Problems and Countermeasures of Water Conservancy Utilization Coefficient in Typical Irrigation District of South China

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Abstract: Irrigation water consumption affect the conversion of regional water resources and the change of ecological environment directly. The study on the impact of water balance factors in irrigation area has important theoretical and practical values to improve the use coefficient of irrigated water and the rational exploitation of regional water resources. As typical irrigation of the South China, the Songtao irrigated of Hainan province and Wuhua irrigated of Guangxi province are choosed as the research object in this research, Study was calculated by the Songtao irrigation district main canal, trunk, trunk and branch canals and agricultural drainage, Songtao irrigation canal system water use coefficient was 0.476, estimates the Wuhua irrigation zone main canal, branch canals, get five irrigation canal system water use coefficient 0.477. the factors that influence water balance of irrigation are analyzed, the problems and the countermeasures of how to improve the canal utilization factor of irrigation are discussed. It provides some basis evidence to improve the canal utilization factor of irrigation and rational development of water resources, Provide technical support for the high-quality development of river basin water conservancy andcurbing agricultural non-point source pollution.

1 INTRODUCTION

The effective utilization coefficient of canal water refers to the ratio of the net discharge from the agricultural canal and the gross canal to the gross discharge introduced from the head of the canal (Wang. et al, 2007; Yan. et al ,2007; Li. et al,2012, Wu. et al,2021). Its value is equal to the product of the water utilization coefficient of the channels at all levels.

$$\eta=\sum(Q_i\eta_i) / \sum Q_i \quad (i=1, 2, \ldots, n) =\eta_{main}\times\eta_{zhi}\times\eta_{dou}\times\eta_{nong}$$

The effective utilization coefficient of canal water is an important indicator to measure the level of irrigation management. The increase in the effective utilization coefficient of the canal system can not only save water, reduce energy consumption, reduce agricultural consumption and increase income, but also reduce the groundwater level and prevent soil salt. The significance of flooding and swamping to prevent deformation and displacement of water conservancy projects (Rao. et al,1992; Wang. et al,2002; Li. et al,2018). In 2009, the irrigation water consumption of large, medium, small and pure well type irrigation districts accounted for 35.7%, 25.3%, 25.6% and 13.3% of the total irrigation water consumption respectively.

There is still a certain gap between 50%, 60%, 70% and 80%. The construction and supporting of irrigation districts in my country started relatively late, the technological innovation and promotion system is not perfect, the supporting water-saving facilities are not mature, the irrigation water technology is backward, the application of automatic control

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technology in irrigation districts is still very few, and the complex topography in my country indicates that our country is complex. The effective utilization coefficient of irrigation water needs to be improved (McKinney. et al, 2002; Pen. et al, 2012; Han. et al, 2011 Mahfouz. et al, 2020). In order to achieve the goal of reaching 0.55 for the irrigation water utilization coefficient in my country's irrigation districts by 2020, the irrigation water utilization coefficient is mainly restricted by the effective utilization coefficient of canal water, that is, channel seepage prevention measures, soil geology, channel water delivery time, channel level and irrigation area scale. Therefore, increasing the effective utilization coefficient of canal water has become the primary goal of increasing the utilization coefficient of irrigation water in various irrigation districts.

Songtao Irrigation District is located in the northern part of Hainan Island, with geographic location N: 18°10′~20°10′, and east longitude 108°37′~111°3′. To the left bank of the Nandu River in the east, the Beibu Gulf coast to the west, the Qiongzhou Strait in the north, and the Zhubi River and Nandu River tributaries to the south, it is 131 km long from east to west and 64 km wide from north to south. The total area of the irrigation area is 5 866 km², accounting for 17.3% of the total area of Hainan Island, involving two cities and two counties, Haikou, Chengmai, Lingao, and Danzhou, 42 townships (towns) and 16 state-owned farms. Most of the water delivery channels (drying and branching) in the irrigation area are located in higher terrain and have the conditions for self-flow irrigation to both sides of the farmland. Small and medium rivers and ravines in the north-south direction divide the irrigation area into multiple independent natural patches. With the addition of small and medium-sized water conservancy projects in the area, the entire irrigation area is divided into 23 irrigation systems, including 13 in the east and 10 in the west. The main canal is divided into two main canals, east and west, forming two irrigation areas in the east and west. The main canal, the east canal, the west canal, 9 sub canals, and 2 water supplement canals have been built with three upper levels of 444 km. The backbone channel; the branch, bucket, and agricultural canal for direct irrigation of Songtao Reservoir and the lower three-level channel of small and medium-sized reservoirs in the irrigation area have a total length of 3 912 km (Xu. et al, 2009).

The Wuhua Irrigation District of Guangxi Zhuang Autonomous Region is located in the central part of Guangxi, in the Guizhong Basin at the foot of Daming Mountain, between 108°23' to 109°15' east longitude and 23°6' to 23°36' north latitude. The irrigation area covers 2620 km 2, accounting for 62.3% of the total area of Binyang and Shanglin counties. It extends from the Dalongdong Reservoir Dam in Shanglin County in the north, Nanshan and Guankou Xiaotang Reservoir in Gula Town, Binyang County in the south, Donggan Reservoir Dam in Shanglin County in the west, and Paitang Xiaotang Reservoir in Litang Town, Binyang County in the east. There are 18 townships in the irrigation area, including 7 townships in Shanglin County and 11 townships in Binyang County. The designed irrigation area of the irrigation area is 569,000 Acre, of which 220,500 Acre is irrigated in Shanglin and 348,500 Acre is irrigated in Binyang. One main canal was built in Wuhua Irrigation District with a length of 151 km, including 77.4 km in Shanglin County and 73.6 km in Binyang County. There are 34 main canals with a length of 319 km over 1 m^3/s. As of 2010, the canal has been impervious to 144.218 km, of which the main canal has been impervious to 79.293 km, the main canal is impervious to 9.852 km, the branch canal above 1 m3/s has been impervious to 55.073 km, and the remaining canal sections have not been impervious (Qin. et al, 2011).

2 CALCULATION OF CANAL UTILIZATION COEFFICIENT

From Table 1 and Table 3, it can be concluded that both the Songtao Irrigation District and Wuhua Irrigation District have insufficient irrigation canal composition. The Songtao Irrigation District test period includes the main canal, main canal, branch canal, branch canal, bucket canal and agricultural canal, and the main canal canal system is used The coefficient is 0.983, the utilization coefficient of main canal system is 0.858, the utilization coefficient of sub-main canal system is 0.845, the utilization coefficient of branch canal system is 0.906, the utilization coefficient of bucket canal system is 0.870, the utilization coefficient of agricultural canal system is 0.990, and the canal system in Songtao Irrigation District The effective water utilization coefficient is 0.476.From Table 2 and Table 3, it can be concluded that the total length of the main canal in Wuhua Irrigation District is 151km, the flow rate during the measurement period is 3.4 m3/s, and the channel water utilization coefficient is 0.77; there are 28 branch canals in Wuhua Irrigation District, with a total length of 309.46km, and canal water utilization The coefficient is 0.72; the water utilization coefficient of the bucket canal is 0.86; the water utilization coefficient of the canal in Wuhua Irrigation District is 0.477.The calculation results of the two irrigation districts show that the water delivery efficiency of the entire canal system in the irrigation district is not high. It is necessary to further accelerate the construction of water-saving transformations such as canal system anti-seepage. While consolidating and improving the upper three-level channels, speed up the lower three-level channels The progress of the reconstruction of the canal system will reduce the loss of channel water delivery and increase the effective utilization coefficient of canal water.

Table 1: Calculation results of canal utilization coefficient in Songtao Irrigation District.

Channel name	V1	V2	Channel water loss rate/%	Canal section water delivery coefficient	Canal water utilization coefficient
Main canal	93.4	91.80	1.70	1.00	0.983
East Canal	70.9	69.20	0.16	0.99	0.842
West Canal	23.4	22.70	3.20	0.97	0.874
Dacheng fenganqu	2.80	2.79	4.69	1.00	0.953
Huangtong fenganqu	0.33	0.27	6.90	0.99	0.931
Fengjiao fenganqu	3.36	3.33	3.96	0.99	0.960
Huangzhu fenganqu	2.57	2.51	8.80	0.99	0.912
Bailianxi fenganqu	0.92	0.90	8.48	0.98	0.915
Bailiandong fenganqu	4.17	4.06	13.80	0.99	0.862
Boliandong fenganqu	2.47	2.45	7.53	0.99	0.925
Songlinling fenganqu	0.22	0.21	13.80	0.99	0.862
Fengjiaofengan 1zhiqun	0.13	0.13	0.70	1.00	0.993
Donggan 4zhiqu	0.34	0.31	8.60	0.99	0.914
Fushanfengan 4zhiqu	2.65	2.46	5.90	0.99	0.941
Lincheng zhiqu	1.16	1.14	6.60	0.97	0.934
Songlinlinglizhitou douqu	0.17	0.17	13.50	0.97	0.866
Songlinling chenfangdou	0.025	0.024	9.60	0.99	0.904
Diaonan douqu	0.031	0.029	7.20	0.99	0.928
Fengjiaofengan 1zhiqu1douqu	0.53	0.52	6.01	0.96	0.940
Donggan4zhiqu 2douqu	0.032	0.031	7.70	0.97	0.923
Fushanfengan 4zhiqu 1douqu	0.12	0.048	30.30	0.97	0.698
Huangzhufengan 2douqu	0.079	0.074	6.60	0.98	0.934
Bailianxifengan1 zhiqu 1douqu	0.45	0.36	4.40	0.96	0.956
Baillianxifengan douqu	0.17	0.17	3.38	0.99	0.966
Dongganqu 9douqu	0.45	0.43	32.80	0.96	0.672
Lanqin douqu	0.25	0.24	3.77	1.00	0.962
Meizhu douqu	0.22	0.22	12.20	0.96	0.879
Fushan fengan 4zhiqu Nongqu	0.04	0.03	12.10	1.00	0.879

Note: V1: Incoming flow at the beginning of the canal section, $m^3 \cdot s^{-1}$; V2 Discharge flow at the end of the canal, $m^3 \cdot s^{-1}$

Table 2: Calculation results of channel water utilization coefficient in Wuhua Irrigation District.

Channel name	V1	V2	Channel water loss rate/%	Canal section water delivery coefficient	Canal water utilization coefficient
Main canal	3.45	3.42	23.00	1.00	0.770
Liba zhiqu	0.40	0.40	40.90	0.99	0.591
Malan zhiqu	0.64	0.64	17.60	1.00	0.824
Baisha zhiqu	0.21	0.21	28.10	1.00	0.719
Dongyi zhiqu	0.28	0.28	31.50	1.00	0.685
Xiyi zhiqu	0.13	0.13	27.20	1.00	0.728
Baishan 1douqu	0.0473	0.05	14.40	1.00	0.856
Yangshan douqu	0.06	0.06	17.00	0.99	0.830
Malanzhiqu 4douqu	0.13	0.13	11.90	1.00	0.882
Malanzhiqu yinzhudouqu	0.26	0.25	9.11	1.00	0.909

Note: V1: Incoming flow at the beginning of the canal section, $m^3 \cdot s^{-1}$; V2 Discharge flow at the end of the canal, $m^3 \cdot s^{-1}$

Table 3: The coefficient of effective use of water for canal system is corrected by channel skipping water delivery in Songtao Irrigation District and Wuhua Irrigation District.

Irrigation District	Canal system classification	Canal effective utilization factor
Songtao Irrigation District	Six	0.476
Wuhua Irrigation District	Three	0.477

3 DISCUSSIONS

There is a close relationship between irrigation districts and the local economy, and the construction and management of irrigation districts play an important role in agricultural production and the development of the local economy. The construction and management of irrigation districts can improve agricultural productivity, promote the development of related industries, and improve rural infrastructure, thus contributing to the prosperity and sustainable development of the local economy.

(1) Songtao Irrigation District

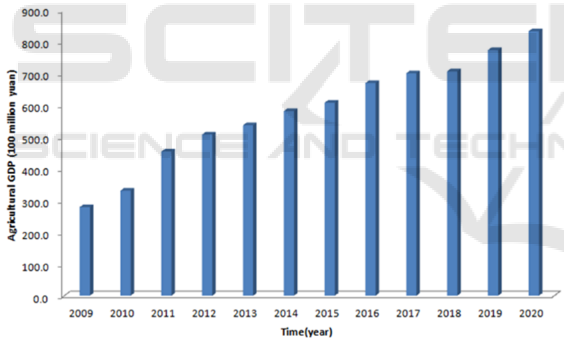

Figure 1: Analysis of GPD Changes in Songtao Irrigation Area (2009-2020).

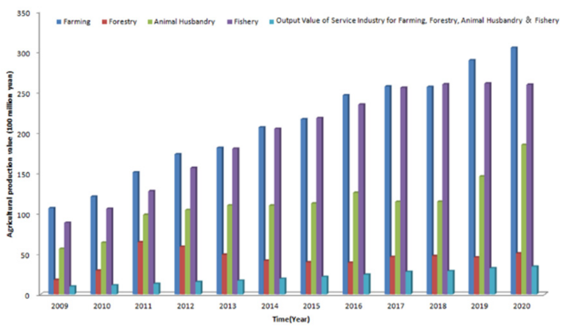

Figure 2: Analysis of Agricultural production value Changes in Songtao Irrigation Area (2009-2020).

The canal flow in the Songtao Irrigation Area is 103m3/s. In this survey, from 2009 to 2020, the cultivated area of the Songtao Irrigation Area is basically maintained at about 3.2 million square meters, and the minimum canal flow rate is 75% guaranteed. However, the gross agricultural production and agriculture, forestry, wood, fishery and other industries have maintained rapid growth, reflecting the Songtao Reservoir Irrigation District has played an important role in local economic development. The average annual growth rate of agricultural production value ranges from 0.84% to 37.2% (Figure 1 and Figure 2), with the fastest growth in 2010. With the financial and engineering investment in the irrigation area, agriculture, fishery and agricultural service industries have grown steadily year by year, becoming the main agricultural economic income of the local area, while the forestry industry has suddenly fallen back to a stable range after the rapid development. Protection and other policies are closely related. Animal husbandry is a slow growth trend.

(2) Wuhua Irrigation District

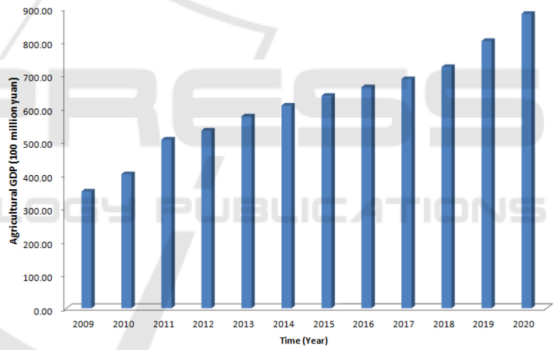

Figure 3: Analysis of GPD Changes in Wuhua Irrigation Area (2009-2020).

Figure 4: Analysis of Agricultural production value Changes in Wuhua Irrigation Area (2009-2020).

The canal flow in the Wuhua Irrigation Area is $3.45m^3/s$. From 2009 to 2020, the minimum flow rate of Wuhua Irrigation District was guaranteed by more than 75%, and the total agricultural production value was developed by Xu Meng, which reflects the importance of Wuhua Irrigation District to the local economy. The average annual growth rate of agricultural production value is 3.68~25.77 %. The Wuhua Irrigation Area is dominated by agriculture, accounting for more than 50% of the planting area in the irrigation area, followed by animal husbandry, while forestry, fishery and agricultural service industries account for a relatively small proportion. This is closely related to local agricultural planning and planting structure.

To sum up, the engineering support, management level, water-saving project input, system construction and modern information construction of the irrigation area directly affect the effective utilization coefficient of irrigation water in the south and the growth of the local agricultural economy.

4 MAIN PROBLEMS AND INFLUENCING FACTORS

4.1 Incomplete Canal System

The composition of the canal system in the two irrigation areas is not perfect. The imperfect composition of the canal system leads to the unbalanced management of the irrigation area. The matching and maintenance of canal lining and canal buildings can improve the flow capacity of the canal system, reduce the channel water level, increase the water delivery velocity, shorten the water delivery time, and reduce leakage losses. Canal lining, especially in the backbone canal lining with relatively large water flow, can effectively improve the water utilization coefficient of the canal system.

4.2 Unadvanced Management Level

The maintenance of the irrigation area is mostly managed by manual patrols, without visualization. Some channels are damaged, blocked by stones and garbage, and the overgrown weeds on both sides of the strait have not been maintained and repaired in time, resulting in low water delivery efficiency.

4.3 Imperfect Engineering Support

The loss of field water is mainly due to runoff and deep infiltration. The use of advanced surface irrigation techniques such as small depression irrigation, furrow irrigation and surge irrigation can reduce the loss of field water runoff; agronomic means such as mulching and moisture preservation are used to reduce the evaporation loss of field water; Determining a reasonable irrigation quota and controlling the irrigation time can prevent leakage. Some of the channels in the irrigation area are the main economic crops in the irrigation area and the water is relatively abundant, but there are still some canal sections without anti-seepage and other work.

4.4 Old and Damaged Engineering Facilities

The aging and disrepair of the project may affect the irrigation area with seepage loss, leakage loss and evaporative loss. The seepage loss includes the amount of water seepage through the canal bottom and the gap of the slope and the amount of water seepage in the deep field of the water supply channels at all levels. Leakage loss includes the amount of water lost due to geological conditions, biological action or engineering formation of leaks or fissures, or the loss of field surface and drainage caused by poor management. evaporative losses. The amount of water that evaporates along the surface of the channel. It can be obtained approximately according to the water surface evaporation data and the total water area of the channel.

5 OUTLOOK

According to the relevant policies and guidelines of the Ministry of Water Resources to save water, increase rural water conservancy construction, and effectively use water resources, through the calculation of the effective use coefficient of canal water in Songtao Irrigation District and Wuhua Irrigation District, a typical irrigation area in the South China, to analyze the impact on the effective use of canal water. Coefficient of irrigation area scale, channel level, channel irrigation method, different regions, different economic crops, different anti-seepage measures, different soil quality and different years are the main influencing factors. Find out the existing problems, and put forward practical methods and countermeasures to improve the channel water utilization coefficient.

(1) Irrigation district maintenance must be strengthened. According to the different regions and scales of the irrigation area, the inspection and maintenance of the irrigation area should be strengthened, the inspection time should be set, and

the problem should be solved in time, so as to achieve timely repair, timely dredging, and timely maintenance to ensure the good operation of the channel.

(2) Water-saving projects in irrigation districts must be further constructed. In large-scale irrigation areas, there are factors such as large area span, long age span, and complex soil quality in the water area, which causes the aging and leakage of the latter part of the anti-seepage and the front part, making it difficult to effectively improve the utilization coefficient of the canal system. Anti-seepage work is carried out in the area, and the corresponding problems encountered in the management process are raised to the higher authorities, so as to effectively improve the effective utilization coefficient of canal water. According to the water requirements of different regions, different soils and different crops, and following the principle of adapting measures to local conditions, establish different water-saving engineering technologies. The introduction of advanced water-saving irrigation technology can effectively improve the effective utilization coefficient of canal water.

(3) Agricultural water saving system must be established. Through perfect water-saving irrigation policies and regulations, corresponding incentive policies and restraint mechanisms, and through grassroots and more publicity to help farmers choose advanced water-saving technologies, so as to improve the benefits of timely implementation of water-saving irrigation.

(4) Eco-agricultural water saving is promoted. ① Upgrade and develop water-saving equipment and materials. ②Formulate stricter water quantity and water quality standards. ③Integrate and use more advanced agricultural water-saving technology. ④ Research and develop integrated systems and application models of water-saving agricultural technologies suitable for water and soil conditions in different regions, and give full play to the overall benefits of water-saving agricultural technology systems. ⑤ Widely promote agricultural water-saving technology products to meet the development needs of modern agriculture.

(4) Strengthen the construction of water-saving informatization in irrigation areas

Strengthen the construction of water-saving informatization in irrigation areas, and gradually realize the collection and reporting of information on water conditions, industrial conditions, conditions of drought, drought, disasters, hydrogeology, land, planting, and meteorology, and learn from other countries and countries on the basis of local actual conditions. Advanced success experience. Provide accurate, timely and reliable basic information services for the rational allocation and monitoring and scheduling of water resources in irrigation areas.

(5) Optimize the planting structure of the irrigation area. According to the change of crops, do a good job in adjusting the canal system and strengthen the control. Improve the coverage of the canal network in the irrigation area, rationally plan crop planting, expand the effective irrigation area, and prevent farmers from stealing water and destroying channels and buildings.

(6) Intensify efforts to promote water conservation. Introduce advanced water-saving irrigation technology, eliminate traditional surface irrigation methods, introduce technologies such as sprinkler irrigation, moisturizing irrigation and well irrigation, and increase water-saving and water-protection publicity to farmers.

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