The Relationship between Natural Resources and Population Development in Liaocheng City

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Abstract According to the relevant data about the land resources and population in Liaocheng City from 1999 to 2008, by using the research method of bearing capacity of natural resources, the thesis analyzes the relationship between natural resources and dynamic change of population in Liaocheng City. The results show that the farmland tends to diminish on the whole, and forests, garden land, urban-rural settlements and land for enterprises and mining increase slowly. Based on the analysis of the dynamic relationship between land resources and population, we conclude that the land resources still can bear the current population in Liaocheng City, but the population development inflict critical pressure on the forest resources and water resources.

Key words Liaocheng City, Natural resources, Bearing capacity index, Capacity of bearing pressure, China

The natural resources underpin the development of economy and society, and guarantee basically the continuous and healthy development of economy and society. Meanwhile, the natural resources also play the role of restriction, and the bearing capacity can restrict the speed, structure and way of economy and society. In the northwestern arid areas, although the population has not yet reached the upper limit of bearing capacity index of natural resources, the relative bearing pressure degree of natural resources tends to ascend. After empirical analysis, by using Solow model, Zhang Hongwei notes that the economic development is, to much extent, at the expense of environment[1]. In some southern cities, the bearing capacity of population is always overloaded, and the contribution rate of land resources bearing capacity to comprehensive bearing capacity tends to dwindle[2]. Liaocheng, located in the west of Shandong province, is a city under development. In the recent years, due to the economic development and mushrooming of population, the way and end of using natural resources is changing, so in order to undergird the research of natural resources change in Liaocheng, analyzing the mutual relationship between natural resources change and population development, is significant to rationally using natural resources, scientifically allocating and optimizing natural resources and promoting the sustainable development of natural resources in this region.

1 Data sources and research methods

1.1 Data sources The data is from *The Statistical Yearbook of Liaocheng City*[3] and *The Statistical Yearbook of Shandong Province* from 2000 to 2009[4].

1.2 Research method The research method takes one or several reference areas as surveyor's pole. According to the possession amount, consumption amount of resources per capita in the reference area, and the stock of resources, the relative bearing capacity of all resources factors in the study area is calculated. The calculation formulae of bearing pressure index Ires and bearing pressure degree Pres are as follows respectively[5]:

$$I_{res} = \frac{\text{The possession amount of a certain resource of research objective}}{\text{The per capita possession amount of corresponding resources in reference area}}$$

$$P_{res} = \frac{\text{The practical population quantity of the research objective}}{I_{res}}$$

2 Results and analysis

2.1 The dynamic change of land resources

2.1.1 The overall change of land resources. From 1999 to 2008, the land area of whole city was 0.865 million hm^2, which had not varied basically, but the land use pattern varied. In Fig. 1a, the farmland area, on the whole, tended to decrease along with the population change, from 0.571 million hm^2 in 1999 to 0.566 million hm^2 in 2008, decreasing by 60 thousand hm^2 and 1.06%. The annual decrease of farmland on the average is 6 thousands hm^2. The farmland suffered the sharpest drop from 2003 to 2004, decreasing by 5 thousand hm^2. The area of garden land, on the whole, tends to increase. It increased by 459 hm^2 and 1.4% from 1999 to 2008 with annual increase of 45.9 hm^2. It increased most prominently from 2002 to 2003, increasing by 384 hm^2; it decreased from 2003 to 2004, decreasing by 281 hm^2, and in the following years, the area of garden land increased slowly (Fig. 1b). The area of garden reached basically 23.6 thousand hm^2 from 1999 to 2003, and it increased to 27.6 thousand hm^2, increasing by 4 thousand hm^2 (Fig. 1c). This change arises from the extensive application of technology in agricultural production. Under the

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circumstance of increasing total output of grain and vegetable, and the low benefit of grain cultivation, people begin to seek other land management patterns and they are active increasingly. They conduct the agricultural structural adjustment, for example, opening up the orchard, growing vegetables by using vinyl house, reclaiming the untapped land and so on, so as to make the farmland area decrease, and the area of garden land and forest land increase.

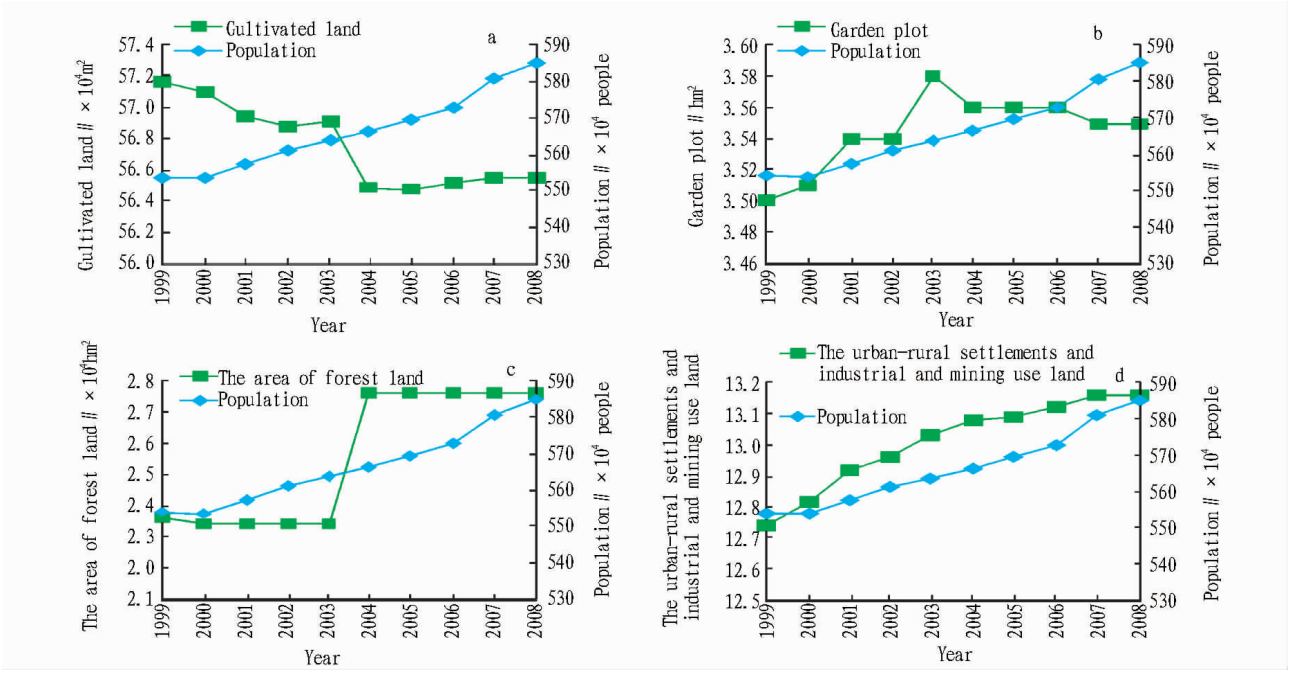

Fig. 1 The changes on land resources and population in Liaocheng City during 1999 – 2008

The area of urban-rural settlements, and industrial and mining land along with the curve of increasing population year by year, is increasing stably, from 0.127 million hm^2 to 0.13 million hm^2, increasing by 2.4% (Fig. 1d). There are many reasons. The farmers' life quality is improved and farmers' life standard is elevated. The rural economic reform develops rapidly and the town enterprises whose main body is processing industry of agriculture and stockbreeding are flourishing. The rural people's requirement of residential conditions is increasing incessantly, and the rural people's requirement of rural house sites and urban residential use land is increasing prominently; as the urban population increases, it needs more construction use land to solve the problems of urban people's residence, and also needs plenty of land to be used in urban road, green land and other infrastructures and public service facilities; due to the low cost of occupying agricultural use land in the periphery of cities and towns and overwhelming momentum of the expansion of urban construction use land, the urban-rural settlements, and industrial and mining use land are increasing[1-2]; the quantity of industrial enterprises is increasing greatly, and the rapid expansion of the industrial and mining use land makes the industrial and mining use land increase.

2.1.2 The per capita change of land resources. The change of per capita natural resources area and quantity is another important index of natural resources change, reflecting the condition and degree of contradiction between human and natural resources. Due to the rapid increase of population, the per capita natural resources change, but different natural resources have different tendency of change. According to the data from 1999 to 2008, the total population of Liaocheng City increases from 5.538 8 million to 5.849 1 million, increasing by 0.310 3 million. From Fig. 2, the per capita farmland amount tends to decrease. The per capita farmland decreases from 0.103 hm^2 in 1999 to 0.097 hm^2 in 2008.

The total amount of garden land either has the tendency of rise or has the tendency of fall. The area of garden land per capita was 0.006 32 hm^2 in 1999, the area of garden land per capita rose to 0.006 35 hm^2, and the area of garden land per capita decreased to 0.006 07 hm^2. The area of forest land per capita tends to rise, and the area of forest land per capita in a decade increases by 0.000 456 hm^2. The total amount of urban-rural settlements and industrial and mining use land increases, but the per capita amount tends to decrease. The per capita amount was 0.023 0 hm^2 in 1999, and it was 0.022 5 hm^2 in 2008, which indicates that the increased garden land, urban-rural settlements, and industrial and mining land can not answer the need of mushrooming of population.

2.2 The relative bearing pressure of resources and population

2.2.1 The analysis of relative bearing capacity of land resources. Taking the average level of Shandong Province as reference, the analysis of bearing capacity of land resources of Liaocheng City can be seen in Table 1. From 1999 to 2008, the bearing capacity index of the farmland area in Liaocheng City tended to rise, and the bearing pressure degree shown the fluctuation of fall and rise. The bearing pressure degree in 2006 was lowest (0.69); the bearing pressure degree in 2009 was highest (0.725). The bearing pressure of farmland area of Li-

aocheng City becomes small day by day, namely the bearable population of farmland area of Liaocheng City tends to increase continuously, which results from the fact that the population of Liaocheng increases slower than that of Shandong Province, indicating that controlling the population quantity can make the bearing pressure degree of farmland area of Liaocheng City rise with small margin. In the light of the farmland area, the population of Liaocheng City has not yet been overloaded, but the practical population is more than half of the bearable population. This is alarming, so according to the data in all years, we can find that in comparison with the average level of whole province, the farmland area of Liaocheng City is enough to sustain the practical population of Liaocheng City, and there is no acute contradiction.

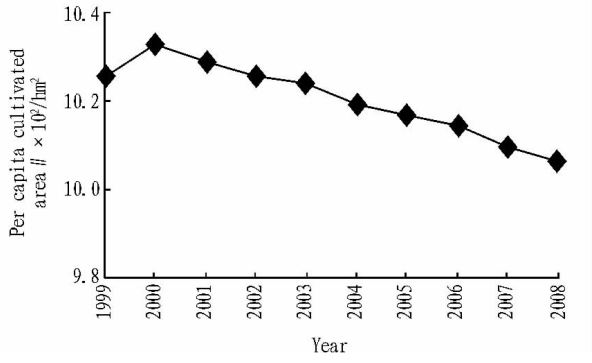

Fig. 2 The change of per capita cultivated land in liaocheng during 1999 – 2008

Table 1 The relative bearing capacity of farmland in Liaocheng city

Year	The farmland area of Shandong Province $\times 10^4$ m^2	The farmland area of Liaocheng City $\times 10^4$ m^2	The population of Shandong Province $\times 10^4$ people	The bearing capacity index $\times 10^4$ people	The population of Liaocheng City $\times 10^4$ people	The bearing pressure degree
1999	6 650 445	571 589	8 883	763.47	553.88	0.725
2000	6 638 861	571 000	8 997	773.82	553.58	0.715
2001	6 607 465	569 431	9 041	779.15	557.52	0.715
2002	6 560 696	568 821	9 082	787.42	561.31	0.713
2003	6 468 100	569 132	9 125	802.91	563.76	0.702
2004	6 374 610	564 923	9 180	813.54	566.45	0.696
2005	6 355 246	564 809	9 248	821.90	569.50	0.693
2006	6 339 382	565 226	9 309	830.00	572.82	0.690
2007	6 326 110	565 535	9 367	837.38	580.75	0.693
2008	6 321 484	565 535	9 417	842.47	584.91	0.694

2.2.2 The analysis of relative bearing capacity of forest resources. Taking the average level of Shandong Province as reference, the bearing capacity index of forest coverage area of Liaocheng City shown the fluctuation of fall, rise, fall and rise from 1999 to 2005, and the bearing capacity degree shown the fluctuation of rise, fall and rise on the whole. The fluctuation of fall and rise regarding the area of forest coverage of Liaocheng City from 1999 to 2002, was mainly caused by the variation of forest resources of Liaocheng City, and it is not the reason of per capita forest coverage area of whole province, because the forest coverage area per capita tends to fall all the while. The lowest relative bearing capacity of forest coverage area of Liaocheng City in 2002 was 1.03, namely it was 1.03 times quantity of the bearable population. The practical population was close to the bearable population. In addition, in the light of the curve of change, the bearing pressure decreased greatly from 1.42 to 1.03 from 2001 to 2002, but the bearing pressure tended to rise in some sort in other years. In 2005, the practical population was close to the bearable population again slowly, namely the forest resources of Liaocheng City can accommodate and sustain the practical population of Liaocheng City, so in order to make the imbalance between forest and population moderate, we must control the population quantity and raise people's awareness of protecting forest resources.

Table 2 The relative bearing capacity of forest resources in Lliaocheng

Year	The area of forest coverage of Shandong Province $\times 10^4$ m^2	The area of forest coverage of Liaocheng City $\times 10^4$ m^2	The population of Shandong Province $\times 10^4$ people	The bearing capacity index $\times 10^4$ people	The population of Liaocheng City $\times 10^4$ people	The bearing capacity index
1999	270.50	13.21	8 883	433.81	553.88	1.28
2000	278.96	12.27	8 997	395.73	553.55	1.40
2001	294.63	12.27	9 041	376.52	557.52	1.48
2002	294.63	16.11	9 082	496.59	511.31	1.03
2003	360.46	17.94	9 125	454.15	563.76	1.24
2004	376.12	17.94	9 180	437.86	566.45	1.29
2005	377.10	21.79	9 248	534.38	569.50	1.07

2.2.3 The analysis of relative bearing capacity of water resources. The practical situation of water resources is identical with the results of forest resources, and it contradicts the population more acutely (Table 3). Taking the total amount of water

resources per capita in Shandong Province as standard, from 2002 to 2008, the bearing capacity index of the total amount of water resources in Liaocheng City, on the whole, undergoes the fluctuation of fall, rise, fall, rise, fall and rise, namely the tendency of annual change is different. The tendency of bearing capacity degree is contrary to that of the water resources, is in that along with the mushrooming of population, the annual change of precipitation and runoff can cause the different total amount of water resources of whole province. The lowest total amount of water resources of Shandong Province in 2006 was 19.978 billion m^3, and the most bearable population of Liaocheng City was 4.729 5 million, but the bearing capacity degree was 1.21. The practical population of Liaocheng City was overloaded critically. So in order to ensure the sustainable use of water resources, we should control the population quantity, and raise people's awareness of saving water and cherishing water resources.

Table 3 The relative bearing capacity of water resources in Liaocheng

Year	The total amount of water resources of Shandong Province $\times 10^8$ m^3	The total amount of water resources of Liaocheng City $\times 10^8$ m^3	The population of Shandong Province $\times 10^4$ people	The bearing capacity index $\times 10^4$ people	The population of Liaocheng City $\times 10^4$ people	The bearing pressure degree
2002	238.81	10.50	9 082	399.32	561.31	1.41
2003	489.69	10.50	9 125	195.66	563.76	2.88
2004	349.46	10.50	9 180	275.83	566.45	2.05
2005	415.86	10.50	9 248	233.50	569.50	2.44
2006	199.78	10.15	9 309	472.95	572.82	1.21
2007	387.11	10.15	9 367	245.60	580.75	2.36
2008	228.96	10.15	9 417	417.46	584.91	1.40

3 Conclusion

In the light of the dynamic curve of natural resources and population, or the single item index, there are acute contradiction between natural resources in Liaocheng City and the practical population in Liaocheng City. In the light of the developmental tendency from 1999 to 2008, the overall tendency of change curve of farmland area along with the population change in land resources descends, but it can bear the current population of Liaocheng City; although the curve of forest resources rises, it is far from bearing the current population of Liaocheng City; the situation of water resources is not so rosy, which contradicts the population acutely. So in order to know the contradiction between large population, and relatively scanty resources and low economic developmental level, we should strictly control the population amount, and raise people's awareness of protecting natural resources so as to realize the harmonious and sustainable development of population, resources and economy.

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