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Research Article

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Correlation analysis on water resources utilization and the sustainable development of economy in Minqin of Gansu Province

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ABSTRACT

This paper analyze the relativity of water resources utilization in Minqin and economic sustainable development adopting optimal multiple regressions. The results show that: 1There is remarkable correlation between the economic growth and the demand of water resources. On condition that the sustainable development of economy is satisfied, the growth of rural population is a huge pressure on water resources. It is an appropriate measure to coordinate the environmental protection and social economic development that reducing the consumption of water for rural population or accelerating the process of urbanization and developing forestry and animal husbandry. 2) Increasing urban population and developing industry and modern farming can promote our economic growth at the same time reduce the pressure on water resources significantly. 3) 97.5% of the variation in the total water requirement of Minqin is caused by two variables-"animal husbandry output value" and "rural population". So the major routes of rational utilization of water resources and the sustainable development of social economy in Minqin are reducing the consumption of water for rural population constantly or accelerating the process of urbanization and optimizing animal husbandry industry further.

Key words: Water Resources Utilization; the Sustainable Development of Economy

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INTRODUCTION

Minqin belongs to the last irrigation area of Shiyang River system, and is short of water resources. It result in serious water resource crisis and ecological crisis in this region that surface runoff and ground water resources in Shiyang River Basin are highly developed and utilized, surface water and ground water transform many times and reuse, and the total water consumption is far more than total amount of water resources, water shortage is very serious. Because of the shortage of water resources，surface vegetation，grassland and psammophyte degenerate，decline and even die in large areas in this region. Sand barrier on the edge of the county piecewise open and originally fixed dune start to move. Desert grassland accounts for more than two-thirds in natural pastures in the whole county, and nearly 4 million mu natural gravel pasture degenerate into desert grassland. Quicksand annually advances towards the county hinterland at the rate of 3 ~ 4 m, and individual sections even reach 8~10m. There are 0.3 million mu of cultivated land directly suffer sandstorm attacks each year, and 0.1million mu of cultivated land is desert. Sandstorm and other severe weather cause huge economic losses to the local and even pose a serious threat to the climate and ecological changes. Study on the utilization of water resources in Minqin received extensive attention, which mainly focused on water resources assessment [1,2,3] and optimal allocation of water resources [4,5,6] etc, on the contrary, rarely focused on the relationship between water resources utilization and social economic development. This paper tries to analyze the relationship between water resources utilization and social economic development and provide basis for coordinating the relationship between environmental protection and economic development of Minqin.

SKETCHY CIRCUMSTANCES IN RESEARCH AREA

Minqin lies in the west of Gansu Province, the lower reaches of Shiyang River on the north side of the eastern end

of the Hexi Corridor, surrounded by Tengeryn and Badan Jilin desert to the east. The county area is vast, the terrain dip from southwest to northeast. The topography is mainly high plains, also includes low mountains and basins, the desert landforms significant. It covers an area of 15900 square kilometers and averages over 1367 meters above sea level. Among them, sand dune and Gobi desert account for over 85%, but the county only account for less than 9%. For thousands of years, Minqin is an important green barrier to prevent the two desert confluence. Once Minqin disappeared, the Tengger Desert and Badan Jilin Desert would join and move south, cutting off the thousands of miles of Hexi Corridor [7]. Minqin has 309,000 people in 2009. The national economy maintained a rapid, healthy development momentum. The second and the third industry development speed pick up，industrial structure develop reasonably. The primary industry agriculture accounted for the major proportion in the development of national economy, the development of the second industry faster than agriculture, having already started to show the promotion on the development of the national economy. Water resources supply in Minqin mainly includes four parts: atmospheric precipitation, surface water, ground water and trans-basin diversion. The surface water and groundwater is the main source of water resources in Minqin, but the precipitation amount is very little, mainly focusing on summer, and the effective precipitation is less, and the amount of trans-basin diversion is limited in a short period. Minqin belongs to the arid area that is no output if there is no irrigation; the supply of water resources directly determines the ecological environment change and social economic development level. Therefore, analysis of the relationship between the utilization of water resources and social economic development of the county has important practical significance in promoting the sustainable development of social economy.

EXPERIMENTAL SECTION

RESEARCH MATERIALS AND METHODS

(1)Research Materials

Research materials come from Minqin Statistical Bureau, Forestry Bureau and Agriculture and Animal Husbandry Bureau.

(2)Research Methods

First, divide water resources of Minqin into ecological water, production water and living water on the basis of the characteristics of the utilization. The secondary structure and dependent water resources of a variety of water resources will be shown in Table 2-1.

Table 2-1 Water resources utilization type and structure of Minqin

Ecological water	Dependent water resources	Production water supply	Dependent water resources	Domestic water	Dependent water resources
Water demands of water and soil conservation	Precipitation、Irrigation supply	Industrial production	Surface water、Groundwater	Human water consumption	Surface water、Groundwater
Vegetation water	Precipitation、Irrigation supply	Agricultural production	Surface water、Groundwater	Livestock water supply	Surface water、Groundwater
Water requirement of water area	Precipitation、Surface water	Tourism	Surface water、Groundwater		
Water requirement of groundwater conservation	Precipitation、Irrigation supply				
Evaporated water	Surface water				

There are many ways to calculate ecological water requirement, such as transpiration method, dry method, soil lysimeter method, hydrothermal coefficient method, water balance method and so forth [8,9,10]. Ecological water requirement (water consumption) calculation of Minqin uses groundwater evaporation. Minqin multi-year average evaporation is 2643.9 mm which is calculated by the diving evaporation method according to a study by Xiuying Yang [11] and others [11]; Minimum ecological water requirement in vegetation is 199.7～247.9 million m3 (Except agricultural irrigation vegetation).Living water and agricultural irrigation water in this region is 426.3～545.8 million m3, but the total water requirement is 666.9～787.2 million m3. According to the sampling survey analysis, the average water consumption of each person in each day (including livestock) is 0.8 m3.In terms of 309000 people in Minqin in 2005, living water requirement is 24.72 million m3, and the total production and living water is 406.08 million m3 except industrial water.

Regard industrial output value（X1，ten thousand Yuan）, crop production（X2，ten thousand Yuan）, forestry output value（X3，ten thousand Yuan）, animal husbandry output value（X4，ten thousand Yuan）, rural population（X5，ten thousand people）, urban population（X6，ten thousand people）as influence factors, and analyze the relationship between water resources and its influence factors in Minqin.

RESULTS ANALYSIS

(1)Correlation Analysis of the Water Resources Carrying Output Value and Total Water Consumption in Minqin

Tab3-1 GDP and the total water requirement statistics of Minqin in 2002-2009

Time (Year)	Water resources carrying output value （Ten thousand Yuan）	Total output value growth rate (%)	Total water requirement(Ten thousand m3)	Total water requirement growth rate （%）
2002	103641		75785	
2003	115013	10.97	71906	-5.12
2004	127006	10.43	72740	1.16
2005	147165	15.87	68555	-5.75
2006	175749	19.42	67100	-2.12
2007	206986	17.77	63600	-5.22
2008	235558	13.80	57600	-9.43
2009	191981	18.50	53600	-6.94

Here, the correlation of the total water requirement (the total water consumption) and the water resources carrying output value is used to measure the extent of economic growth and social development on water resources dependence. The water resources carrying output value and total water requirement from 2002-2009 in Table 3-1 will be treated as variables, then work out the correlation coefficient of the total water requirement and water resources carrying output value through SPSS analysis software. It is shown in Table 3-2(X and Y represent the water resources carrying output value and total water requirement).

Table 3-2.Correlation Coefficient and Covariance between GDP and Water Consumption in Minqin

		Y	X
Y	Pearson Correlation	1.000	-0.871（**）
	Sig.（2-tailed）		0.005
	The Standard Deviation of Cross Product	15570000000	-2207000000
	Covariance	2225000000	-315300000
	N	8	8
X	Pearson Correlation	-0.871（**）	1.000
	Sig.（2-tailed）	0.005	
	The Standard Deviation of Cross Product	-2207000000	412800000
	Covariance	-315300000	58980000
	N	8	8

***. It is significantly correlated in 0.01 levels (double side).*

It is seen from table 3-2, the Pearson correlation coefficient of the total water resources capacity output value and the total water requirement in Minqin is -0.871.If the probability is only $P=0.005<0.01$,that the correlation coefficient between the total water resources carrying output value and the total water requirement is zero, we can reject the null hypothesis, and believe that there is a strong negative correlation relationship between the total water resources carrying output value and the total water requirement in Minqin. The above suggest that the growing of the total water resources carrying output value in Minqin is realized under the condition of the total water requirement shrinking. It is precisely in accord with the overall direction of water resources and the relevant industrial planning in Minqin, that the average of per ten thousand Yuan output value of water resources requirement that is the average water consumption quota (unit: ten thousand cubic meters / ten thousand Yuan) is shrinking, and also suggest that Minqin water resources and the relevant industrial planning has been achieved significant results.

(2)The Correlation Analysis of Total Water Requirement and Each Influence Factor in Minqin

Table 3-3.Impact Factors and Water Consumption from 2002 to 2009 in Minqin

Time （Year）	Industrial output	Crop production value	Forestry output value	Animal husbandry output value	Rural population	Urban population	Total water requirements
2002	49316	43796	1092	9317	25.01	5.68	75785
2003	58006	46106	1241	9650	24.70	6.01	71906
2004	65065	50756	619	10565	24.70	6.02	72740
2005	79238	55483	404	11040	24.51	5.62	68555
2006	103803	60068	427	11451	24.19	6.92	67100
2007	127528	67648	412	11398	23.98	7.32	63600
2008	158366	67914	678	8600	22.65	7.55	57600
2009	117982	63782	804	9413	22.60	7.75	53600

Table 3-4.The Means and Standard Deviations of Impact Factor and Water Consumption in Minqin

Variable	Mean	Standard Dev	Cases
X1	94913	38320.1810	8
X2	5694413	9427.8626	8
X3	709.625	318.1540227	8
X4	10179.25	1075.5161	8
X5	24.0425	0.9308023	8
X6	6.60875	0.8731296	8
Y	6360.75	7679.5792	8

Table 3-5.The Zero Order Correlation Coefficients among Variables

Variable	X1	X2	X3	X4	X5	X6	Y
X1	1.0000	0.964	-0.487	-0.114	-0.872	0.895	-0.870
Sig.	0.000	0.000	0.220	0.787	0.005	0.003	0.005
X2		1.0000	-0.645	0.111	-0.813	0.876	-0.863
Sig.		0.000	0.084	0.793	0.014	0.004	0.006
X3			1.000	-0.690	0.194	-0.277	0.292
Sig.				0.058	0.646	0.506	0.483
X4				1.000	0.412	-0.161	0.250
Sig.					0.310	0.703	
X5					1.000	-0.896	0.977
Sig.						0.003	0.000
X6						1.000	-0.906
Sig.							0.002
Y							1.000
Sig.							0.000

Table 3-6.The Results of Correlation Analysis between Independent and Dependent Variables

	X_1	X_2	X_3	X_4	X_5	X_6
Y	-0.87	-0.863	0.292	0.250	0.977	-0.906
Sig.	0.005	0.006	0.483	0.550	0.000	0.002

Table 3-7.Industrial and Agricultural Output and Water Consumption from 2002-2009 in Minqin

Time (Year)	Industrial output	Growth rate	Industrial water requirement	Rate of change in water requirements	Crop production value	Growth rate	Crop water requirement	Rate of change in water requirements	Total water requirements
2002	49316		677		43796		64010		75785
2003	58006	17.62	690	1.92	46106	5.27	58272	-8.95	71906
2004	65065	12.17	710	2.90	50756	10.08	57840	-0.01	72740
2005	79238	21.78	953	34.23	55483	9.31	55539	-3.98	68555
2006	103803	31.00	900	-5.56	60068	8.26	56200	0.01	67100
2007	127528	22.85	900	0.0	67648	12.62	52000	-7.47	63600
2008	158366	24.18	317	-183.90	67914	3.92	48234	-7.81	57600
2009	117982	-25.50	150	-111.33	63782	-6.08	42708	-12.94	53600

From the point of partial correlation coefficient, there is a strong negative correlation relationship（ryx1=-0.87，Sig=0.005） between industrial production (X1) and water requirement(Y). It suggests that under the condition of satisfying economic sustainable development，industrial output growth that increase by 17.78% annually is far higher than the growth rate of industrial water. Therefore industrial development is beneficial to reduce the demand for water resources. Likewise, there is also a strong negative correlation relationship（ryx6=-0.906，Sig=0.002） between urban population (X6) and water requirement (Y).(See Table 3-6for details). It suggests that the improvement of urbanization is also beneficial to reduce water requirement. During the period of 2002-2009, there also exists a significant negative correlation relationship（ryx2=-0.863，Sig=0.006）between crop production (X2) and water requirement (Y).It suggests that in contrast to the traditional farming, with the optimization of planting structure in recent years and the total cultivated area reducing slightly, the annual average crop production growth is 8.24%, and water requirement reduce by 5.88% annually. The increasing output don't increase the demand of water resources, which reduces the instead (Table 3-7), that also shows planting industry structure adjustment and the allocation of water resources has presented a benign planning trend in recent years in Minqin.

From the point of zero order correlation coefficient, forestry output value (X3), animal husbandry output value (X4), the rural population (X5) and the total water requirement (Y) have a positive correlation. The zero order correlation coefficient of forestry output value (X3), animal husbandry output value (x4) and the total water requirement (Y) is only 0.292 and 0.250, and the significance level respectively is 0.483, 0.550, suggesting that there don't exist

significant correlation between forestry output value (X3), animal husbandry output value (X4) and the total water requirement (Y). But the zero order correlation coefficient of rural population (X5) and the total water requirement (Y) is 0.977, and the significance level respectively is 0.0000, suggesting that there exists a significant correlation between rural population (X5) and the total water requirement (Y)(It is shown in Table 3-3, 3-4, 3-5 and 3-6). From a realistic perspective, these results also showed that during 2002—2009, the planning of these two industries forestry and animal husbandry appear a certain randomness, and there is no clear trend of planning and great planning space, so it need to make further spatial planning for these two industries in the future; contrary to the urban population (X6), the increasing of the rural population (X5) is not conducive to reducing water resources requirement. So it can improve the efficiency of water utilization by reducing the consumption of water for rural population and urbanizing the rural population in the future.

CONCLUSION

The correlation analysis between water resources and social economic sustainable development indicates that：

1）The growth of water resources carrying output value in Minqin is realized under the condition of total water requirement declining. It is precisely in accord with the overall direction of water resources and the relevant industrial planning in Minqin, that the average of every ten thousand Yuan output value of water resources requirement that is the average water consumption quota (unit: ten thousand cubic meters / ten thousand Yuan) is shrinking, and also suggest that Minqin water resources and the relevant industrial planning has been achieved significant results.

2) There is a remarkable correlation between the economic growth and the demand of water resources. On condition that the sustainable development of economy is satisfied, the growth of rural population is a huge pressure on water resources. It needs to reduce the consumption of water for rural population or accelerate the process of urbanization and make further spatial planning for forestry and animal husbandry in the future; on the contrary, urban population growth, industrial and modern agriculture development can significantly reduce the pressure of economic development on water resources, and present a benign development trend, and need to constantly maintain and continue to optimize in the future.

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