Development of urbanization in arid and semi arid regions based on the water resource carrying capacity -- a case study of Changji, Xinjiang

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Abstract. The arid and semiarid region in China where have a relatively weak economic foundation, independent development capacity, and the low-level of urbanization. The new urbanization within these regions is facing severe challenges brought by the constraints of resources. In this paper, we selected the Changji Hui Autonomous Prefecture, Xinjiang Uyghur Autonomous Region as study area. We found that agricultural planting structure is the key water consumption index based on the research about the main water demands of domestic, agriculture and industry. Finally, we suggest that more attentions should be paid to the rational utilization of water resources, population carrying capacity, and adjust and upgrade the industrial structure, with the purpose of coordination with the Silk Road Economic Belt.

1. Introduction

In 1935, geographers Hu Huanyong proposed a China's population density contrast line [1]. The line divided China into two parts. The area of the southeast of the line with population of more than 96% of the country in an area of 36% of the total area. The area of the northwest of the line with population of 4% and an area of 64% of the country [2]. In the meantime, this line fits with China's 400 mm annual rainfall isoline and is boundary of China semi-arid region and semi-humid region [3]. The climatic and environmental constraints directly led to the fact that a vast territory with a sparse population and weak economics in the northwest arid and semi-arid region [4].

Rapid urbanization and industrialization would inevitably cause pressure on the regional ecological environment [5]. Only quickly upgrading the level of urbanization and industrialization effectively alleviating the pressure on the fragile ecological environment and water resources in the western region of China, can ensure the sustainable development of urbanization and industrialization[6]. Chinese president Xi Jinping proposed the Grand strategic idea about the Silk Road Economic Belt offer the new opportunity for the development of the arid and semi-arid regions in western China [7]. We selected the Changji Hui Autonomous Prefecture, Xinjiang Uyghur Autonomous Region as study area, under the condition of limited water resources, to put forward a more reasonable new urbanization structure framework.

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2. Data & Methodology

2.1. Data

This research used Landsat 8 OLI_TRIS satellite digital products with spatial resolution of 30 meters and DEM with spatial resolution of 30 meters. They were both from Geo spatial data cloud (http://www.gscloud.cn/). Data pre-processing include image stitching and cutting, atmospheric correction, etc. Demographic and economic data were from Bureau of Statistics of Changji Hui Autonomous Prefecture. Water supply and use data were from the Statistics Bureau of Xinjiang Uygur Autonomous Region. The cultivated area and the unit area yield data of the main crops were from the Changji Hui Autonomous Prefecture national economic and social development statistical bulletin in 2015.

2.2. Methodology

2.2.1. Statistical Study of Changji's urbanization

In recent years, Changji's economic and social developed rapidly. In 2015, the GDP of Changji was 114 billion yuan and increased by 12% over the previous year. Among them, the first industry added to 25 billion 200 million yuan, increased by 4.9%; second industry added value of 55 billion yuan, increased by 15.3%; the third industry added value of 33 billion 800 million yuan, increased by 11.2%. Per capita GDP of the resident population was 70700 yuan and increased by 12.0% [8]. But economic was imbalance at Changji where western two counties and one city accounted for 68% of the total economic output, and eastern three counties accounted for 32%.

2.2.2. Statistical Study of Water resources in Changji

The total amount of available water resources is 2 billion 942 million cubic meters in the Changji Hui Autonomous Prefecture, accounting for only 4.04% of the available total amount of the whole Xinjiang. Changji is one of the most water shortage states in Xinjiang. The per capita possession of surface water resources is only 1,617 cubic meters and is below the average level of the whole country (1920 cubic meters) and Xinjiang (2988 cubic meters) and is below the Internationally recognized signs point for water use (1700 cubic meters). This is visible that water resources pressure is obvious in the development process of Changji[9],[10].

Table 1. Water resources comparison between Chingji and Urumqi（Units: billion cubic meters）.

Region	Water supply	Water consumption			
		primary industry	secondary industry	tertiary industry	Life & environment
Urumqi	11.24	6.51	2.39	0.32	2.01
Hui Autonomous Prefecture of Changji	**47.92**	**44.27**	**2.20**	**0.16**	**1.30**

(Data sources: Statistical Bureau of Urumqi Autonomous Region)

The primary industry precise agricultural irrigation water accounts for 91% of the total water consumption of the national economy. It plays a significant role in the water structure of the Hui Autonomous Prefecture of Changji. Israel has a more severe problem about water resource shortages, but Israel's agriculture has become one of the three pillar industries for the national economy and foreign trade[11-13].

Table 2. The agricultural economic contrast analysis between Changji and Israel

Region	Crop	Cultivated Area(hm^2)	Water consumption per unit(m^3/hm^2)	Yield(kg/ hm^2)	Water economic benefit (USD/m^3)
Hui Autonomous Prefecture of Changji (in 2015）	wheat	185720	5 742	5936.85	0.41
	corn	108240	5052	10296.6	0.52
	cotton	80286.67	8 650	1867.05	0.27
	primary industry	**547366.7**	\	\	**1.22**
Israel (in 1997)	\	**518100**	**2179**	\	**13.59**

(Data sources: Source Mews Beauru of Israel Embassy in China, “Agriculture of Israel (1997)”)

2.2.3. Constructed water resources carrying capacity model

Although the total amount of water resources in the Hui Autonomous Prefecture of Changji is relatively stable, the water supply capacity in Changji region continued to increase from 2005 to 2014 years, especially after the year of 2010. In 2014, the total water consumption in Changji was 4 billion 792 million cubic meter, which is about 4.3 times of Urumqi City, while Changji's GDP was 106 billion yuan, which was less than 50% of Urumqi's GDP. The first industrial water accounted for 92.4% of the total water supply, second and third of the industrial water accounted for 4.9% of the total water supply, water consumption accounted for only 1.7% of the residents. Among them, the agricultural irrigation water accounted for 91% of the total water consumption of the national economy. Agricultural water consumption has a significant role on the total amount of water in Changji, and is also the key factor to restrict the carrying capacity of water resources in the Hui Autonomous Prefecture of Changji. Although the water structure has improved slightly in recent years, the change is not significant.

The structure of water consumption can reflect the economic level, the scientific and technological levels, and the civilization degree. In developed countries, the proportion of living water is 15%~20%, the proportion of industrial water is 35%~40%, and the proportion of agricultural water is 45% ~ 50%[14].

We use regression analysis method and nearly a decade of data sets built the per capita water demand forecasting model of the Hui autonomous prefecture of Changji, then improve the model by selecting some coefficients from the structure of water consumption in developed country, the final conceivable prediction population capacity based on water resources may attain to 2.0514 million at Changji. This number may be a good reference in the future development of urbanization in this region.

3. Conclusion

Changji's situation of water supply has improved in recent years, water supply capacity increased year by year. But the supply of water resources is basically used by the first industry which did few contributions to the region economic development. Adjusting the water supply structure, reducing the first industrial water consumption, more to use on the second industries, promoting the transformation of economic structure, is conducive to better development.

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