

The Factor of Water Shortage

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Keywords: rainfall capacity, city development, the large population base, fast increasing population.

Abstract. This report chooses Zhengzhou in China as the example. We discover rainfall capacity is getting less by historical data, so there is not enough groundwater storage. This is the environmental drive factors of physical shortage. According to the historical data, we also discover that the fast city development, the large population base and fast increasing population are the social drive factors of physical shortage. Using s-type curve model to compare Zhengzhou to the saving water city Shanghai, we get the fact that backward technology and poor realization of saving water are the social drive factors of economic shortage.

1. Introduction

We choose Zhengzhou as our research object which has a serious water shortage in China by observing and analyzing the UN water scarcity map. We think from social factors and environmental factors separately. By the natural condition of topographic climate and the historical data probe. The influence of the environmental drivers which cause the physical shortage of water sources in the aspects which are water utilization rate, usable exploration, and the quantity of water diversion. Taking social economic development and population increase that cause the increase of water requirement in the region probes the influence of the social drivers which cause the physical shortage of water sources.

2. Model

Resolve the reason of water shortage in Zhengzhou in physical aspect. The reason has two aspects which are environmental factors and social factors^[1].

The influence of the environmental factors is shown as below:

Zhengzhou is in the semi-humid and semi-arid regions in China. Environmental factors are also the reason of water sources shortage. Environmental factors mainly include climate, landscape, geological condition and so on aspects. Environmental factors causing water sources shortage mainly include two below factors: firstly annual precipitation is little and the plustochron of twice precipitation. The precipitation concentrate in between seven and eight month as well as it continues drought in winter and spring. The ratio of maximum precipitation and minimum precipitation is comparatively large. The also comparatively large change of inter annual precipitation variation causes meteorological drought and make supply of the water sources drop. So cause the water shortage; The Zhengzhou landscape incline from southwest to northeast on the whole and conform high, middle and low three ladders. Excess from middle mountain, low mountain and hills to plane and the divide of hills and plane is distinct.

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Under the restraint that the landscape surface and underground shallow layer lack water and that the water storage doesn't have enough space. Even if it meet the short period precipitation in the flood season, main precipitation will flow away in form of cataract. After the flood season the water sources is short as before. Because the precipitation is rare and the water storage doesn't have enough space, somewhere surface and underground shallow layer water sources are very limited and can't satisfy the demand of the human's lives and possession. So conform water shortage.

The below table analyze and prove the environmental factors which cause water shortage by some historical data^[2].

The situation of water supply is shown as below:

Table 1 The situation of water supply

Year	QWD	OWS	TWS	SWU	UWU
1999	2.582	0.00	8.840	1.00	1.00
2000	-3.939	0.00	13.003	0.92	0.77
2001	2.579	0.00	9.063	1.00	1.00
2002	2.419	0.00	9.441	1.00	0.71
2003	-11.48	0.00	21.002	1.00	0.67
2004	-6.228	0.00	16.703	1.00	0.87
2005	-2.876	0.00	12.870	1.00	1.00
2006	0.582	0.33	10.525	1.00	1.00
2007	0.423	0.35	11.262	1.00	1.00
2008	4.793	0.36	8.427	1.00	1.00
2009	2.675	0.36	10.327	1.00	1.00
2010	0.891	0.35	11.403	1.00	1.00
2011	3.784	0.35	10.961	1.00	0.93
2012	7.372	0.35	8.573	1.00	1.00
2013	6.317	0.57	8.170	1.00	1.00
2014	6.559	0.84	7.915	1.00	1.00

Notes:

- QWD is the quantity of water diversion which the unit is one hundred million m^3 .
- OWS is other water consumption which the unit is one hundred million m^3 .
- TWS is total water resources which the unit is one hundred million m^3 .
- SWU is surface water utilization.
- UWU is underground water utilization.

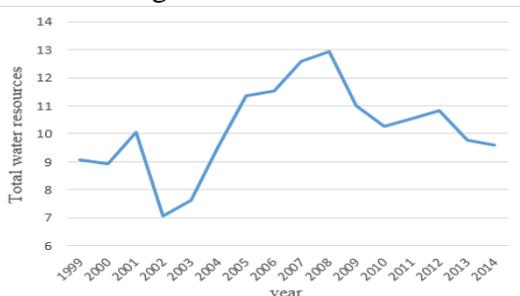


Fig.1 Total water resources

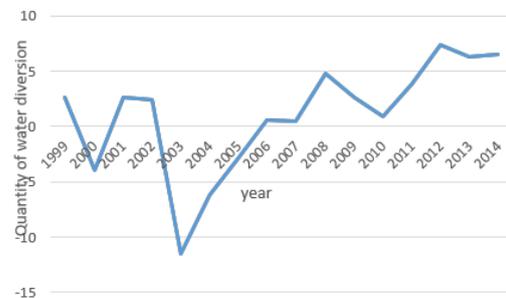


Fig.2 Quantity of water diversion

From Table 1 we can get surface water utilization and underground water utilization most are equal to one. The usable exploitation of surface and underground water has gotten to the limit. Minority which didn't reach the limit is due to the precipitation is large in the year. Over-exploitation can make grounder water level decline sharply and significantly so that conforms groundwater drop

funnel, cause the ground settlement and subsidence damage, affect soil and water conservation, cause soil erosion and affect the growth of vegetation. So people can't overmuch explore surface and underground sources. By above analyzing the exploration of surface and underground water has approached to saturation. Such as Fig.2 the quantity of water diversion appears growing trend. The quantity of water diversion all is plus which represents need to move water from outland except extremely individual precipitation in the year. Other water supply quantity is the available water by means of rainwater treatment, reuse of sewage and other water treatment technology. By this we can get the Zhengzhou development is very late. Such as Fig.1 the wave motion of total water resources is related to the wave motion of surface water resources and the increase of other water supply quantity. Under the combination of both although total water resources has wave motion, the total water resources in Zhengzhou don't have the growing trend.

In summary we can get the physical drive factors which cause Zhengzhou water resources shortage by historical data. These shortage reflects in that the use of groundwater resources and surface water resources have reached to saturation. By the increase of economic and the number of population yearly water consumption need to increase continuously.

The situation of demand water is shown as below table:

Table 2 The situation of demand water

Year	NP	PWC	IWC	AWC	TWC
1999	631.6	2.469	3.581	8.13	14.361
2000	665.9	2.734	3.776	7.979	14.488
2001	677	3.086	3.9509	8.125	15.512
2002	687.7	3.06	3.93	8.79	15.78
2003	697.7	3.162	3.82	7.251	14.232
2004	708.2	3.659	3.816	6.426	13.765
2005	716	4.04	4.805	7.049	15.894
2006	724.3	4.328	5.232	6.557	16.117
2007	735.6	4.749	5.393	6.323	16.465
2008	743.6	6.8	5.756	6.174	18.73
2009	752.1	6.326	5.118	5.978	17.422
2010	866.1	6.72	5.467	5.388	17.584
2011	885.7	7.088	5.628	4.034	20.475
2012	903.1	7.395	5.678	4.055	20.725
2013	919.1	10.814	5.812	4.474	17.374
2014	937.8	10.992	5.610	4.839	17.844

Notes:

- NP is the number of population which the unit is one thousand people.
- PWC is the population water consumption which the unit is one hundred million m³.
- IWC is the industrial water consumption which the unit is one hundred million m³.
- AWC is the agricultural water consumption which the unit is one hundred million m³.
- TWC is the total water consumption which the unit is one hundred million m³.

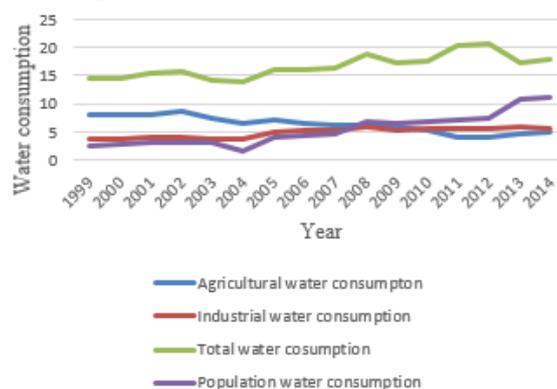


Fig.3 Water consumption

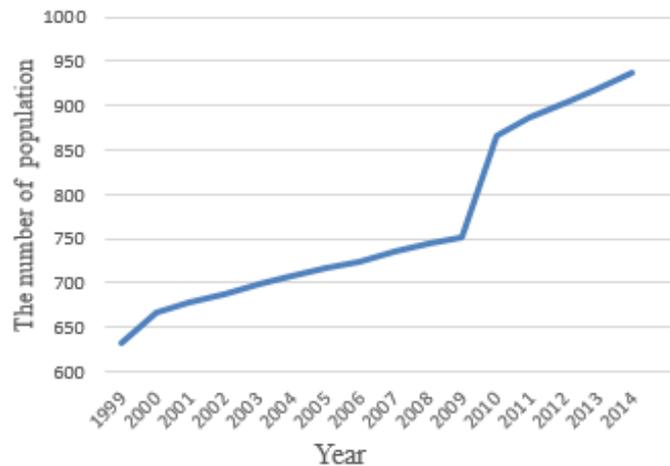


Fig.4 The number of population

Population water consumption appears growing trend by Fig.3. And industrial water consumption appears growing trend too. This is because water consumption under unit million GDP is decreasing but the development of economic is fast. So the demand of industrial water consumption is increasing^[3]. The agricultural water consumption appears decline trend. This is because the development of economic and the increase of degree of urbanization^[4]. Agricultural technology improve continuously. Corresponding agricultural water consumption and the area of crop are less and less. But due to the decline of agricultural water consumption has little influence to the total water consumption, the total water consumption also appears growing trend.

In short, in the common influence of increasing population, economic development, per capita GDP and other social factors, Zhengzhou total water consumption is increasing which is the social factors causing water sources physical shortage,

Above environmental and social factors common cause the water sources physical shortage.

3. Summary

In the example of Zhengzhou of China, we discover rainfall capacity is getting less by historical data, so there is not enough groundwater storage. This is the environmental drive factors of physical shortage. According to the historical data, we also discover that the fast city development, the large population base and fast increasing population are the social drive factors of physical shortage. Using s-type curve model to compare Zhengzhou to the saving water city Shanghai, we get the fact that backward technology and poor realization of saving water are the social drive factors of economic shortage.

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