Chapter 11
Measurement and Analysis of Carrying Potential of Natural Resources and Environment

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To accelerate the transformation of the economic development pattern, it is necessary to coordinate the development of the economy, resources and environment. In the course of economic development, much attention should be paid to the resources, ecological protection, environmental stress and climate change. The Index of Carrying Potential of Natural Resources and Environment (ICPNRE) measures the Carrying Potential of resources, ecological protection, environmental stress and climate change that underlies future economic development and human activities in a region. As one of the important elements of the Green Development Index (GDI), ICPNRE reflects the conditions of natural resources and ecology, and the impacts of human activities on natural resources, environment, ecology and climate in that region.

From a regional comparison perspective, we adopted the evaluation and weight criterion of "China Province Green Development Index System" and "China City Green Development Index System" to calculate the ICPNRE of 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) and 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan) in this chapter. Basing on the calculated results, we analyzed and depicted the characteristics and basic configuration of two indicators in these regions: Resource Abundance Status and Ecological Conservation, and Environmental Stress and Climate Change. We also compared the ICPNRE among different regions and offered our suggestions.

11.1 Calculated Results of ICPNRE

According to the measurement system and weighing criterion of Green Degree of Economic Growth (GDEG) in the "China Province Green Development Index System" and "China City Green Development Index System", the Green Index

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Group (GIG) calculated the ICPNRE of 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) and 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan), and ranked all regions basing on the scores of two indicators: Resource Abundance Status and Ecological Conservation, and Environmental Stress and Climate Change.

11.1.1 Calculated Results of Provincial ICPNRE

The calculated results of ICPNRE of 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) were shown in the following Table 11.1 based on the measurement system and weighing criterion in the "China Province Green Development Index System".

As shown in Table 11.1, the top ten provinces in the ranking of ICPNRE were Qinghai, Guizhou, Yunnan, Hainan, Heilongjiang, Inner Mongolia, Sichuan, Gansu, Xinjiang and Jiangxi. The top ten provinces in the ranking of Resource Abundance Status and Ecological Conservation Indicator were Qinghai, Inner Mongolia, Heilongjiang, Yunnan, Hainan, Sichuan, Jilin, Shanghai, Jiangxi and Guangxi. The top ten provinces in the ranking of Environmental Stress and Climate Change Indicator were Qinghai, Guizhou, Yunnan, Hainan, Gansu, Xinjiang, Heilongjiang, Sichuan, Shanxi and Inner Mongolia.

Basing on the data in Table 11.1, we drew Fig. 11.1 to show the level of ICPNRE of different provinces. The horizontal axis represented the ICPNRE value, and the origin stood for the average ICPNRE of 30 provinces. The green bar represented the regions above the average level, and the higher the ICPNRE value, the longer the green bar. On the contrary, the white bar represented the regions below the average, and the lower the ICPNRE value, the longer the white bar.

From Table 11.1, we got the general characteristics of the ICPNREs of China's 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) as follows:

(1) There were a significant regional disparity of the ICPNRE

From a national perspective, there was a significant inter-provincial disparity of the ICPNRE. The score of the No. 1 province Qinghai was over twice that of the No. 2 Guizhou and the No. 3 Yunnan. Only three provinces scored more than 0.2. Nineteen provinces scored below the national average. The range of the 30 provinces was 4.5 times of their standard deviation.

From a regional perspective, a significant disparity of the ICPNREs existed among East, Central, Northeast and West China. As shown in Fig. 11.2, the ICPNRE level of the western region was higher, compared to the lower level of the eastern and central regions, and level of the northeastern region approximated the national average. Two reasons accounted for such a regional disparity. One was that the western and

Table 11.1 ICPNRE and rankings of 30 provinces in China in 2009

Indicator	Carrying potential of natural resources and environment		Second-class indicators			
			Resource abundance and ecological protection indicators		Environmental stress and climate change indicators	
Weight	100 %		30 %		70 %	
Province	Score	Ranking	Score	Ranking	Score	Ranking
Qinghai	0.556	1	0.143	1	0.413	1
Guizhou	0.269	2	−0.026	20	0.295	2
Yunnan	0.241	3	0.078	4	0.163	3
Hainan	0.160	4	0.060	5	0.100	4
Heilongjiang	0.156	5	0.121	3	0.035	7
Inner Mongolia	0.135	6	0.130	2	0.006	10
Sichuan	0.081	7	0.052	6	0.029	8
Gansu	0.070	8	−0.022	18	0.092	5
Xinjiang	0.056	9	0.011	12	0.045	6
Jiangxi	0.019	10	0.033	9	−0.014	13
Jilin	0.011	11	0.050	7	−0.039	15
Shaanxi	−0.009	12	−0.026	19	0.016	9
Guangxi	−0.031	13	0.027	10	−0.058	20
Fujian	−0.037	14	0.023	11	−0.059	21
Hunan	−0.047	15	−0.005	13	−0.042	17
Anhui	−0.054	16	−0.058	23	0.004	11
Chongqing	−0.055	17	−0.021	17	−0.033	14
Beijing	−0.063	18	−0.062	26	−0.001	12
Zhejiang	−0.092	19	−0.007	14	−0.085	26
Hubei	−0.104	20	−0.038	21	−0.065	23
Tianjin	−0.105	21	−0.046	22	−0.059	22
Shandong	−0.108	22	−0.062	24	−0.047	19
Guangdong	−0.117	23	−0.013	15	−0.104	29
Shanghai	−0.117	24	0.040	8	−0.157	30
Hebei	−0.118	25	−0.077	29	−0.041	16
Henan	−0.121	26	−0.079	30	−0.042	18
Liaoning	−0.123	27	−0.019	16	−0.103	28
Ningxia	−0.137	28	−0.071	27	−0.066	24
Shanxi	−0.158	29	−0.074	28	−0.084	25
Jiangsu	−0.159	30	−0.062	25	−0.097	27

Notes

1. Figures in this table are calculated based on data of each indicator for 2008 and 2009 in accordance with the indicator system of CCNRE embedded in the Province Measurement System
2. Index of each province in this table is ranked in descending order

Sources China Statistical Yearbook 2010, China Statistical Yearbook 2009, Desert and Its Treatment in China, Annual Statistical Report on Environment in China 2009, and China Environmental Statistical Yearbook 2010

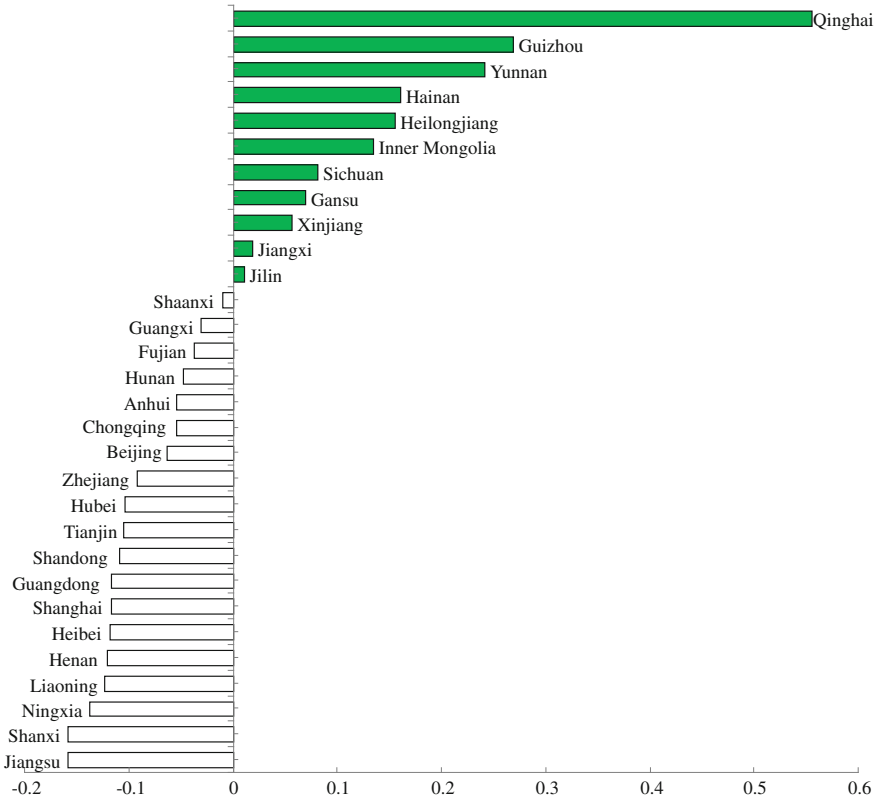

Fig. 11.1 Inter-provincial comparison of ICPNRE rankings

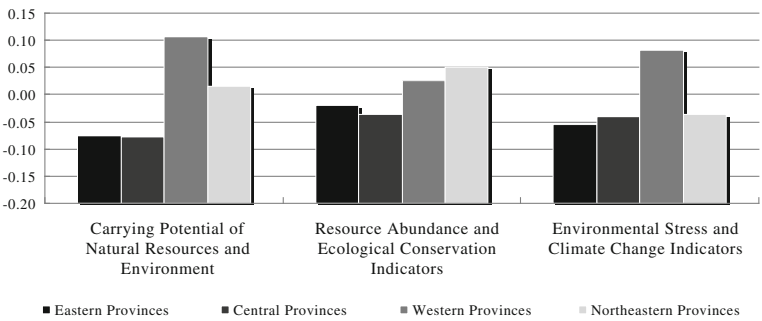

Fig. 11.2 Comparison of ICPNRE among 4 major areas in China

northeastern regions had far more resources and better ecology than the eastern and central regions. The other was that the western region was relatively better able to cope with environmental stress and climate change than the rest of the country.

From the perspective of provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) inside the four major regions, we found that, among the ten eastern provinces, except the No. 4 Hainan, Fujian, Beijing and Zhejiang all ranked in the middle as No. 14, 18 and 19; Shandong, Guangdong, Hebei, Tianjin, Jiangsu and Shanghai all ranked behind, among No. 21–29, and Jiangsu even ranked at the bottom of the list. Among the six central provinces, Jiangxi ranked forward as No. 10. Hunan, Anhui, Hubei were in the middle, ranking No. 15, 16, and 20. Henan and Shanxi ranked behind as No. 26 and 29. Among the 11 western provinces (except Tibet), Qinghai, Guizhou, Yunnan, Inner Mongolia, Sichuan, Gansu and Xinjiang all ranked among the top ten. Moreover, Qinghai, Guizhou and Yunnan ranked at top 3 and Qinghai was ahead of all provinces with the score of 0.5561. In addition, No. 12 Shanxi (−0.009) and No. 13 Guangxi (−0.031) scored slightly below the national average. Chongqing and Ningxia ranked behind as No. 17 and 28 (or the last third place). Of the three northeastern provinces, Heilongjiang was better and ranked No. 5, the No. 11 Jilin was slightly above the national average, but Liaoning lagged behind, ranking No. 27.

(2) The level of ICPNRE mainly depended on the score of Environmental Stress and Climate Change Indicator

Table 11.1 indicated that the level of ICPNRE mainly depended on the score of Environmental Stress and Climate Change Indicator. Deeper statistical analysis showed a correlation of 0.935 between the level of ICPNRE and Environmental Stress and Climate Change Indicator, higher than that between ICPNRE and Resource Abundance Status and Ecological Conservation Indicator (0.745). The key reason for such a high correlation was that the indicator reflected lots of human activities such as methods of production, pollutant discharge and treatment.

(3) There was a negative correlation to a certain degree between the level of ICPNRE and that of economic development

GDP per capita was one of the most important indexes for measuring the level of regional economic development. Through analyzing the correlation between the level of ICPNRE and that of economic development, we found a negative correlation between the two: regions with high GDP per capita had low ICPNRE levels, and vice versa (See Table 11.2).

From Table 11.2, the top five provinces with highest GDP per capita in 2009 were Shanghai, Beijing, Tianjin, Jiangsu and Zhejiang, meanwhile their level of ICPNRE were much lower than the national average. Among them, the highest one was Beijing, ranking No.18, while Jiangsu ranked at the bottom of the list. Zhejiang, Tianjin and Shanghai ranked No. 19, 21 and 24. The last ten provinces with lowest GDP per capita were Guizhou, Gansu, Yunnan, Guangxi, Anhui, Jiangxi, Sichuan, Hainan, Qinghai and Xinjiang, but eight of them ranked among the top ten in terms of the ICPNRE level except Guangxi and Anhui. What's more, Qinghai, Guizhou, Yunnan and Hainan took the first four places.

Table 11.2 Inter-provincial comparison of ranking gap between GDP per capita and ICPNRE

Province	Ranking of GDP per capita (1)	Ranking of carrying potential of natural resources and environment (2)	Ranking gap (1)–(2)	Province	Ranking of GDP per capita (1)	Ranking of carrying potential of natural resources and environment (2)	Ranking Gap (1)–(2)
Shanghai	1	24	−23	Ningxia	16	28	−12
Beijing	2	18	−16	Shaanxi	17	12	5
Tianjin	3	21	−18	Shanxi	18	29	−11
Jiangsu	4	30	−26	Henan	19	26	−7
Zhejiang	5	19	−14	Hunan	20	15	5
Guangdong	6	23	−17	Xinjiang	21	9	12
Inner Mongolia	7	6	1	Qinghai	22	1	21
Shandong	8	22	−14	Hainan	23	4	19
Liaoning	9	27	−18	Sichuan	24	7	17
Fujian	10	14	−4	Jiangxi	25	10	15
Jilin	11	11	0	Anhui	26	16	10
Hebei	12	25	−13	Guangxi	27	13	14
Chongqing	13	17	−4	Yunnan	28	3	25
Hubei	14	20	−6	Gansu	29	8	21
Heilongjiang	15	5	10	Guizhou	30	2	28

Out of the 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government), 24 experienced a ranking gap of ten or more places between the per capita GDP and ICPNRE, 13 experienced a ranking gap of 15 or more places, and six experienced a ranking gap of 20 or more places. The larger the gap, the stronger the negative correlation. Statistics showed the correlation coefficient between per capita GDP and ICPNRE was −0.5791. In other words, ICPNRE had a reverse gradient relationship with per capita GDP.

(4) There was a slight serial correlation between ICPNRE and Green Development Index (GDI)

Most of the 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) also experienced a ranking gap between the ranking of GDI and that of ICPNRE. 14 experienced a ranking gap of ten or more places, and they were Beijing, Tianjin, Zhejiang, Jiangsu, Guangdong, Shandong, Guizhou, Heilongjiang, Sichuan, Jilin, Guangxi, Hunan and Gansu, seven from the eastern region, one from the central region, four from the western region and two from the northeastern region (See Table 11.3).

Our analysis revealed a significant level of 0.205 between GDI and ICPNRE, far above 0.05. Hence a slight serial correlation between the two. Provinces with low

Table 11.3 Inter-provincial comparison of ranking gap between GDI and ICPNRE

Province	Ranking of GDI (1)	Ranking of ICPNRE (2)	Ranking Gap (1)–(2)	Province	Ranking of GDI (1)	Ranking of ICPNRE (2)	Ranking gap (1)–(2)
Beijing	1	18	−17	Xinjiang	16	9	7
Shanghai	2	24	−22	Jiangxi	17	10	7
Qinghai	3	1	2	Hebei	18	25	−7
Tianjin	4	21	−17	Sichuan	19	7	12
Hainan	5	4	1	Anhui	20	16	4
Zhejiang	6	19	−13	Chongqing	21	17	4
Yunnan	7	3	4	Hubei	22	20	2
Fujian	8	14	−6	Jilin	23	11	12
Jiangsu	9	30	−21	Guangxi	24	13	11
Guangdong	10	23	−13	Liaoning	25	27	−2
Inner Mongolia	11	6	5	Hunan	26	15	11
Shandong	12	22	−10	Ningxia	27	28	−1
Guizhou	13	2	11	Shanxi	28	29	−1
Shaanxi	14	12	2	Gansu	29	8	21
Heilongjiang	15	5	10	Henan	30	26	4

ICPNRE but high GDI are mostly from East China, such as Shanghai, Jiangsu, Beijing, Tianjin, Zhejiang, Guangdong and Shandong, where GDEG and Support Degree of Government Policies were both high. Provinces with high ICPNRE but low GDI such as Gansu, Sichuan, Jilin, Guizhou, Guangxi, Hunan and Heilongjiang experienced low GDEG and low Support Degree of Government Policies.

The different GDI and ICPNRE rankings of one place was due to the unique economic development pattern and domestic conditions of China. East China enjoyed a high GDI as a result of high economic development level and high GDEG and government policy support, but the region was low in ICPNRE. Part of Central, West and Northeast China enjoyed a high ICPNRE contributed by rich resources and well-preserved ecology, but the backward industrial structure, economic inefficiency and low GDEG of these regions pulled down the GDI.

Therefore, different regions had different priorities in transforming the economic development pattern. We should take actions that suited local circumstances, maximized favorable factors and minimized unfavorable ones. Regions with low GDI and high ICPNRE should focus on green economic growth and give more preferential policies in regard with resources and environmental issues. On the contrary, regions with low ICPNRE, especially the developed eastern region, should speed up the transformation of the development pattern and economic restructuring, and reduce environment damage and excessive reliance on resources, so as to improve green development.

11.1.2 Calculated Results of City ICPNRE

The calculated results of ICPNRE of 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan) were shown in the following Table 11.4 based on the measurement system and weighing criterion in the "China City Green Development Index System".

As shown in Table 11.4, the top ten cities in the ranking of ICPNRE were Kunming, Haikou, Harbin, Nanning, Fuzhou, Guiyang, Changchun, Chongqing and Changsha. The top ten cities in the ranking of Resource Abundance Status and Ecological Conservation Indicator were Lanzhou, Hangzhou, Nanning, Chongqing, Kunming, Guiyang, Changsha, Ningbo, Shenzhen and Guangzhou. The top ten provinces in the ranking of Environmental Stress and Climate Change Indicator were Kunming, Haikou, Harbin, Nanning, Hefei, Fuzhou, Changchun, Guiyang, Chongqing and Changsha.

Basing on the data in Table 11.4, we drew Fig. 11.3 to show the level of ICPNRE of different cities. The horizontal axis represented the ICPNRE value, and the origin stood for the average ICPNRE of 34 cities. The green bar represented the cities above the average level, and the higher the ICPNRE value, the longer the green bar. On the contrary, the white bar represented the cities below the average, and the lower the ICPNRE value, the longer the white bar.

From Table 11.4 and Fig. 11.3, we got the general characteristics of the ICPNRE of China's 34 cities as follows:

(1) Inter-city disparity of the ICPNRE was also significant, and the level of western and northeastern cities was much higher than that of eastern and central cities

The disparity of 34 cities in ICPNRE was far more significant than that of the 30 provinces. The score of No. 1 Kunming was respectively 1.5, 2.7, 2.7 and 3.3 times that of No. 2 Haikou, No. 3 Harbin, No. 4 Nanning and No. 5 Hefei. 32 cities scored within −0.2 and 0.2. The range of the 34 cities was 4.7 times their standard deviation.

If we look at the four major regions the 34 cities belong to: the eastern, central, northeastern and western regions, we would find that the western and northeastern cities had much higher ICPNRE levels than the eastern and central cities. The northeastern region scored 0.06 on average, western region 0.04, but the eastern and central regions scored below the national average. Such a regional disparity was caused by the difference in Environmental Stress and Climate Change among the four regions, whose Resource Abundance and Ecological Conservation did not differ much (Fig. 11.4).

From a regional perspective, among the ten calculated cities from West China, four ranked among top ten: Kunming, Nanning, Guiyang and Chongqing. The No. 1 Kunming scored 0.546 with an overwhelmingly superiority. Hohhot was slightly above the national average while Yinchuan and Lanzhou were slightly below it. Other western cities ranked behind. For example, Xining lied third from the

Table 11.4 Indexes of ICPNRE and rankings of 34 cities in China in 2009

Indicator	Carrying potential of natural resources and environment		Second-class indicators			
			Resource abundance and ecological protection indicators		Environmental stress and climate change indicators	
Weight	100 (%)		5 (%)		95 %	
City	Score	Ranking	Score	Ranking	Score	Ranking
Kunming	0.546	1	0.003	5	0.543	1
Haikou	0.368	2	−0.009	33	0.377	2
Harbin	0.202	3	−0.001	12	0.204	3
Nanning	0.201	4	0.010	3	0.190	4
Hefei	0.167	5	−0.006	22	0.173	5
Fuzhou	0.087	6	−0.005	18	0.092	6
Guiyang	0.073	7	0.003	6	0.071	8
Changchun	0.072	8	−0.006	21	0.078	7
Chongqing	0.060	9	0.008	4	0.052	9
Changsha	0.042	10	0.003	7	0.040	10
Dalian	0.029	11	−0.006	23	0.036	11
Hohhot	0.029	12	−0.004	16	0.034	12
Shenzhen	0.029	13	0.002	9	0.027	13
Qingdao	0.011	14	−0.006	24	0.017	14
Ningbo	0.004	15	0.002	8	0.002	15
Nanchang	−0.014	16	0.001	11	−0.015	17
Yinchuan	−0.020	17	−0.009	34	−0.011	16
Zhengzhou	−0.047	18	−0.008	31	−0.039	18
Shenyang	−0.064	19	−0.006	19	−0.059	19
Lanzhou	−0.067	20	0.091	1	−0.158	32
Guangzhou	−0.068	21	0.002	10	−0.070	20
Hangzhou	−0.071	22	0.013	2	−0.084	22
Shijiazhuang	−0.091	23	−0.007	28	−0.084	21
Beijing	−0.101	24	−0.007	27	−0.094	24
Taiyuan	−0.102	25	−0.008	32	−0.093	23
Xiamen	−0.107	26	−0.002	13	−0.105	26
Jinan	−0.110	27	−0.007	26	−0.103	25
Xi'an	−0.131	28	−0.007	25	−0.124	27
Chengdu	−0.135	29	−0.004	15	−0.131	29
Tianjin	−0.136	30	−0.008	30	−0.129	28
Nanjing	−0.152	31	−0.006	20	−0.146	30
Xining	−0.159	32	−0.004	14	−0.155	31
Shanghai	−0.166	33	−0.008	29	−0.158	33
Wuhan	−0.183	34	−0.005	17	−0.178	34

Lhasa and Urumqi. were unmeasured due to lack of basic data

Notes

1. Figures in this table are calculated based on data of each indicator for2098 and 2009 in accordance with the indicator system of ICPNRE embedded in the City Measurement System
2. Index of each province in this table is ranked in descending order

Sources China City Statistical Yearbook 2008, *China City Statistical Yearbook* 2009, *China Urban Life and Price Statistical Yearbook* 2010, *Annual Statistical Report on Environment in China* 2008, *Annual Statistical Report on Environment in China* 2009, and Data Center Network of the Ministry of Environmental Protection

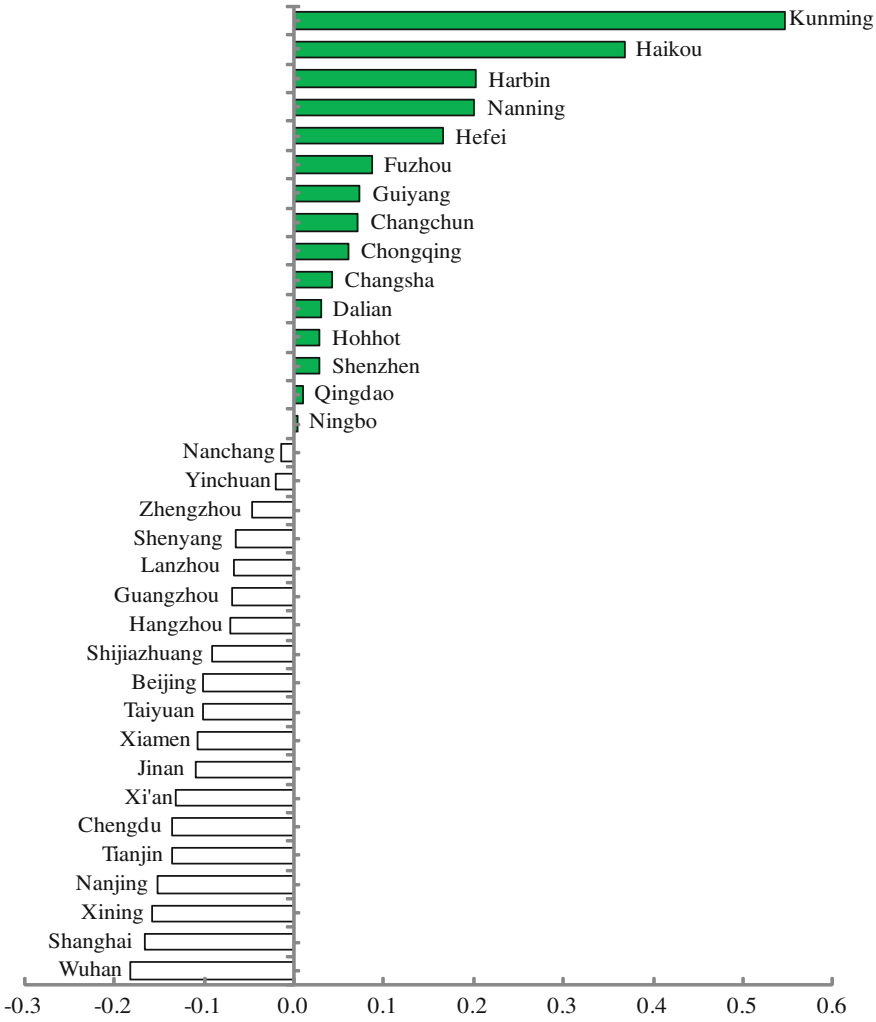

Fig. 11.3 Inter-city comparison of ICPNRE rankings

bottom. Among the four northeastern cities, two ranked among top ten: No. 3 Harbin and No. 8 Changchun. No. 11 Dalian and No. 19 Shenyang also ranked forward. Among the fourteen eastern cities, the highest-ranking city was No. 2 Haikou. Most cities in this region such as Beijing, Tianjin, Shijiazhuang and Nanjing ranked in the middle or the second half of the list, and Shanghai even lied second from the bottom. Two of the six central cities ranked among top ten: No. 5 Hefei and No. 10 Changsha. In particular, Wuhan was the tail-end.

(2) The level of ICPNRE mainly depended on the score of Environmental Stress and Climate Change Indicator

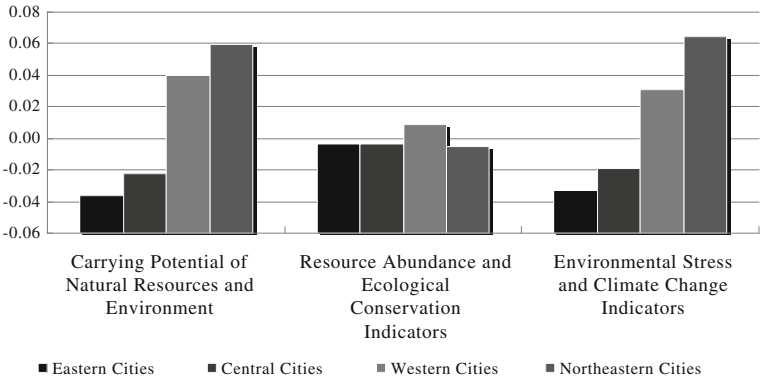

Fig. 11.4 Inter- city comparison of ICPNRE among 4 major areas in China

Table 11.4 showed that the level of city ICPNRE depended on the score of Environmental Stress and Climate Change Indicator to a great extent. Analysis demonstrated a correlation coefficient of 0.994 between the level of ICPNRE and Environmental Stress and Climate Change Indicator, distinctly higher than that between ICPNRE and Resource Abundance Status and Ecological Conservation Indicator (0.023). This revealed a huge impact of one city's Environmental Stress and Climate Change Indicator on its ICPNRE. As the indicator was closely related to the methods of production, pollutant discharge and control in a city, more favorable policies should be given in this field.

(3) There was a negative serial correlation to a certain degree between the level of ICPNRE and that of economic development

The ranking showed a negative serial correlation the level of ICPNRE and that of economic development in 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan). Cities with high levels of economic development had low levels of ICPNRE, and vice versa. Details were shown in Table 11.5.

From Table 11.5, the top five cities in terms of GDP per capita in 2009 were Shenzhen, Guangzhou, Shanghai, Dalian and Beijing, but these cities ranked low in terms of ICPNRE. The highest of them was No. 11 Dalian, and the lowest was No. 33 Shanghai. Shenzhen, Guangzhou and Beijing ranked No. 13, 21 and 24. The bottom ten cities in terms of GDP per capita were Xi'an, Harbin, Shijiazhuang, Lanzhou, Haikou, Kunming, Guiyang, Chongqing, Xining and Nanning. However, six of them ranked among top ten in terms of ICPNRE, four of them lied at top 4, and Kunming ranked even No.1.

In general, the 34 cities experienced a great ranking gap between the ranking of GDP per capita and that of ICPNRE. 19 cities experienced a ranking gap of ten or more places, 14 ones experienced a gap of 15 or more places, and nine experienced a gap of 20 or more places. Two cities even experienced a gap of 30 places. Further analysis revealed that the correlation coefficient between the rankings of

Table 11.5 Inter-city comparison of ranking gap between GDP per capita and ICPNRE

City	Ranking of GDP per capita (1)	Ranking of ICPNRE (2)	Ranking gap (1)–(2)	City	Ranking of GDP per capita (1)	Ranking of ICPNRE (2)	Ranking gap (1)–(2)
Shenzhen	1	13	−12	Zhengzhou	18	18	0
Guangzhou	2	21	−19	Hefei	19	5	14
Shanghai	3	33	−30	Nanchang	20	16	4
Dalian	4	11	−7	Fuzhou	21	6	15
Beijing	5	24	−19	Changchun	22	8	14
Xiamen	6	26	−20	Chengdu	23	29	−6
Nanjing	7	31	−24	Yinchuan	24	17	7
Hangzhou	8	22	−14	Xi'an	25	28	−3
Tianjin	9	30	−21	Harbin	26	3	23
Hohhot	10	12	−2	Shijiazhuang	27	23	4
Ningbo	11	15	−4	Lanzhou	28	20	8
Qingdao	12	14	−2	Haikou	29	2	27
Changsha	13	10	3	Kunming	30	1	29
Shenyang	14	19	−5	Guiyang	31	7	24
Wuhan	15	34	−19	Chongqing	32	9	23
Jinan	16	27	−11	Xining	33	32	1
Taiyuan	17	25	−8	Nanning	34	4	30

GDP per capita and ICPNRE was only −0.3665, a loose reverse gradient relationship.

(4) There was a significant ranking gap between the rankings of ICPNRE and GDI on the city level

The calculated results revealed that most cities experienced a significant ranking gap between the rankings of ICPNRE and GDI. 12, or 35 % of the 34 cities experienced a ranking gap of ten or more places: Beijing, Hohhot, Changchun, Harbin, Shanghai, Nanjing, Xiamen, Guangzhou, Shenzhen, Chongqing, Guiyang and Lanzhou. Six of them were from the eastern region, four from the western region and two from the northeastern region (See Table 11.6).

The data above showed that, due to high level of economic development, high GDEG and strong policy support from the government, some eastern cities such as Shenzhen, Nanjing, Shanghai, Guangzhou, Xiamen and Beijing ranked forward in terms of GDI. However, because of huge discharge of pollutants which led to great stress on environment, these cities ranked low in terms of ICPNRE. As a result, the ranking gap between GDI and ICPNRE was significant. As to some underdeveloped cities such as Chongqing, Guiyang, Lanzhou and Hohhot, despite the advantage in ICPNRE ranking, they still had problems with the GDEG and financial support from the government. Therefore, the GDI levels of these cities were relatively low.

Next, we worked out the reason why Beijing and Chongqing had the largest ranking gap. Beijing ranked No. 24 in terms of ICPNRE. As to the two Second-

Table 11.6 Inter-city comparison of ranking gap between GDI and ICPNRE

City	Ranking of GDI (1)	Ranking of ICPNRE (2)	Ranking gap (1)–(2)	City	Ranking of GDI (1)	Ranking of ICPNRE (2)	Ranking gap (1)–(2)
Shenzhen	1	13	−12	Nanjing	18	31	−13
Haikou	2	2	0	Shanghai	19	33	−14
Kunming	3	1	2	Changchun	20	8	12
Beijing	4	24	−20	Jinan	21	27	−6
Hefei	5	5	0	Yinchuan	22	17	5
Guangzhou	6	21	−15	Nanchang	23	16	7
Dalian	7	11	−4	Hohhot	24	12	12
Qingdao	8	14	−6	Zhengzhou	25	18	7
Changsha	9	10	−1	Guiyang	26	7	19
Fuzhou	10	6	4	Taiyuan	27	25	2
Xiamen	11	26	−15	Tianjin	28	30	−2
Nanning	12	4	8	Chongqing	29	9	20
Ningbo	13	15	−2	Xi'an	30	28	2
Shenyang	14	19	−5	Wuhan	31	34	−3
Harbin	15	3	12	Chengdu	32	29	3
Shijiazhuang	16	23	−7	Lanzhou	33	20	13
Hangzhou	17	22	−5	Xining	34	32	2

Level Indicators-Resource Abundance Status and Ecological Conservation Indicator and Environmental Stress and Climate Change Indicator, Beijing ranked No. 27 and 24. By analyzing the Third-Level Indicators under Environmental Stress and Climate Change, we discovered that Beijing ranked only No. 27 in terms of water resources per capita. What's more, Beijing ranked behind in terms of pollutant discharge per square and in the middle in terms of pollutant discharge per capita. However, due to the highly developed economy and preferential policies, Beijing ranked second in terms of GDEG and Support Degree of Government Policies. These advantages supplemented the deficiency of resources and environment. As a result, Beijing still led the country in terms of GDI. Chongqing ranked No. 33 in terms of GDEG and No. 30 in terms of Support Degree of Government Policies, but it ranked ninth in terms of ICPNRE. Hence a huge gap between the rankings of ICPNRE and GDI.

11.2 Comparative Analysis of ICPNRE on the Provincial Level

Basing on "China Province Green Development Index System", we analyzed the calculated results of Resource Abundance Status and Ecological Conservation and Environmental Stress and Climate Change Indicators of 30 provinces (autonomous

regions and municipalities), in order to fully compare the different levels of ICPNRE of different regions.

11.2.1 Measurement Results and Analysis of Resource Abundance Status and Ecological Conservation Indicator on the Provincial Level

Under the "China Province Green Development Index System", Resource Abundance Status and Ecological Conservation Indicator consisted of six Third-Level Indicators including water resources per capita, forest area per capita, forest coverage rate, proportion of area of natural reserves in the total area of a region, proportion of area of wetlands in the total area of a region and total standing stock volume per capita. The weights and indications of the Third-Level Indicators were shown in Table 11.7.

Table 11.7 Third-class indicators, their weights and attributes of inter-provincial resource abundance and ecological conservation

Sequence number	Indicator	Weight (%)	Attribute
1	Water resources per capita	2.00	Positively correlated
2	Forest area per capita	2.00	Positively correlated
3	Forest coverage rate	2.00	Positively correlated
4	Proportion of area of natural reserves in total area of a region	2.00	Positively correlated
5	Proportion of area of wetlands in total area of a region	2.00	Positively correlated
6	Total standing stock volume per capita	2.00	Positively correlated

Note The contents in this table are determined by the task force after having conducted a lot of expert workshops

Basing on data normalization and the weights of the Third-Level Indicators, we worked out the calculated results of Resource Abundance Status and Ecological Conservation Indicator of different provinces (autonomous regions and municipalities) (See Table 11.8).

Generally speaking, from Table 11.8 and Fig. 11.5, provinces varied little in terms of Resource Abundance Status and Ecological Conservation, the score of which ranged from −0.08 to 0.08. Only Qinghai, Inner Mongolia and Heilongjiang scored slightly higher.

The top ten provinces were Qinghai, Inner Mongolia, Heilongjiang, Yunnan, Hainan, Sichuan, Jilin, Shanghai, Jiangxi and Guangxi, five including the top two

Table 11.8 Indexes of resource abundance and ecological conservation indicators and rankings of 30 provinces

Indicator	Resource abundance and ecological conservation		Indicator	Resource abundance and ecological conservation	
Province	Score	Ranking	Province	Score	Ranking
Qinghai	0.143	1	Liaoning	−0.019	16
Inner Mongolia	0.130	2	Chongqing	−0.021	17
Heilongjiang	0.121	3	Gansu	−0.022	18
Yunnan	0.078	4	Shaanxi	−0.026	19
Hainan	0.060	5	Guizhou	−0.026	20
Sichuan	0.052	6	Hubei	−0.038	21
Jilin	0.050	7	Tianjin	−0.046	22
Shanghai	0.040	8	Anhui	−0.058	23
Jiangxi	0.033	9	Shandong	−0.062	24
Guangxi	0.027	10	Jiangsu	−0.062	25
Fujian	0.023	11	Beijing	−0.062	26
Xinjiang	0.011	12	Ningxia	−0.071	27
Hunan	−0.005	13	Shanxi	−0.074	28
Zhejiang	−0.007	14	Hebei	−0.077	29
Guangdong	−0.013	15	Henan	−0.079	30

Sources China Statistical Yearbook 2010, *China Statistical Yearbook* 2009, *Desertification and Its Control in China, Annual Statistical Report on Environment in China* 2009, and *China Environmental Statistical Yearbook* 2010

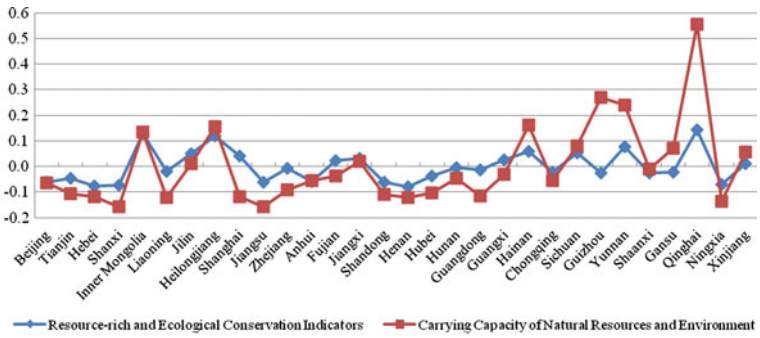

Fig. 11.5 Inter-provincial comparison of resource abundance and ecological conservation index and ICPNRE

from West China, two from Northeast China, one from Central China and two from East China.

From a regional perspective, among the No. 11–No. 20 provinces, half were from West China and ranked behind, including No. 12 Xinjiang, No. 17 Chongqing, No. 18 Gansu, No. 19 Shanxi and No. 20 Guizhou; outside the region were three eastern provinces, one central province and one northeastern province.

Among the bottom ten provinces, five were from East China, including No. 22 Tianjin, No. 24 Shandong, No. 25 Jiangsu, No.26 Beijing and No. 29 Hebei; four were from Central China, and one were from West China.

Among the calculated provinces, the No.1 province was Qinghai whose score was much higher than that of the rest. It ranked first in terms of two-Third-Level Indicators: the water resources per capita and proportion of area of natural reserves in its total area. Its forest area per capita ranked second, but the forest coverage ranked last but one. The No. 1 province in terms of forest area per capita and total standing stock volume per capita was Inner Mongolia, and this was probably due to major policy decisions like the Three North Shelter Forest Engineering Construction and Natural Forest Protection Plan.

As to eastern provinces such as Beijing, Shanghai and Jiangsu, except a relatively high ranking in terms of proportion of area of natural reserves in the total area, they ranked low in terms of water resources per capita, forest area per capita and forest coverage. Four out of the six central provinces ranked among the bottom ten. These data reflected a huge stress on resources confronted by the eastern and central regions. In addition, the only one western province in the bottom ten was Ningxia which ranked No. 27 in terms of Resource Abundance Status and Ecological Conservation, far behind the No. 1 Qinghai.

11.2.2 Measurement Results and Analysis of Environmental Stress and Climate Change Indicator on the Provincial Level

Under the "China Province Green Development Index System", Environmental Stress and Climate Change Indicator consisted of 13 Third -Level Indicators, including CO_2 emissions per unit of land area, CO_2 emissions per capita, SO_2 emissions per unit of land area, SO_2 emissions per capita, COD emissions per unit of land area, COD emissions per capita, ***NOx*** emissions per unit of land area, ***NOx*** emissions per capita, Ammonia Nitrogen emissions per unit of land area, Ammonia Nitrogen emissions per capita, consumption of chemical fertilizer per unit of area of cultivated land, consumption of pesticides per unit of area of cultivated land, and ***NOx*** emissions from road traffic per capita. The weights and indications of these Third -Level Indicators were shown in Table 11.9.

Basing on data normalization and weights of Third-Level Indicators, we worked out and ranked the calculated results of Environmental Stress and Climate Change Indicator of different provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) (See Table 11.10).

From Table 11.10 and Fig. 11.6, the scores of Environmental Stress and Climate Change Indicator varied slightly among 26 provinces, ranging from −0.1 to 0.1 (including Liaoning and Guangdong). However, Qinghai, Guizhou and Yunnan scored much higher than the others. Shanghai scored rather low. On the whole, the range of the 30 provinces was 3.5 times higher than the standard deviation, indicating a significant disparity among provinces.

Table 11.9 Third-class indicators, their weights and attributes of inter-provincial environmental stress and climate change

Sequence number	Indicator	Weight (%)	Attribute
1	CO_2 emissions per unit of land area	2.45	Negatively correlated
2	CO_2 emissions per capita	2.45	Negatively correlated
3	SO_2 emissions per unit of land area	2.10	Negatively correlated
4	SO_2 emissions per capita	2.10	Negatively correlated
5	COD emissions per unit of land area	2.10	Negatively correlated
6	COD emissions per capita	2.10	Negatively correlated
7	Nitrogen oxides emissions per unit of land area	2.10	Negatively correlated
8	Nitrogen oxides emissions per capita	2.10	Negatively correlated
9	Ammonia nitrogen emissions per unit of land area	2.10	Negatively correlated
10	Ammonia nitrogen emissions per capita	2.10	Negatively correlated
11	Consumption of chemical fertilizers per unit of area of cultivated land	2.10	Negatively correlated
12	Consumption of pesticides per unit of area of cultivated land	2.10	Negatively correlated
13	Nitrogen oxides emissions from road traffic per capita	2.10	Negatively correlated

Note The contents in this table are determined by the task force after having conducted a lot of expert workshops

From a national perspective, the western region scored much higher than the other three regions, and no huge disparity existed inside the three.

The top ten provinces were Qinghai, Guizhou, Yunnan, Hainan, Gansu, Xinjiang, Heilongjiang, Sichuan, Shanxi and Inner Mongolia. From a regional perspective, eight of top ten were western provinces: No. 1 Qinghai, No. 2 Guizhou, No. 3 Yunnan, No. 5 Gansu, No. 6 Xinjiang, No. 8 Sichuan, No. 9 Shanxi and No. 10 Inner Mongolia. The other two were No. 4 Hainan from East China and No. 7 Heilongjiang from Northeast China.

The provinces ranking from No. 11 to No. 20 were Anhui, Beijing, Jiangxi, Chongqing, Jilin, Hebei, Hunan, Henan, Shandong and Guangxi, all of which except Anhui were below the national average. There was a slight disparity. From a regional perspective, there were four central provinces: No. 11 Anhui, No. 13 Jiangxi, No. 17 Hunan and No.18 Henan; two western provinces were No. 14 Chongqing and No. 20 Guangxi; three eastern provinces were No. 12 Beijing, No. 16 Hebei and No. 19 Shandong. No. 15 Jilin was the only northeastern province.

Table 11.10 Indexes of environmental stress and climate change indicators and rankings of 30 provinces

Indicator	Environmental stress and climate change indicators		Indicator	Environmental stress and climate change indicators	
Province	Score	Ranking	Province	Score	Ranking
Qinghai	0.413	1	Hebei	−0.041	16
Guizhou	0.295	2	Hunan	−0.042	17
Yunnan	0.163	3	Henan	−0.042	18
Hainan	0.100	4	Shandong	−0.047	19
Gansu	0.092	5	Guangxi	−0.058	20
Xinjiang	0.045	6	Fujian	−0.059	21
Heilongjiang	0.035	7	Tianjin	−0.059	22
Sichuan	0.029	8	Hubei	−0.065	23
Shaanxi	0.016	9	Ningxia	−0.066	24
Inner Mongolia	0.006	10	Shanxi	−0.084	25
Anhui	0.004	11	Zhejiang	−0.085	26
Beijing	−0.001	12	Jiangsu	−0.097	27
Jiangxi	−0.014	13	Liaoning	−0.103	28
Chongqing	−0.033	14	Guangdong	−0.104	29
Jilin	−0.039	15	Shanghai	−0.157	30

Sources China Statistical Yearbook 2010, *China Statistical Yearbook* 2009, *Desertification and Its Control in China, Annual Statistical Report on Environment in China* 2009, and *China Environmental Statistical Yearbook* 2010

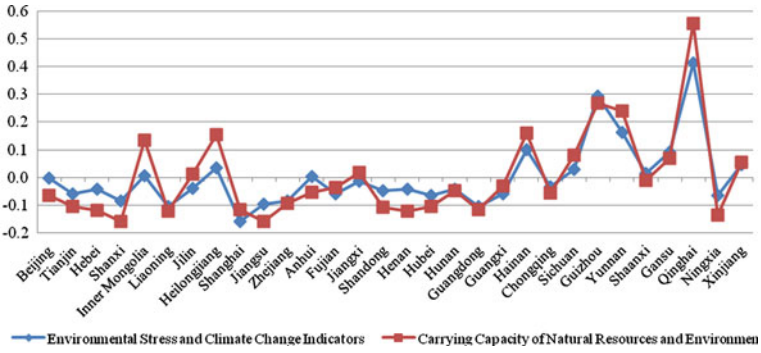

Fig. 11.6 Inter-provincial comparisons of environmental stress and climate change index and ICPNRE

The bottom ten provinces were Fujian, Tianjin, Hubei, Ningxia, Shanxi, Zhejiang, Jiangsu, Liaoning, Guangdong and Shanghai. From a regional perspective, there were six eastern provinces: No. 21 Fujian, No. 22 Tianjin, No. 26 Zhejiang, No. 27 Jiangsu, No. 29 Guangdong and No. 30 Shanghai; two central provinces were No. 23 Hubei and No. 25 Shanxi. No. 24 Ningxia and No. 28 Liaoning were the only western and northeastern provinces.

The top three provinces were Qinghai, Guizhou and Yunnan. Their high ranking was mainly contributed by low emissions of SO_2, COD, *NOx and* Ammonia Nitrogen per capita and per unit of land area.

Hainan ranked No. 4 as a result of its dominating service industry. In 2009, service accounted for 45.3 % of the local GDP, compared with 27.9 % contributed by secondary industry. In this regard, Hainan became the smallest emitter of SO_2 and *NOx* per capita across the country. Moreover, the total emission of pollutants of Hainan was lower than that of most provinces.

The bottom two provinces were Guangdong and Shanghai, as they were large emitters of pollutants per unit of land area. Shanghai was the largest emitter of SO_2, COD, *NOx and* Ammonia Nitrogen per unit of land area. Also one of the largest emitters in this regard, Guangdong was the second and third largest consumer of chemical fertilizer and pesticides per unit of area of cultivated land in China.

11.3 Comparative Analysis of ICPNRE on the City Level

Basing on "China City Green Development Index System", we analyzed the calculated results of Resource Abundance Status and Ecological Conservation and Environmental Stress and Climate Change Indicators of 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan), so as to fully compare their different levels of ICPNRE.

11.3.1 Measurement Results and Analysis of Resource Abundance Status and Ecological Conservation Indicator on the City Level

In the "China Province Green Development Index System", compared to Environmental Stress and Climate Change Indicator, Resource Abundance Status and Ecological Conservation Indicator was a smaller factor, whose weight was only 5 %. Below the indicator, there was only one-Third-Level positively correlated indicator-water resources per capita, whose weight in GDI was only 1.6 %.

Basing on data normalization and weights of Third-Level Indicators, we worked out and ranked the calculated results of Resource Abundance Status and Ecological Conservation Indicator of the 34 cities (See Table 11.11).

Table 11.11 showed that 33 cities varied from −0.009 to 0.013, a small disparity. Only Lanzhou was scored relatively higher (Fig. 11.7).

From a national perspective, 11 of the 34 calculated cities scored above the national average. From a regional perspective, the scores of the four regions varied slightly, the western region having the highest and the eastern region the lowest.

Table 11.11 Indexes of resource abundance and ecological conservation indicators and rankings of 34 cities

Indicator	Resource abundance and ecological conservation indicators		Indicator	Resource abundance and ecological conservation indicators	
City	Score	Ranking	City	Score	Ranking
Lanzhou	0.091	1	Fuzhou	−0.005	18
Hangzhou	0.013	2	Shenyang	−0.006	19
Nanning	0.010	3	Nanjing	−0.006	20
Chongqing	0.008	4	Changchun	−0.006	21
Kunming	0.003	5	Hefei	−0.006	22
Guiyang	0.003	6	Dalian	−0.006	23
Changsha	0.003	7	Qingdao	−0.006	24
Ningbo	0.002	8	Xi'an	−0.007	25
Shenzhen	0.002	9	Jinan	−0.007	26
Guangzhou	0.002	10	Beijing	−0.007	27
Nanchang	0.001	11	Shijiazhuang	−0.007	28
Harbin	−0.001	12	Shanghai	−0.008	29
Xiamen	−0.002	13	Tianjin	−0.008	30
Xining	−0.004	14	Zhengzhou	−0.008	31
Chengdu	−0.004	15	Taiyuan	−0.008	32
Hohhot	−0.004	16	Haikou	−0.009	33
Wuhan	−0.005	17	Yinchuan	−0.009	34

Sources China City Statistical Yearbook 2008, *China City Statistical Yearbook* 2009, *China Urban Life and Price Statistical Yearbook* 2010, *Annual Statistical Report on Environment in China* 2008, *Annual Statistical Report on Environment in China* 2009, and Data Center Network of the Ministry of Environmental Protection

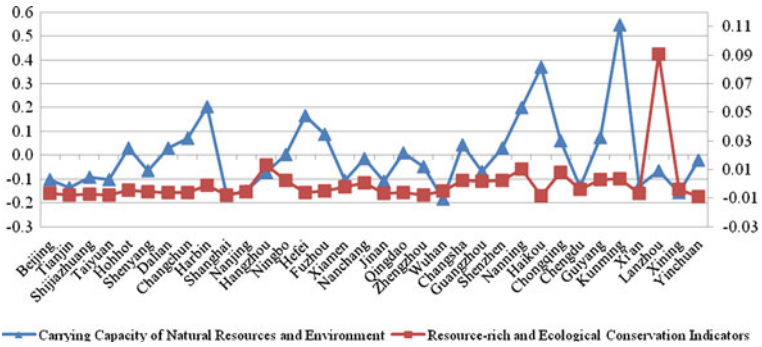

Fig. 11.7 Inter-city comparison of resource abundance and ecological conservation index and ICPNRE

The top ten cities were Lanzhou, Hangzhou, Nanning, Chongqing, Kunming, Guiyang, Changsha, Ningbo, Shenzhen and Guangzhou. Among them, five were western cities among the top six, one was from the central region and four from the western region.

Table 11.12 Difference in water resources per capita between Lanzhou and other cities (Unit: m^3/person)

Area	Water resources per capita	Difference between other cities and Lanzhou
Eastern cities	646.34	−9543.25
Central cities	577.93	−9611.65
Western cities	1865.07	−8324.52
Northeastern	489.34	−9700.25

Lanzhou ranked first with a leading advantage. The reason lied in its large amount of water resources as much as 10189.59 cubic meters per person. From table 11.12, the total water resource of Lanzhou was much higher than the average of the other three regions, which was less than 1/10 of Lanzhou's.

The bottom ten cities were Xian, Jinan, Beijing, Shijiazhuang, Shanghai, Tianjin, Zhengzhou, Taiyuan, Haikou and Yinchuan. Six of them were from the eastern region, taking up half of the calculated eastern cities. This meant the eastern cities behaved poorly as a whole. There were also two central cities and two western cities. Yinchuan lied at the end.

Four northeastern cities ranked in the middle and they were Harbin (No. 12), Shenyang (No. 19), Changchun (No. 21) and Dalian (No. 23). But they scored below the national average, indicating low storage of water resources in this region.

11.3.2 Measurement Results and Analysis of Environmental Stress and Climate Change Indicator on the City Level

In the "China Province Green Development Index System", Environmental Stress and Climate Change Indicator consisted of twelve Third-Level Indicators, including CO_2 emissions per unit of land area, CO_2 emissions per capita, SO_2 emissions per unit of land area, SO_2 emissions per capita, COD emissions per unit of land area, COD emissions per capita, *NOx* emissions per unit of land area, *NOx* emissions per capita, Ammonia Nitrogen emissions per unit of land area, Ammonia Nitrogen emissions per capita, ratio of days with air quality at and above level two to the whole year, ratio of days with principal pollutants as respirable particles to the whole year. The weights and indications of these indicators were shown in Table 11.13.

Basing on data normalization and weights of the Third-Level Indicators, we worked out and ranked the calculated results of Environmental Stress and Climate Change Indicator of the 34 cities (See Table 11.14).

Table 11.13 Third-class indicators, their weights and attributes of inter-city environmental stress and climate change

Sequence number	Indicator	Weight (%)	Attribute
1	CO_2 emissions per unit of land area	2.81	Negatively correlated
2	CO2 emissions per capita	2.81	Negatively correlated
3	SO2 emissions per unit of land area	2.67	Negatively correlated
4	SO2 emissions per capita	2.67	Negatively correlated
5	COD emissions per unit of land area	2.67	Negatively correlated
6	COD emissions per capita	2.67	Negatively correlated
7	Nitrogen oxides emissions per unit of land area	2.67	Negatively correlated
8	Nitrogen oxides emissions per capita	2.67	Negatively correlated
9	Ammonia nitrogen emissions per unit of land area	2.67	Negatively correlated
10	Ammonia nitrogen emissions per capita	2.67	Negatively correlated
11	Ratio of days with air quality at and above level 2 to the whole year	2.67	Positively correlated
12	Ratio of days with principal pollutants as respirable suspended particulate to the whole year	2.67	Negatively correlated

Note The contents in this table are determined by the task force after having conducted a lot of expert workshops

From Table 11.14 and Fig. 11.8, the scores of the 34 cities ranged from −0.178 to 0.543, a significant disparity. Some cities such as Kunming and Haikou scored much higher over others. Besides, since the weight of Environmental Stress and Climate Change Indicator was 95 %, the exponential curve of the indicator resembled that of ICPNRE. In other words, compared to Resource Abundance Status and Ecological Conservation Indicator, this indicator made a larger contribution to ICPNRE.

From a national perspective, northeastern and western cities scored much higher than other parts of China. The lowest were eastern cities, which approximated the scores of central cities.

The top ten cities were Kunming, Haikou, Harbin, Nanning, Hefei, Fuzhou, Changchun, Guiyang, Chongqing and Changsha. From a regional perspective, they covered all the regions. Among them were four western cities including No. 1 Kunming, No. 4 Nanning, No. 8 Guiyang and No. 9 Chongqing, two eastern cities including No. 2 Haikou and No. 6 Fuzhou, and two northeastern cities including

Table 11.14 Indexes of environmental stress and climate change indicators and rankings of 34 cities

Indicator	Environmental stress and climate change Indicators		Indicator	Environmental stress and climate change Indicators	
City	Score	Ranking	City	Score	Ranking
Kunming	0.543	1	Zhengzhou	−0.039	18
Haikou	0.377	2	Shenyang	−0.059	19
Harbin	0.204	3	Guangzhou	−0.070	20
Nanning	0.190	4	Shijiazhuang	−0.084	21
Hefei	0.173	5	Hangzhou	−0.084	22
Fuzhou	0.092	6	Taiyuan	−0.093	23
Changchun	0.078	7	Beijing	−0.094	24
Guiyang	0.071	8	Jinan	−0.103	25
Chongqing	0.052	9	Xiamen	−0.105	26
Changsha	0.040	10	Xi'an	−0.124	27
Dalian	0.036	11	Tianjin	−0.129	28
Hohhot	0.034	12	Chengdu	−0.131	29
Shenzhen	0.027	13	Nanjing	−0.146	30
Qingdao	0.017	14	Xining	−0.155	31
Ningbo	0.002	15	Lanzhou	−0.158	32
Yinchuan	−0.011	16	Shanghai	−0.158	33
Nanchang	−0.015	17	Wuhan	−0.178	34

Sources China City Statistical Yearbook 2008, *China City Statistical Yearbook* 2009, *China Urban Life and Price Statistical Yearbook* 2010, *Annual Statistical Report on Environment in China* 2008, *Annual Statistical Report on Environment in China* 2009, and Data Center Network of the Ministry of Environmental Protection

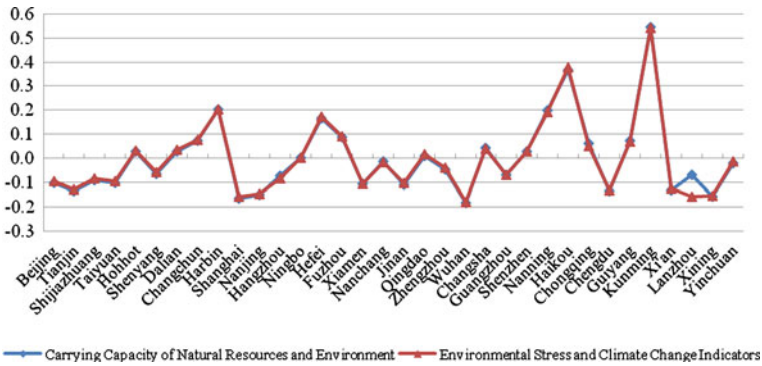

Fig. 11.8 Inter-city comparisons of environmental stress and climate change index and ICPNRE

No. 3 Harbin and No. 7 Changchun. The other two were central cities: No. 5 Hefei and No. 10 Changsha.

The cities ranking from No. 11 to No. 24 were Dalian, Hohhot, Shenzhen, Qingdao, Ningbo, Yinchuan, Nanchang, Zhengzhou, Shenyang, Guangzhou, Shijiazhuang, Hangzhou, Taiyuan and Beijing. Dalian, Hohhot, Shenzhen, Qingdao,

and Ningbo scored higher than the national average. From a regional perspective, there were three central and two western cities, and seven eastern and two northeastern ones.

The bottom ten provinces were Jinan, Xiamen, Xian, Tianjin, Chengdu, Nanjing, Xining, Lanzhou, Shanghai and Wuhan, none of which was from the northeastern region. There were five eastern cities: No. 25 Jinan, No. 26 Xiamen, No. 28 Tianjin, No. 30 Nanjing and No. 33 Shanghai and four western cities: No. 27 Xian, No. 29 Chengdu, No. 31 Xining and No. 32 Lanzhou. The only central city Wuhan lied at the end of the list.

Viewed from the scores of the Third-Level Indicators, Kunming ranked first in terms of COD emissions per unit of land area and per capita, Ammonia Nitrogen emissions per unit of land area and per capita, ratio of days with air quality at and above level two to the whole year, which pushed the score of Environmental Stress and Climate Change Indicator to the first place. Other western cities like Nanning and Chongqing were low emitters of pollutants per square and per capita, mainly due to the low population in the vast region. However, Guiyang was a larger emitter in this regard, and the largest emitter of SO_2. In a word, the industrial structure varied greatly among western cities.

Tourism was the main economic driver of Hainan, a large province with a small population and a favorable natural environment. The province was the smallest emitter of SO_2 per unit of land area and per capita, and had the biggest number of days with air quality at and above level two in a year and the fewest days with principal pollutants as respirable particles in a year. That was why Hainan ranked second in terms of Environmental Stress and Climate Change Indicator.

The tail-end city of this indicator, Wuhan, except the emission of SO_2 per capita, the other Third-Level Indicators all ranked among the bottom ten. Undoubtedly, Wuhan had the lowest score in general.

11.4 Conclusion

On the whole, ICPNRE varied significantly among both the 30 provinces (autonomous regions and municipalities directly under the jurisdiction of the central government) and the 34 provincial capital cities (including municipalities directly under the jurisdiction of the central government and specifically designated cities in the state plan). West China was much better than East China in terms of ICPNRE and GDI. The disparity stemmed from the different economic development levels and natural endowments, but more importantly from different levels of Environmental Stress and Climate Change Indicator. Therefore, less consumption of resources and lower emission of pollutants were the right way to ease the stress on environment and improve ICPNRE.

Given the significant regional disparity of ICPNRE, we could reflect on our choices of the development pattern. We suggest all regions adjust measures to the local conditions, speed up economic restructuring and transforming the

development pattern and strengthen cooperation among all sides in different fields to promote green development among themselves and the country. To be specific, underdeveloped regions should work out more innovative solutions towards green development and avoid the old track of low-efficient growth through high pollution and energy consumption. Developed regions should explore new ways in energy conservation and emission reduction and improving afforestation. Both West and East China should establish a compensation mechanism of environment and resources and a linkage mechanism of green development as soon as possible. The western region should vigorously promote sound and effective flow of resources and back the development of the eastern region. In return, the eastern region should help the western region develop by sharing experience, capital, technologies, talents, and market opportunities, etc.