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Study on Population Development and Carrying Capacity of Water Resources and Land Resources in China——Taking the Next 10 Years as an Example

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Abstract. The article takes the next 10 years as the research period to explore the challenges that water resources and land resources will face in the context of the universal two-child policy in China. By adjusting the population parameters in the policy context and using CPPS population forecasting software to predict the population size in the next 10 years, we find that the total population of China will continue growing in the next 5 years. In the next 10 years, the urban population will decrease very slightly after the increase for 7 years, reaching a peak in 2027, and the increase will cause deepening urbanization. It is necessary to take countermeasures to cope with the problem of the carrying capacity of water resources and land resources brought about by the growth of the total population and the deepening of urbanization under the influence of the universal two-child policy effect, so as to achieve the harmonious development of population growth and urbanization with ecological environment.

1. Introduction

In December 2015, the Standing Committee of the National People's Congress voted to approve the amendments to the Population and Family Planning Law. The full two children will be officially implemented on January 1, 2016. According to the statistics of the National Bureau of Statistics(2010)[1], the birth population of China in 2016-2018 showed a significant growth trend, indicating that the policy effect is obvious. Under the policy background, predicting the future population change trend is of reference value for analyzing the carrying of ecological resources. Eco-carrying capacity refers to the ecological environment resources within a certain period of time and a certain geographical range, which can meet the scale, scope and intensity of the social and economic activities of the population within the geographical range under the normal circulation and operation of the ecological environment. (Na GUO, Bo-Duo WANG, Chen CUI, Qiu-Ju ZHANG, 2011[2]). China has abundant land resources, energy, mineral resources, water resources and forest resources. Among them, water resources and land resources are the most important indicators for the natural resource demand of population development, and their carrying capacity should be paid attention to.

According to the statistics released by the Ministry of Natural Resources(2017)[3]: In terms of water resources, China's water resources estimate is 27,115 cubic meters, but the per capita possession of freshwater resources in China is 2,100 cubic meters, only 28% of the world per capita level. There are also problems such as water shortage, serious water pollution, serious soil erosion, and serious waste of water resources. In terms of land resources, China's soil area ranks third in the world,



mountain area is more than flat land, grassland, cultivated land and forest land account for 37.4%, 10.4% and 12.7% respectively, and the total number of hard-to-use land such as desert, Gobi, stone mountain and glaciers is about 20.5%, China's per capita possession of arable land is 802 square meters, less than one third of the world average.

Population development and ecological carrying capacity are inseparable. At present, the per capita possession of land resources and water resources in China is less than one third of the world average. Under the background of the universal two-child policy, the population size will change, which is related to ecological carrying capacity level in China. To forecast the trend of population change in the context of policies is of reference value for addressing land and water issues.

2. Research Methods and Data Description

2.1. Population Prediction Method

Selecting reasonable population prediction parameters and cardinality and forecasting tools is the key to accurately predicting the population. Through a detailed analysis of the benefits of demographic information in regional censuses and sample surveys, the academic community has progressively improved demographic prediction methods derived from mathematical methods. The well-known and commonly used population prediction method in the academic world is a scenario prediction method based on the queue factor prediction method, also called the fixed value prediction method. The probability prediction method corresponds to the scenario prediction method, also called the extrapolation prediction method. The calculation of the rules of the probability prediction requires a high level of statistical knowledge and its use rate is low(Fei TIAN,2010[4]). Ling LI et al (2016)[5] used the "China Population Forecasting Software" (CPPS) developed by Wang Guangzhou to predict the size of compulsory education students in 2016-2035 by adjusting the population parameters, and then estimated the compulsory education resources needed for the same period. Yan-Mei CHEN et al (2018) [6] established the ARIMA model based on the different age and sex mortality data of the population in China in 1994-2010, and predicted the mortality of the population with different age and sex in China in 2011-2050, and calculated the survival rate of different age and sex in the same period. Then based on the 2010 census data and the above predicted results, they predicted the elderly population with different age and sex in 2015-2050, and analyzed the aging trend in China. Yong-Bin WANG et al (2017)[7] calculated the number of childbearing age women(aged 15-49) with different age in China in 2015-2025, derived the number of births in 2015-2025, calculated the survival probability of the population with different age, and used the recursive formula to predict the population in China from 2015 to 2025.

The Population Prediction Software (CPPS) developed by Wang Guangzhou in 2002 by the Chinese Academy of Social Sciences uses the multi-factor method of demographic prediction method and adjust the population parameters for population prediction. The prediction results are consistent with the laws of population development and are persuasive. This paper uses CPPS software to predict the population of China's urban and rural population in the next 10 years. The article separately carries urban and rural population predictions. On the one hand, the measurement of urbanization degree has reference value for measuring the utilization degree of resources. On the other hand, the prediction of population separation between urban and rural areas will result in more accurate population results.

Guang-Zhou WANG (2002)[8] gave the analysis process of urban and rural population prediction algorithm in the "China Population Forecasting Software Training Manual" published in 2002, as follows:

(a) Rural population model:

$$nPt2(x+n)=(nPt1(x)-nMPt1(x))*[nL(x+n)/nL(x)];$$

x is in the range of 0 to 100 years old; nPt1(x) is the number of people aged x to x + n at t1; nPt2(x+n) is the number of people aged x+n to x+2n at t2; nL(x) is the number of years of cohort surviving in the exact age range of x to x+n; nL(x+n) is the number of years of survivors in the queue from the exact age of x+n to x+2n; nMPt1(x) is the number of rural migrants aged between x and x+n at t1, where:

$nMPt1(x)=TMPt1*nMIG(x)$; $TMPt1$ is the population migration during $t1$ year; $nMIG(x)$ is the migration mode, ie the age-specific population mobility.

(b) Urban population model:

$$nP't2(x+n)=(nP't1(x)+nMPt1(x))*[nL'(x+n)/nL'(x)];$$

x is in the range of 0 to 100 years old; $nP't1(x)$ is the number of people aged x to $x + n$ at $t1$; $nP't2(x+n)$ is the population aged $x+n$ to $x+2n$ at $t2$; $nL'(x)$ is the number of years of survival for the exact age in the x to $x+n$ queue; $nL'(x+n)$ is the number of years of survival for the exact age in the $x+n$ to $x+2n$ queue; $nMPt1(x)$ is the number of rural migrants or urbanized population aged between x and $x+n$ at $t1$.

(c) Total population model:

$$Tpop=\sum nPt2(x)+\sum nP't2(x);$$

$Tpop$ is the total population at time $t2$; $nPt2(x)$ is the number of rural population aged x to $x+n$ at $t2$; $nP't2(x)$ is the number of urban population aged between x and $x+n$ at $t2$.

2.2. The Selection of Population Prediction base and the Setting of Parameter

2.2.1. Population base. Based on the population data of cities, towns and villages in the sixth census data of 2010, including the population by age and sex. The urban and town population will be merged into urban population, and the rural population will be used directly.[1]

2.2.2. Fertility rate. The total fertility rate announced in the 2010 census was 1.44 and 0.98 respectively, bringing the total fertility rate into 2010-2013. After the implementation of the two-child policy alone and the universal two-child policy, the fertility rate changed. The study of Smith (1992) [9] shows that the total fertility rate (TFR) has a linear relationship with the general fertility rate (GFR), namely: $TFR = 30 * GFR$. We use the 2014-2016 population data published by the Bureau of Statistics to calculate the general fertility rate, and calculate total fertility rate by Smith's formula. The total fertility rates for urban and rural in 2014-2016 are shown in Table 1:

Table 1. Fertility forecast for 2014-2016

Fertility rate		Year		
		2014	2015	2016
Urban	TFR	1.379142	1.37147	1.602585
	GFR	0.045971	0.045716	0.053419
Rural	TFR	1.379122	1.371478	1.385092
	GFR	0.045971	0.045716	0.04617

2.2.3. Mortality. The use of CPPS to predict the population needs the gender-based, age-specific population mortality data, and the National Bureau of Statistics announced the gender-specific and age-specific mortality rates for 2010-2016. We use the 2016 TFR as the TFR for 2017-2030.

2.2.4. Life expectancy. The National Bureau of Statistics did not publish the expected life expectancy for urban and rural areas and for gender. We introduce the population basic data into the CPPS software, and the rural and urban gender-specific life expectancy is generated: 73.23 years old for rural males, 78.57 years old for females, 78.87 years old for urban males, and 83.08 years old for females. Use these data as the life expectancy of the population during 2010-2030.

2.3. Population Prediction Results and Analysis under the Background of Universal Two-Child Policy Introduce the base year data into the CPPS, and modify the corresponding parameters according to the above predictions. The total population, total urban and rural population data for 2020-2030 are shown in Figure 1- Figure 3:

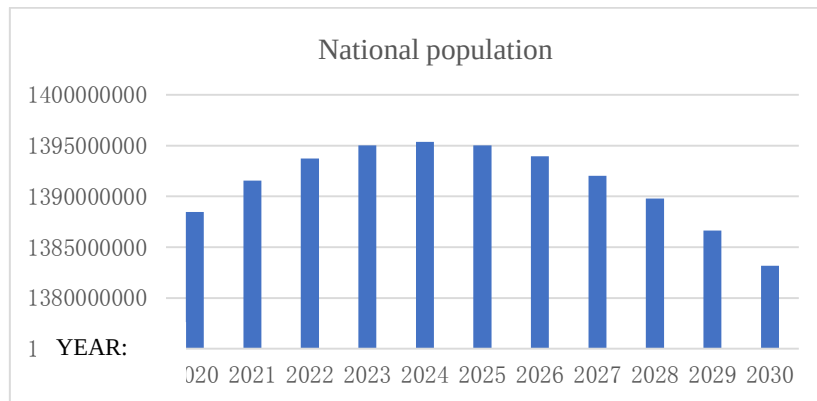


Figure 1. The total population of the country in 2020-2030

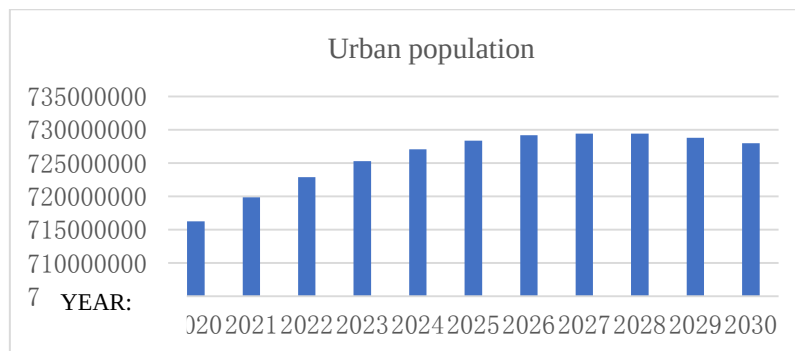


Figure 2. Urban population in 2020-2030

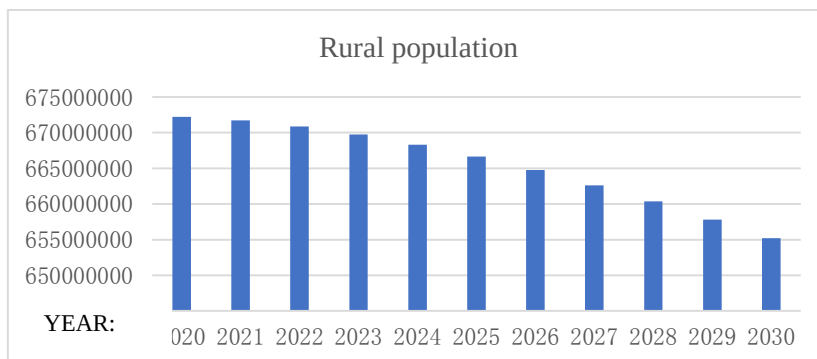


Figure 3. Rural population in 2020-2030

It can be seen that the total population of the country has continued to grow from 2020 to 2024, and has declined slowly from 2024 to 2030. The total urban population will rise continually from 2020 to 2027, and will decrease slightly from 2027 to 2030. The rural population decrease strictly during the period 2020-2030. The decrease indicates that China's urbanization rate is on the trend of rise.

3. Conclusions and Policy Recommendations

3.1. Conclusions

From the results of population prediction, we can see that China's natural resources will be shared by more people in the next 5 years (2000-2024), and the urban population will increase first and then decrease slightly in the next 10 years, reaching its peak in 2027, which will make China face the problem of deepening urbanization. Therefore, in the next 5 years, we need to deal with the carrying

capacity of water resources and land resources brought about by the growth of the total population, and in the next 10 years, we need to deal with the carrying capacity of land resources brought about by the deepening of urbanization.

3.2. Policy Recommendations and Conclusions

3.2.1. Summary. In general, water and land resources are the main natural resources. The effective and rational use of water and land has always been an important issue for the national economy and the people's livelihood. Although the Chinese economy has achieved remarkable results since the Reform and Opening-up, and China has basically achieved the goal of a well-off society. However, economic development is accompanied by the cost of overexploitation and overutilization of natural resources. While material life is being upgraded, we must pay more attention to the harmony and long-term development of population and natural resources. In order to effectively deal with the problem of natural resources, on the one hand, in the case of population growth, land and water should be more rational used as major natural resources. On the other hand, cultivate the long-term development awareness of the whole citizens, and encourage all citizens to innovate and save to laying a rich material foundation for sustainable development.

3.2.2. Policy recommendations. (a) Appropriate use and strengthen the protection of land resources. China's existing per capita land resources are far less than the world average. In the next 5 years, the total population will continue to grow, and more land resources need to be exploited and utilized. In the next 10 years, the urban population will decrease very slightly after the increase for 7 years, reaching a peak in 2027, and the increase will cause deepening urbanization. Urbanization is at the cost of the reduction of cultivated land and forest land, and the protection of land resources is more difficult in this case. It is necessary to improve the relevant laws and regulations on land use, strictly control land development, increase the research of land use efficiency technologies, increase the average utilization value of land, and try to meet the needs of more people living, leisure and production with less land.

(b) Save water and strengthen water resources protection. Like the dilemma faced by land resources, China's water resources per capita possesses only one-third of the world average level. In the sustained population growth of the next 5 years, the rational development and protection of water resources are more important. We should use the law as a compulsory force guarantee, use social media as a propaganda force, strengthen investment in science and technology research, pay attention to multi-use of water and use water as little as possible, strengthen the awareness of water conservation of all citizens, so as to raise the level of water purification, strictly control the scope and extent of water pollution, and achieve the sustainable development of water resources.

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