Postprint: Assessment of Water Resources Development Potential in Central Asia Based on Fuzzy Comprehensive Evaluation Model

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Date: 2020-01-06T00:00:00+00:00

Abstract

Quantitative assessment of water resources development potential is of great significance for grasping the current status of regional water resources development and improving water resources utilization efficiency. By selecting eight important indicators including water resources utilization rate, irrigation rate, surface water control rate, per capita water availability, water reuse rate, domestic water quota, water supply modulus, and ecological environmental water use rate, a quantitative analysis of the water resources development potential of the five Central Asian countries was conducted using the fuzzy comprehensive evaluation model. The results show that the overall water resources development and utilization in Central Asia is at an intermediate stage, with a comprehensive development potential score of 0.502 7, indicating considerable development potential. Among them, Kazakhstan has the highest comprehensive water resources score of 0.712 4, with great development potential, but it is crucial to abandon unreasonable water resources utilization patterns; Kyrgyzstan and Tajikistan have comprehensive scores of 0.591 1 and 0.488 7, respectively, with considerable development potential, but attention should be paid to gradually shifting from extensive development to intensive development. The downstream countries of Turkmenistan and Uzbekistan are at an advanced stage of development and utilization, with comprehensive scores of 0.352 6 and 0.315 0, respectively, and have limited water resources development potential. In the future, attention should be paid to developing a water-saving economy and emphasizing integrated water resources management.

Full Text

Preamble

DOI: 10.12118/j.issn.1000-6060.2020.01.15

Journal: Arid Land Geography

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Abstract

Central Asia is located in the center of Eurasia, with a large number of transboundary rivers, and the conflicts in using water resources are aggravating under the dual influence of climate change and human activities. The problem of water resources and ecological environment in this region has always been a hot topic in academic research. The quantitative assessment of the development and utilization potential of water resources in the region is of great significance for understanding the current status of water resources and improving the utilization rate of water resources. Based on the statistics of water resources from 1997 to 2014, we selected eight indicators, including utilization rate of water resource, irrigation ratio of arable land, control rate of surface water, per capita water supply, recycling rate of water resource, live use water quota, water supply module, and ecological water use ratio to establish an evaluation index system for the water resources, then quantitatively analyzed the development potential of water resources for five countries in Central Asia by using fuzzy comprehensive evaluation model. The results show that the development and utilization of water resources in Central Asia is in the intermediate stage, and the evaluated value is comparatively great (0.5027), which indicates a great exploitation potential of water resources. Among these five countries, Kazakhstan has the highest evaluated value (0.7124), which indicates the greatest exploitation potential of water resources, but unreasonable use of water should be abandoned. The evaluated values of Kyrgyzstan and Tajikistan are 0.5911 and 0.4887 respectively, which indicates a large exploitation potential of water resources, but these two countries should be transformed from breadth development to depth development gradually. The development and utilization of water resources in Turkmenistan and Uzbekistan are all in the advanced stage, and the evaluated values are 0.3526 and 0.3150 respectively, which indicates a least exploitation potential of water resources. In the future, these two countries should develop

water-saving economy, and pay attention to the integrated management of water resources. All these conclusions provide scientific basis and decision support for the sustainable utilization of water resources in Central Asia.

Keywords: development potential of water resources; fuzzy comprehensive evaluation model; the five Central Asian countries

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Tables

Table 1: Socioeconomic Situation of the Five Central Asian Countries in 2014

Country	Population (10 persons)	Population Growth Rate (%)	GDP (10 USD)	Per Capita GDP (USD)	Area (10 km²)	Grain Yield (kg · hm ²)
KAZ	1728.83	1.45	583.55	2214.16	272.49	836.27
KGZ	583.55	1.45	12807.26	74.68	19.99	92.36
TJK	546.62	2.21	3075.77	92.36	14.31	435.24
TKM	6771.05	1.40	2214.16	630.67	49.93	3447.11
UZB	1279.77	1.83	1104.46	7962.37	44.89	2050.45
Total	5090.96	–	1172.70	2276.30	3189.70	1198.00

Note: KAZ = Kazakhstan; KGZ = Kyrgyzstan; TJK = Tajikistan; TKM = Turkmenistan; UZB = Uzbekistan; Total = Sum of the five countries

Table 2: Water Consumption of Central Asian Countries in 2014

Country	Agricultural Water Use (10 m³)	Industrial Water Use (10 m³)	Domestic Water Use (10 m³)	Total Water Use (10 m³)	Percentage of Total (%)
KAZ	140.00	62.60	8.80	211.40	16.97
KGZ	74.50	3.40	2.20	80.10	6.43
TJK	104.40	4.10	6.50	115.00	9.23
TKM	263.60	8.40	7.50	279.50	22.43
UZB	504.00	15.00	41.00	560.00	44.94
Total	1086.50	93.50	66.00	1246.00	100.00

Note: Data source from references [8-9]

References

[1] FU Ying-xin. Transboundary rivers and international relations in Central Asia[D]. Lanzhou: Lanzhou University, 2009.

[2] HU Z Y, ZHANG C, HU Q, et al. Temperature changes in Central Asia from 1979 to 2011 based on multiple datasets[J]. Journal of Climate, 2014, 27(3): 1143-1167.

[3] ZHU Yi-zhong, XIA Jun, WANG Gang-sheng. Assessment of water resources carrying capacity of northwest China[J]. Acta Scientiarum Naturalium Universitatis Sunyatseni, 2004, 43(3): 104-107.

[4] JIN Lu. Practical fuzzy mathematics[M]. Beijing: Science and Technology Literature Press, 1989: 179-227.

[5] DENG Ming-jiang. International cooperation problems on transboundary rivers in Kazakhstan[J]. Arid Land Geography, 2012, 35(3): 365-376.

[6] WU Miao, ZHANG Xiao-yun, LUO Ge-ping, et al. Situation of water resources utilization in Kazakhstan[J]. Arid Land Geography, 2010, 33(2): 196-202.

[7] YAO Hai-jiao, ZHOU Hong-fei. Games analysis of water resources strategy among the Central Asian countries around the Aral Sea Basin[J]. Arid Land Geography, 2013, 36(4): 764-771.

[8] JIAO Fan. Overview of water resources in Central Asia[J]. Science and Technology, 2011, 9(4): 103-104.

[9] SCHLUTER. [Title not fully visible in original]

[10] [Reference incomplete in original]

[11] [Reference incomplete in original]

[12] [Reference incomplete in original]

[13] [Reference incomplete in original]

[14] [Reference incomplete in original]

[15] [Reference incomplete in original]

[21] SU Yong-hong, FENG Qi, LIU Wei, et al. Evaluation of the carrying capacity of water resources in the Shiyang River Basin using integrated fuzzy assessment[J]. Arid Zone Research, 2009, 26(2): 169-175.

[22] MA Dong-shan, WANG Sheng-rui, LI Gui-bao. Africa water resources crisis and Lake Chad' s problem[J]. World Environment, 2015, (2): 42-44.

[23] LI Shu-qin, SHI Jin-gui. Status of water resources and utilization in Africa[J]. Express Water Resources & Hydropower Information, 2009, 30(1): 7-9.

[24] CHEN Hui, FENG Li-hua, DONG Jian-bo. Carrying capacity and sustainable utilization of water resources in Africa[J]. Journal of Water Resources, 2010, 21(2): 49-52.

[28] DENG Ming-jiang. International cooperation problems on transboundary rivers in Kazakhstan[J]. Arid Land Geography, 2012, 35(3): 365-376.

[29] WU Miao, ZHANG Xiao-yun, LUO Ge-ping, et al. Situation of water resources utilization in Kazakhstan[J]. Arid Land Geography, 2010, 33(2): 196-202.

[30] WU Miao, ZHANG Xiao-yun, WANG Li-xian, et al. Study on water resources and its utilization in Kyrgyzstan[J]. Arid Zone Research, 2011, 28(3): 455-462.

[31] YAO Jun-qiang, LIU Zhi-hui, ZHANG Wen-na, et al. Water resources and utilization in Turkmenistan[J]. Journal of Desert Research, 2014, 34(3): 885-892.

[32] YAO Hai-jiao, ZHOU Hong-fei. Games analysis of water resources strategy among the Central Asian countries around the Aral Sea Basin[J]. Arid Land Geography, 2013, 36(4): 764-771.

Note: Figure translations are in progress. See original paper for figures.