Current Status and Challenges of the Water and Soil Conservation in Hotan County, Xinjiang

Junhui WANG *, **Lei ZHANG**

Academy of Science, Hetian Normal College, Hotan 848000, China

Abstract In order to thoroughly analyze the current status and challenges faced by the water and water conservation in Hotan County of Xinjiang, the use situation of water resources, the effectiveness and shortcomings of water and soil conservation work in the region are reviewed. Hotan County has achieved several remarkable achievements in the soil and water conservation project, daily management and maintenance, and ecological restoration projects. Some measures, such as terrace construction, slope protection engineering, and the construction of windproof and sandwood belts, have also had a positive impact on improving the quality of surface water resources while effectively curbing soil erosion. But there are also lack of operating policy detailed rules and implementation plans, and planning and design of some water and soil conservation projects lack of integrity and systematicness, application and promotion of new technologies, and soil loss management and ecological recovery effect assessment lack of comprehensive assessment indicators and methods. It has caused some water and soil conservation works to fail to be effectively implemented. In this regard, countermeasures and suggestions are put forward, such as strengthening the planning and management of water and soil conservation, promoting the technology and measures of water and soil conservation, increasing investment and funding support, and strengthening publicity education and personnel training.

Key words Hotan County; Water and soil conservation; Status; Challenge

DOI 10.19547/j.issn2152 - 3940.2024.03.015

Water and soil conservation is an important part of achieving harmony between humans and nature, promoting sustainable economic and social development, and is also a fundamental work for advancing ecological civilization construction. It is of great significance for protecting the ecological environment and promoting sustainable development[1]. As an important county-level administrative region of Xinjiang Uygur Autonomous Region, Hotan County is located at the edge of the Tarim Basin, with rich natural resources and unique ecological environment[2]. However, due to long-term human activities and natural factors, the water and soil conservation work in Hotan County is facing a series of challenges and problems. This paper analyzes the current situation and challenges of water and soil conservation in Hotan County, conducts in-depth research on the water and soil conservation work in Hotan County, and explores its current situation and existing problems. It could provide reference and inspiration for further improving environmental protection work, and promote the continuous improvement and protection of the local ecological environment.

1 Geographical environment and soil characteristics of Hotan County

1.1 Geographical location and terrain characteristics Hotan County is located at the southern end of Xinjiang Uygur Autonomous Region of China, at the northern foot of the Karakoram Mountains and the southern edge of the Taklamakan Desert. The total area of Hotan County is $4.096\ 6 \times 10^4$ km^2[3-4]. The terrain is complex and diverse. The magnificent Kunlun Mountains in the south form an arc across the east and west, and the Tarim Basin in the north is low and flat. The Karakoram Mountains are located on the southwest border of Hotan County, running in a northwest - southeast direction. Its main body is on the border between Xinjiang and Kashmir, and it is the watershed of the Indus River and Tarim River systems. The landform types of Hotan County can be roughly divided into high mountain zone and undulating belt in front of mountain in the south, central alluvial fan plain zone in front of mountain, and northern alluvial desert plain zone[5-6].

1.2 Climate characteristics and precipitation situation Hotan County is located in the hinterland of the Eurasian continent and has a typical temperate desert climate. The main characteristics are sparse precipitation, dry climate, distinct four seasons, sufficient sunshine, long frost free period, and large daily and annual temperature difference. In spring, warming is rapid, with variable weather. In summer, it is hot, and evaporation capacity is large. In autumn, it is cool, and cooling is rapid. In winter, it is cold and sunny. Hotan County has a large elevation difference in terrain, and the vertical distribution characteristics of climate are obvious. It can be divided into four climate zones from the basin to the mountain (Table 1).

There is very little precipitation in Hotan, but there is much weather of wind, sand and floating dust. On average, there are more than 200 d of wind, sand and floating dust weather in the

Received: April 29, 2024 Accepted: June 7, 2024

Supported by Annual Regional Science and Technology Plan Project of Hotan Science and Technology Bureau (202439).

* Corresponding author.

plain zone each year, which significantly reduces the sunshine hours and sunshine percentage. This phenomenon is most prominent in spring. The sunshine hours in the plain zone are 2 643.9 h, and the available sunshine hours are 4 433.5 h, and the annual average sunshine percentage is 60%. Among them, the sunshine hours in October are 266.1 h, which is the most, and the sunshine percentage reaches 77%. Due to the dry climate, soil moisture evaporates rapidly, and surface water circulation is insufficient, resulting in increased soil dryness and erosion. In addition, insufficient precipitation also limits the growth and development of crops, which has a certain impact on agricultural production. The dry climate and insufficient precipitation in Hotan County pose challenges to local water and soil conservation work. How to scientifically and reasonably carry out water and soil conservation work under such climate conditions and protect local soil and water resources is an urgent problem that needs to be solved.

Table 1 Distribution characteristics of climate zones in Hotan County

No.	Climate zone type	Altitude	> 10 ℃ accumulated temperature//℃	Vegetation
1	Warm temperate zone	Flat area below 1 500 m	4 100 – 4 700	Agricultural, forestry, and silkworm planting areas
2	Temperate zone	Undulating belt in front of the mountain between 1 500 and 2 400 m	3 000 – 4 100	Semi-agricultural and semi-pastoral area
3	Cold temperate zone	A shallow mountainous area between 2 400 and 3 000 m	2 000 – 3 000	Only barley can be cultivated, and it is the main pastoral area within Hotan County
4	Frigid zone	Above 3 000 m	Lower than 2 000	Desert grassland, mountain grassland, alpine grassland, alpine meadow, and alpine cushion vegetation

1.3 Soil type and characteristics Hotan County has a complex and diverse geographical environment, and soil types are abundant. According to the influence of terrain and climate, the soil in Hotan County can be mainly divided into the following types:

(1) Alpine meadow soil. It is located in the Kunlun Mountains and Pamirs Plateau region, belonging to the alpine soil type. Due to its location in a high-altitude area, the temperature is low, and the vegetation growth period is short, and the soil freeze-thaw effect is more pronounced. Usually, soil fertility is low, and it contains more organic matter, making it suitable for the growth of herbaceous vegetation.

(2) High mountain brown soil. It is located in the Kunlun Mountains and Pamirs Plateau region, belonging to the alpine soil type. This type of soil is more common in high mountain areas, with good permeability and drainage, but lower fertility. It is suitable for crop cultivation in high mountain areas, such as barley, wheat, *etc.*

(3) Saline-alkali soil. It is mainly distributed in the Tarim Basin. Due to long-term drought, salt in soil accumulates seriously, forming saline-alkali soil. This type of soil has poor fertility and certain limitations on crop growth, requiring improvement of saline-alkali land for crop cultivation.

(4) Sandy soil. It is distributed in the Tarim Basin. Due to arid climate and wind force, the soil contains a large number of fine sand particles, which belongs to sandy soil. This type of soil has poor drainage and low fertility, which is not conducive to crop growth and requires soil improvement and protection.

The soil types in Hotan County are diverse, but most of them have low fertility and are greatly affected by arid climate. Different types of soil pose their own challenges to water and soil conservation work, and targeted measures need to be developed to protect local soil and water resources.

2 Utilization situation of water resources in Hotan County

2.1 Current situation and utilization methods of water resources The total amount of water resources in Hotan County is limited. But due to the dry climate, scarce precipitation, and high surface evaporation, the contradiction between water supply and demand is more prominent[7]. Water resources mainly rely on snowmelt in the Tianshan Mountains and river supply for irrigation of farmland, domestic water, and industrial water. Irrigation farmland is the main way of utilizing water resources. But due to the scarcity of water resources and low irrigation efficiency, there is a phenomenon of waste[8]. Domestic water mainly relies on groundwater and river sources, but excessive exploitation of groundwater resources has led to a decrease in groundwater level and deterioration of water quality. Industrial water usage is relatively low, but it also needs to be utilized reasonably to avoid excessive pressure on water resources. The sustainability of water resources is facing challenges due to climate change and human activities. When carrying out water and soil conservation work, it is necessary to comprehensively examine the current situation and utilization of water resources, take effective measures to improve the efficiency of water resource utilization, and simultaneously commit to the protection of water environment, aiming to ensure the long-term sustainable use of water resources.

2.2 Water resource management and protection measures As an arid region in southern Xinjiang, Hotan County is facing severe challenges in water resource management and protection. The monitoring and scheduling capabilities of water resources management need to be strengthened, and its management system and policies need to be improved. The systematic collection and in-depth analysis of water resources data also need to be strengthened to ensure the long-term sustainable use of water resources. To effectively

maintain water resources, Hotan County urgently needs to implement a set of comprehensive measures: first, strengthening water and soil conservation efforts, curbing soil erosion, and optimizing water quality conditions; second, vigorously promoting water-saving irrigation technology, improving irrigation efficiency, and eliminating unnecessary loss of water resources; third, strictly guarding the water source protection zone, strictly prohibiting any illegal occupation and construction behavior, and carefully caring for the ecological environment of water source conservation to ensure the safety of water quality. At the same time, it should strengthen publicity and education, raise public awareness of water resource protection, and form a joint force for water resource protection with the participation of the whole society[9].

Hotan County needs to comprehensively consider factors such as water supply and demand, utilization efficiency, and environmental protection in water resource management and protection, and take effective measures to achieve sustainable utilization and protection of water resources. Only through comprehensive water resource management and protection can we effectively solve problems such as water scarcity and soil erosion, and promote the sustainable development of local water and soil resources.

2.3 Issues and challenges in water resource utilization There are a series of problems and challenges in the utilization of water resources in Hotan County, and attention and effective measures need to be taken. The water resources in Hotan County are scare, but the existing water resource utilization efficiency is relatively low, mainly manifested in the phenomenon of waste when irrigating farmland, outdated irrigation methods in some farmland, and low water use efficiency. There is also a certain degree of waste in domestic and industrial water use, resulting in low water resource utilization efficiency. There are certain irregularities in water resource management, including a lack of comprehensive water resource planning, inadequate monitoring and scheduling mechanisms, and other issues. With the impact of climate change and human activities, water resources in Hotan County are facing greater challenges. Climate change may lead to uneven precipitation, increase evaporation, and exacerbate water scarcity. Human activities such as excessive cultivation of desertified areas and disorderly occupation and construction have also had a certain degree of impact on water resources[10]. The many problems and challenges in water resource utilization in Hotan County require measures such as strengthening water resource management, promoting water-saving technologies, controlling groundwater extraction, and strengthening monitoring and scheduling to improve utilization efficiency and achieve sustainable use of water resources.

3 Effectiveness and shortcomings of water and soil conservation work in Hotan County

3.1 Policies and regulations for water and soil conservation work The formulation and implementation of policies and regulations play a crucial role in the effectiveness of water and soil conservation work in Hotan County. At the level of policy support, the Hotan County Government faithfully fulfills its responsibilities in implementing and supervising a series of laws and regulations such as the *Water Law of the People's Republic of China*, the *Water and Soil Conservation Law of the People's Republic of China*, and the *Fisheries Law of the People's Republic of China*. It firmly implements the local water conservancy policies, regulations, rules, and normative texts issued by the autonomous region, adheres to the principle of water management according to law, and lays a solid legal foundation and policy support for the development of water and soil conservation work. However, in some details, the policy measures for water and soil conservation are not detailed and specific enough, lacking specific and actionable policy rules and implementation plans, making it difficult to effectively promote some water and soil conservation work. Some local governments and relevant departments have not fully implemented their responsibilities and supervision in water and soil conservation work, resulting in ineffective implementation of some water and soil conservation work[11-14].

3.2 Construction and management of water and soil conservation projects The construction and management of water and soil conservation facilities play a crucial role in the water and soil conservation work in Hotan County. Hotan County has made significant achievements in the promotion of water and soil conservation projects. For example, measures such as terraced field construction, slope protection engineering, and the construction of windproof and sand fixing forest belts, have effectively curbed soil erosion and had a positive impact on improving the quality of surface water resources[15]. However, there are still many shortcomings, and some water and soil conservation projects lack effective maintenance and management after construction, resulting in damage and failure of engineering facilities, which affects the effectiveness of water and soil conservation. The planning and design of some water and soil conservation projects are not scientific and reasonable enough, lacking integrity and systematicity, resulting in poor results after project implementation. The lack of application and promotion of new technologies in the construction and management of water and soil conservation projects limits the innovation and development of water and soil conservation work[16-19].

3.3 Assessment of soil erosion control and ecological restoration effects Hotan County has effectively reduced the degree of soil erosion and improved soil quality and water resource utilization efficiency by implementing measures such as terrace restoration, vegetation restoration, and construction of water and soil conservation forest. Some ecological restoration projects have achieved significant results, such as wetland restoration and desertification control, which help improve the local ecological environment and increase biodiversity[20]. However, there are still many problems in the control of soil erosion and ecological restoration in Hotan County. For example, it lacks comprehensive evaluation indicators and methods in the assessment of soil erosion control and ecological

restoration effects, making it difficult to objectively evaluate the effectiveness of the work; the effectiveness of some soil erosion control projects is unstable and may be affected by climate change, human factors, *etc.*, requiring more sustained and systematic monitoring and evaluation; some ecological restoration projects lack scientific planning and design, and consideration for long-term ecological benefits, resulting in unsatisfactory ecological restoration results.

4 Countermeasures and suggestions for water and soil conservation work in Hotan County

4.1 Strengthening planning and management of water and soil conservation In order to further strengthen the water and soil conservation work in Hotan County, it is necessary to enhance the planning and management of water and soil conservation. Firstly, a comprehensive plan for water and soil conservation could be developed. Long-, medium-, and short-term water and soil conservation plans should be established, with clear objectives, tasks, and measures, to ensure the scientific and operational nature of the plans. In the planning stage, it is necessary to deeply consider the attributes of local soil and water resources and ecological environment needs, and formulate differentiated water and soil conservation strategies in a targeted manner, aiming to ensure that various measures accurately match the real situation, follow and comply with natural laws. Additionally, efforts should be made to strengthen the construction of the monitoring and evaluation system. It is recommended to establish a sound water and soil conservation monitoring system, covering multiple levels such as soil erosion observation and vegetation coverage detection. It is also suggested to establish a specialized water and soil conservation management agency or department, clarify responsibilities, strengthen coordination and guidance, improve the overall efficiency of water and soil conservation work, and ensure the smooth implementation of project and continuous improvement of effectiveness.

4.2 Promoting water and soil conservation technologies and measures In water and soil conservation work, it is necessary to actively promote advanced water and soil conservation technologies and measures. Firstly, it should promote water and soil conservation technologies that are suitable for the local area. Suitable water and soil conservation technologies and strategies should be selected based on the terrain, climate, and soil characteristics of Hotan County, including but not limited to terraced field construction, vegetation restoration, windbreak and sand fixation measures. Through demonstration and training, farmers should be guided to master these technologies and improve their awareness and ability of water and soil conservation. It should actively promote the construction of farmland water and soil conservation projects, including terraced fields, vegetation cover, drainage facilities, *etc.*, to effectively reduce soil erosion and soil erosion[21]. The cultivation mode of adhering to the ecological concept should be advocated and promoted, such as organic farming, crop rotation and fallow, with the aim of limiting the use of fertilizers and pesticides to effectively protect the soil ecological environment. By promoting ecological agriculture, it can achieve a win-win situation between agricultural production and ecological environment.

4.3 Increasing investment and financial support Water and soil conservation work requires a significant amount of funding and investment support. It should increase government investment. The government should increase special funding for water and soil conservation work, strengthen financial support, and ensure the smooth implementation of water and soil conservation projects. It should establish a comprehensive fund management system, optimize the efficiency of fund utilization, and ensure the rational use of funds. Social capital can be attracted to participate in water and soil conservation work by establishing water and soil conservation funds, guiding social donations, and other means. By collaborating with enterprises and others, it can jointly promote the implementation of water and soil conservation projects, achieve resource sharing and complementary advantages. It should establish a strict mechanism for fund supervision, strengthen monitoring and evaluation of fund utilization, and ensure the rational allocation and use of funds[22]. Water and soil conservation projects could be regularly evaluated, to promptly identify problems and take measures to solve them, thereby improving the efficiency of fund utilization.

4.4 Strengthening publicity, education, and personnel training Efforts will be made to enhance the publicity and education of water and soil conservation, with the aim of significantly improving the awareness and importance of water and soil conservation work among farmers. The primary task is to vigorously promote water and soil conservation knowledge, which can be achieved through various forms such as planning diversified publicity and education activities, compiling easily understandable promotional materials, holding professional themed lectures, *etc.*, to popularize water and soil conservation knowledge to local farmers and residents, and enhance their awareness of protection. New media platforms could be used, such as the Internet and social media, to expand the coverage of publicity and improve the efficiency of information transmission. It should organize experts, scholars, and technical personnel to conduct training courses on water and soil conservation technology, imparting water and soil conservation techniques and measures to local farmers and relevant practitioners. Through theoretical teaching and on-site operations, their water and soil conservation skills and practical abilities could be enhanced[23]. It should establish a talent training system for water and soil conservation, and cultivate a group of water and soil conservation professionals who understand technology, management, and publicity. It could attract more talents to participate in water and soil conservation work by setting up scholarships and introducing external experts, thereby promoting the development of water and soil conservation.

5 Conclusions

As an important county in Xinjiang, Hotan County faces severe challenges and pressures in water and soil conservation work. Factors such as geographical environment, soil characteristics, and water resource utilization make its water and soil conservation work particularly important. Although some progress has been made, there are still shortcomings that need to be further strengthened and improved. Therefore, it is suggested that relevant government departments should attach great importance to the water and soil conservation work in Hotan County, increase funding investment, and improve the level of science and technology. It should encourage research institutions and universities to deepen cooperation and exchanges with local governments, carry out targeted research and technology promotion, and inject more support and assistance into the cause of water and soil conservation[24]. The whole society should participate in water and soil conservation work together, protect the soil and water resources and environment of Hotan County, and contribute to the sustainable development of the local area. Only through the joint efforts of everyone can the water and soil conservation work in Hotan County achieve better results, realize the sustainable utilization of soil and water resources, and build a solid foundation for the progress of regional economy and society.

References

[1] TIAN N. Soil and water conservation and ecological civilization construction to promote rural revitalization[J]. Soil and Water Conservation in China, 2024(2): 72 - 74.

[2] WANG MH, LI J. Analysis of land use change and its driving forces in Hotan County, Xinjiang[J]. Scientia Geographica Sinica, 2018, 38(8): 1281 - 1289.

[3] HANG H, SU QL. The application of Visual Modflow in the evaluation of groundwater resources in the new agricultural economic zone of Hetian County[J]. Shaanxi Water Resources, 2024(3): 27 - 30.

[4] ALIMIRE · ABUDOUKADIER. Empirical analysis on the influence factors of helping effect of facility horticulture industry in Hetian County[J]. Journal of Anhui Agricultural Sciences, 2024, 52(2): 208 - 212.

[5] LI QX, SHANG YJ, YI XT, *et al*. Stability analysis of the 509 Banxi old landslide in Dahongliutan County of Hotan County of Xinjiang[J]. Xinjiang Geology, 2023, 41(4): 609 - 613.

[6] JING GX, WU SY. Analysis on formation conditions and dynamic characteristics of debris flow disaster in Mitiz Village, Langru Township, Hetian County[J]. Xinjiang Geology, 2023, 41(S1): 81.

[7] NI YM, OUYANG ZY. Comparative study on the landscape pattern of desert vegetation in Xinjiang[C]//Summary of Papers from the 7th National Congress of the Chinese Ecological Society. Ecological Environment Research Center of the Chinese Academy of Sciences, 2004.

[8] LI ZF, MEN BH, ZHANG SF, *et al*. A comparative study of narrow/general water resources vulnerability in Hexi Corridor region[J]. Arid Land Geography, 2014, 37(5): 939 - 947.

[9] WANG SH, ZHOU BH, YANG G. A brief discussion on soil and water conservation planning and research in Hotan City, Xinjiang[J]. Ground Water, 2023, 45(5): 275 - 276, 296.

[10] FAN RG, BAO LW, LI XM, *et al*. Research progress on evaluation methods of aquatic eco-physical habitat integrity[J]. Asian Journal of Ecotoxicology, 2024,19(2): 53 - 65.

[11] WANG C, LI H, XIE XH, *et al*. Research on future climate change prediction in the Yangtze River basin[J/OL]. Pearl River, 2024(3): 1 - 10.

[12] WANG Y. Application of water ecological restoration technology in river management[J]. Pearl River Water Transport, 2024(4): 129 - 131.

[13] LIU XM, ZHANG WG, ZHOU DQ, *et al*. Challenges and supervision strategies for ecological protection in China[J]. Environmental Ecology, 2024, 6(2): 85 - 89, 94.

[14] LIU BW, SONG N. A brief discussion on the new characteristics and prevention measures of soil and water loss in Hunan Province[J]. Land & Resources Herald, 2014, 11(10): 40 - 43.

[15] LIU X, JIANG DW, BI HX. Primary study on market access system of soil and water conservation in China[J]. Science of Soil and Water Conservation, 2007(3): 109 - 113.

[16] YUE ZH, YANG JX. Practice and exploration of the transformation of soil and water conservation from greening to efficiency improvement in Ningxia Hui Autonomous Region in the new era[J]. Soil and Water Conservation in China, 2024(2): 16 - 19.

[17] WANG SH. Current situation of soil erosion and soil conservation planning in Minfeng County, Xinjiang[J]. Xinjiang Farm Research of Science and Technology, 2021, 44(4): 55 - 57.

[18] LIU DH. Initial analysis on the soil conservation supervision at new era: Case study at Yantian District of Shenzhen City[J]. Subtropical Soil and Water Conservation, 2023, 35(4): 38 - 40.

[19] SHI HJ. Study on ecological restoration and comprehensive treatment of Gangue Mountain in Yungang Mine[J]. Shandong Coal Science and Technology, 2019(1): 196 - 198.

[20] DENG L, WANG KB, WANG XZ, *et al*. Soil and water conservation and high quality development of the Loess Plateau in the Yellow River basin: Effects, problems and countermeasures[J]. Journal of Henan Normal University (Natural Science Edition), 2024, 52(1): 1 - 7, 181.

[21] LIU BL. Practices of comprehensive management of soil and water conservation in small watersheds of Yuexi County[J]. Soil and Water Conservation in China, 2023(9): 29 - 31.

[22] ZHANG ZC, ZHOU XL. Research on soil and water conservation planning in windy desert areas of Liaoning Province[J]. Technology of Soil and Water Conservation, 2016(2): 19 - 20.

[23] ZHANG Y, GUO TL, SUN K, *et al*. Evaluation and countermeasures of soil and water loss in cold regions: A case study of Shannan City, Tibet [C]// 2023 China Water Conservancy Academic Conference. Chongqing Branch of Changjiang Academy of Sciences, Changjiang Water Resources Commission; Shannan City Water Resources Bureau, 2023.

[24] LI YX. Application research of unmanned aerial vehicle remote sensing in soil and water conservation field[J]. Agricultural Science-Technology and Information, 2020(7): 57 - 58.