	Performance of Energy consumption	1.097	1.141	1.192	1.376	1.390	1.460	1.260	1.158	1.045	1.054	1.055
Guizhou	Comprehensive performance of resource and environment	3.034	3.202	3.082	2.976	2.971	2.963	2.409	2.194	2.035	1.853	1.712
	Performance of COD	1.490	1.506	1.539	1.507	1.508	1.507	1.175	1.083	1.037	0.989	0.934
	Performance of SO2	4.976	5.313	5.220	4.776	4.736	4.718	4.273	3.877	3.588	3.259	2.995
	Performance of solid waste	3.372	3.607	3.195	2.758	3.201	3.050	2.020	1.878	1.859	1.578	1.408
	Performance of Energy consumption	2.297	2.383	2.372	2.865	2.438	2.575	2.167	1.937	1.658	1.585	1.510
Yunnan	Comprehensive performance of resource and environment	1.330	1.447	1.512	1.580	1.611	1.606	1.840	1.691	1.635	1.565	1.530
	Performance of COD	1.089	1.132	1.188	1.192	1.209	1.239	1.221	1.186	1.181	1.169	1.155
	Performance of SO2	1.108	1.172	1.224	1.213	1.276	1.310	1.715	1.664	1.648	1.621	1.580
	Performance of solid waste	1.876	2.168	2.288	2.358	2.406	2.229	2.955	2.555	2.486	2.235	2.171
	Performance of Energy consumption	1.247	1.314	1.346	1.557	1.553	1.647	1.469	1.360	1.227	1.234	1.213
Shaanxi	Comprehensive performance of resource and environment	1.379	1.353	1.364	1.364	1.249	1.232	1.105	1.031	1.019	1.043	1.116
	Performance of COD	1.180	1.152	1.171	1.098	1.064	1.014	0.872	0.827	0.819	0.801	0.837
	Performance of SO2	1.722	1.756	1.763	1.674	1.552	1.454	1.617	1.490	1.463	1.440	1.504
	Performance of solid waste	1.625	1.463	1.465	1.406	1.162	1.167	0.862	0.820	0.848	0.971	1.085
	Performance of Energy consumption	0.988	1.042	1.055	1.277	1.217	1.293	1.070	0.988	0.944	0.959	1.037
Gansu	Comprehensive performance of resource and environment	1.657	1.642	1.709	1.614	1.623	1.877	2.008	1.932	1.878	1.930	2.081
	Performance of COD	1.249	1.203	1.260	1.303	1.356	1.357	1.546	1.536	1.530	1.532	1.660
	Performance of SO2	2.139	2.034	2.120	2.180	2.328	2.531	2.742	2.585	2.611	2.746	3.098
	Performance of solid waste	1.620	1.648	1.709	1.698	1.592	1.558	1.970	1.939	1.712	1.776	1.798
	Performance of Energy consumption	1.619	1.684	1.747	1.277	1.217	2.063	1.772	1.666	1.660	1.664	1.767
Qinghai	Comprehensive performance of resource and environment	1.822	1.952	2.095	1.951	1.993	2.311	4.203	4.116	4.170	4.188	4.813
	Performance of COD	1.745	1.774	1.859	1.771	1.924	2.053	1.209	1.222	1.245	1.279	1.330
	Performance of SO2	1.677	1.701	1.839	1.822	1.978	2.008	2.068	2.073	2.172	2.185	2.300
	Performance of solid waste	1.664	1.969	2.179	2.206	2.133	2.263	10.906	10.669	10.701	10.667	12.892
	Performance of Energy consumption	2.203	2.365	2.503	2.006	1.936	2.920	2.631	2.501	2.560	2.621	2.727
Ningxia	Comprehensive performance of resource and environment	2.940	3.024	3.042	2.788	2.687	3.042	2.944	2.825	2.899	3.021	3.048
	Performance of COD	3.087	2.964	2.918	2.649	2.527	2.403	2.176	2.171	2.189	2.241	2.234
	Performance of SO2	4.102	4.464	4.405	3.983	3.661	3.476	4.307	4.432	4.425	4.469	4.528
	Performance of solid waste	1.635	1.594	1.751	1.596	1.769	2.501	2.411	2.077	2.320	2.654	2.469
	Performance of Energy consumption	2.936	3.074	3.094	2.925	2.793	3.788	2.881	2.618	2.661	2.718	2.960
Xinjiang	Comprehensive performance of resource and environment	1.263	1.314	1.491	1.563	1.779	1.711	1.909	2.142	2.317	2.281	2.392
	Performance of COD	1.379	1.453	1.607	1.661	1.832	1.816	1.993	2.018	2.035	2.028	2.183
	Performance of SO2	1.464	1.529	1.802	1.926	2.174	2.046	2.547	2.707	2.889	3.000	3.078
	Performance of solid waste	0.693	0.752	0.933	0.979	1.283	1.234	1.197	1.724	2.017	1.661	1.632
	Performance of Energy consumption	1.515	1.521	1.620	1.684	1.827	1.746	1.898	2.118	2.328	2.434	2.676

As can be seen from table 4, although the provinces in western regions accounted for only 1/3, the relative pollution and energy consumption of unit GDP were higher, thus the resource and environmental performance index value was significantly higher than that of the eastern regions, slightly higher than the central

region. Before 2013, the COD performance index and SO_2 performance index of 30 regions showed a slight downward trend, but the performance index of energy consumption and the industrial solid waste emissions showed upward trend, the solid waste performance index was especially significant. In 2013-2015, all the indicators were on an upward trend, and the environmental pollution situation is not optimistic. Among them, COD performance index, SO_2 performance index is higher than the national mean value includes the provinces of Hainan in eastern region, the central region of Shanxi, Jilin, Heilongjiang, Jiangxi, Hunan provinces and all the provinces in the western region. The industrial solid waste performance index is higher than the national average has 10 provinces, of which 6 are in the western region, except Hebei and Liaoning provinces in the east, Shanxi and Jiangxi provinces in central. Among them, the waste pollution in Qinghai has been especially serious in recent years, since 2011, the index rose from 2.26 in 2010 to 10.91, and has been growing quickly. For energy performance index, whose value is higher or close to the national average are Hebei, Liaoning, Shanxi and provinces in western regions. In these places, the steel industry and building materials industry accounted for a larger proportion and recently rising gradually.

In addition, there is a strong relationship between the industrial structure and regional resources and environmental performance. For the provinces or cities, tertiary industry accounts for a higher proportion or industrial structure is relatively light, with lower energy consumption and less environmental pollution, and all the indicators are lower, such as the Beijing, Tianjin, Shanghai area and Jiangsu, Zhejiang, Guangdong and other places. Secondly, the province is in the period of accelerated industrialization, or heavy industry-oriented, their pollution are heavier, performance of resource environment is poor, such as Hebei, Liaoning and the western region. Hebei province is in the stage of heavy industry developed quickly, and its output value of iron and steel industry is the first province in the country. In 2015, the heavy industrial output accounted for 76% of the gross industrial output value. It is obviously too high whether compared with the national average level or the developed provinces, which makes Hebei become the most polluted province in the whole country. Liaoning is the main producing province of steel industry and building material industry. These two industries are the main sources of industrial pollution and high energy consumption. The industrial structure of energy and chemical industry is the main cause of high pollution and high energy consumption in the western region. Compared with other western provinces, the industrial structure of Sichuan, Chongqing and Guangxi in the western region is lighter than that of other provinces in western China, and the performance of resources and environment is excellent or good. Except that the performance index of energy consumption shows a slight increase, the other four indexes all show the downward trend. And the western heavy chemical industry dominated Inner Mongolia and Xinjiang, as well as Gansu and Qinghai, almost all indicators show a rising trend of fluctuation. The performance index of energy consumption in Guizhou and Qinghai is 1.7 to 2.0 times higher than the average of 30 regions, and more than 3 times higher than that of Guangdong and Jiangsu. In Qinghai, the performance index of solid waste is 4.6 times higher than that of the whole country, more than 34 times higher than Guangdong province, and the environmental comprehensive Performance index is more than 2 times higher than that of 30 regions, and is about 5 times higher than Jiangsu and Guangdong. This shows that the western gap is still large.

Furthermore, industrial policies and environmental policies have a strong impact on regional resources and environmental performance. Even if the original environment is good, the rate of environmental disruption will be greatly accelerated if environmental protection cannot be put at the forefront of economic development. For example, Hainan was originally a region with excellent environmental protection. But in the past ten years, a number of major industrial projects such as oil refining, methanol, office paper have been gradually built, heavy industry gradually developed, industrial pollution emission intensity gradually increased. From the table above, since 2006, air pollution in Hainan has worsened, especially COD performance index is much higher than the national average. It is worth pondering that blindly pursue the rapid development of industry, and disregard the long-term sustainable development of society, then the future of environmental governance will be a big burden of local economic development. As for Shaanxi, which is dominated by energy and chemical industry, in recent years, it attaches great importance to the problem of environmental pollution, spends huge sums of money on resources and environmental governance, and the governance investment ranked the first one in the western region of China, so that the environmental condition has been greatly improved, and the indicators' index are showing a downward trend.

4. Conclusions and suggestions

Resources and environment are the two basic elements of sustainable development, and their restrictions on economic development are becoming more and more obvious. In this paper, based on the panel date, the comprehensive performance index of resources and environment is used to evaluate the performance of resources and environment in 30 provinces of China from 2005 to 2015, and the results show that: (1) China's resource and environmental performance index shows "N" shape, the ecological carrying capacity is overloaded, and the ecological fragility is obvious. The larger emission intensity of waste gas and industrial solid waste is the main restricting factor that leads to poor resource and environmental performance in China. (2) The performance of resources and environment has significant spatial characteristics, and the provincial differences are obvious, the eastern region is superior to the central region, the central region is superior to the western region, and the difference between the western region and other regions became larger after 2010. (3) According to the comprehensive resources and environmental performance index of 30 provinces, it can be divided into four gradients, in which the provinces with excellent resource and

environmental performance are concentrated in the eastern region, and the provinces with poor resources and environment performance are concentrated in the western region, which is the core area of need future attention and improvement. (4) There is a strong correlation between industrial structure, resource environmental policy and regional resource and environmental performance.

Overall, the resources and environmental pressure in the eastern region is relatively light, but the performance of the resources and environment in some provinces is declining. While the western region is in the irrational economic growth mode, the high consumption of resources and serious environmental pollution caused by low resource and environmental efficiency, which has caused great pressure to the fragile ecological environment in western region, and has become a major constraint to economic growth. In the future we must based on the status quo, strengthen the management of resource and environmental performance, promote the industrial transformation and upgrading, enhance scientific and technological innovation, shorten the developing stage of high energy consumption and pollution emission, reduce the spatial difference and narrow the gap with developed countries and regions. Firstly, taking the western region as the main area, we will strengthen the management and supervision of the resources and environmental performance and strict control of resource consumption, pollutant emission of each province. Establishing assessment and monitoring system, clarify the responsibility of people to promote the coordinated development of economy-resource-environment. Secondly, we should change the pattern of economic development and promote the optimization and upgrading of industrial structure, ensuring that economic development is within the threshold of carrying capacity of resources and environment. Besides, we should speed up transition from traditional economic growth mode dominated by resource dependence to recycling economy. Adjusting the industrial structure features of "heavy characteristics, high energy consumption and heavy pollution" especially in the central and western region, and eliminating high-energy-consumption and low-output industries, accelerating the development of high-added value equipment manufacturing industry, low-energy consumption and low-pollution consumer goods industries, and service industries, so as to change "resource advantage" to "industrial advantage". We should follow the path of low-carbon and green economic development, make reasonable and orderly exploring plan for resources, and extend the industrial chain and enhance deep processing. Thirdly, promoting technological innovation, actively explore Low-carbon technology, strengthen the production process for energy conservation and environmental protection, develop new equipment in high energy consumption and high pollution industry, as well as waste treatment and resources recycling, striving to achieve a breakthrough in the ecological development, improve economic efficiency and effectiveness, in turn to reduce resource consumption and pollution emissions. Accelerating the new biotechnology and new energy technologies development, increase the proportion of renewable energy resources in supply, break the constraints of resources on economic development. Fourthly, each provinces should based on their own problems of resources and environment, determining their resources and environmental performance's shortage, and take measures in energy consumption or pollutant emission, actively explore their own coupling development path of economy-resource-environment. Through the transformation of industrial structure to lightness, greenness and ecology, promoting coupling coordinated development of economy, resource and environment, enhancing provinces' resource and environmental performance, realizing the sustainable development of regional economy.

References

[1] Research on Sustainable Development Strategy of Chinese Academy of Sciences. China's Sustainable Development Strategy report :building a resource-conserving and environment-friendly society[M]. Beijing: Science Press, 2006.
[2] ZHI Yingbiao, WANG Zailan, et al. The domestic comparison of resource and environmental performance toward resource- efficient society of Anhui province[J]. Journal of Anhui University(Natural Sciences), 2008(05):87-90.
[3] Qiao Qiong. The Research of Natural Resources Using in Two-Oriented Society Construction[J]. Ecological Economy, 2008(11):83-86.
[4] CHEN Shaofeng. A study on the evaluation of China's resource and environmental performance in 2000-2005[J]. Scientific Management Research, 2007, 25(6): 51-53, 84.
[5] Wen Hongjian, ZhaoXia, Research on the Comprehensive Performance Evaluation of Resources and Environment in China Since 2000-- Calculation Based on REPI Index Value[J]. Development Research, 2013(10):102-105.
[6] YU Zhonghua, LIU Haibin, XIE Fangjian. A case study on Nanjing: Performance evaluation of resources and environment based on eco-efficiency in vice-provincial cities[J]. Resources & Industries, 2013, 15(02):99-103.
[7] Huang Heping, Wu Shian, et al. Dynamic Evaluations of Resources and Environmental Performance Based on Eco-efficiency: A Case Study of Jiangxi Province[J]. Resources Science, 2010, 32(05):924-931.
[8] LU Zhanyuan, ZHI Yingbiao, et al. Parallel analysis of resource and environmental performance and Its regional ecological capacity — A case study for Guangxi Zhuang Autonomous Region[J]. Ecology and Environmental Sciences, 2010, 19(08):1815-1821.
[9] ZHI Yinhiao, WANG Zailan, et al. Research on Inner Mongolia's Resource and Environmental Performance and Its Changing Trends in Recent 12 Years[J]. China Population Resources and Environment, 2013, 23(S2):42-45.
[10] LIU Surong, LI Chan, et al. A study on the impact of regional technological innovation on environmental performance -- multiple regression analysis based on REPI[J].Enterprise Science And Technology & Development, 2016(09):13-16+20.