

China: The functional and protective mechanism of gravity irrigation system in Ziquejie Terrace (#483)

Description of the problem

The Ziquejie Terrace is one of the three famous Chinese ancient terraces in Hunan Province. The crops cultivated in the terraces can manage to thrive through drought and flood without reservoir or other water storage constructions. This traditional primitive gravity irrigation system is a model for ecological construction of irrigation systems. However, the mechanism of Gravity Irrigation and water allocation within Ziquejie Terrace has not been well revealed, which to large extent affects the efficiency of environmental and ecological protection for this extraordinary natural reserve.

Actions taken

To better understand the mechanism of Gravity Irrigation and water resource allocation and provide the background for future systematic managements within the Ziquejie Terrace, large amounts of observational data were collected and processed. The nonlinear autonomic regulation theory and “the groundwater reservoir on the same slope position” theory have been applied to model the water supply-demand balance model for groundwater irrigation.

Based on the knowledge gained from the model and the local features of planning, history and culture, functional zoning for Ziquejie Terrace is proposed. A broad consultation process culminated in adoption of protective regulations and measures applied in functional zones.

Achievement

- The results have been implemented in “The Planning Report of the Water Conservancy Project of Ziquejie Terrace Scenic Spot” and “The Implementation Plan of 2012 Waterwheel Project of Xinhua County”.
- The results have been adopted by local government for preparing the application of World Heritage of Irrigation Projects.
- The results have also been implemented by the local tourism department as the technical support for sustainable utilization and tourism development of Ziquejie Terrace.

Lessons learned

- The gravity irrigation mechanism of Ziquejie Terrace has been proven correctly.
- The protection strategy and measures of functional zones are relevant and have been promoted among local farmers.
- The outcomes serve as the technical support for the sustainable development
- The land protection and nature protection measures were linked through wise use of water resources.

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Keywords

Ziquejie Terrace, Gravity Irrigation, Functional division, Protective Mechanism

FULL CASE STUDY

The problem description

Ziquejie Terrace, also known as Ziquejie Primitive Terraced Field, is a fascinating natural reserve area located in Loudi Town of Xinhua County, Hunan Province (Figure 1).

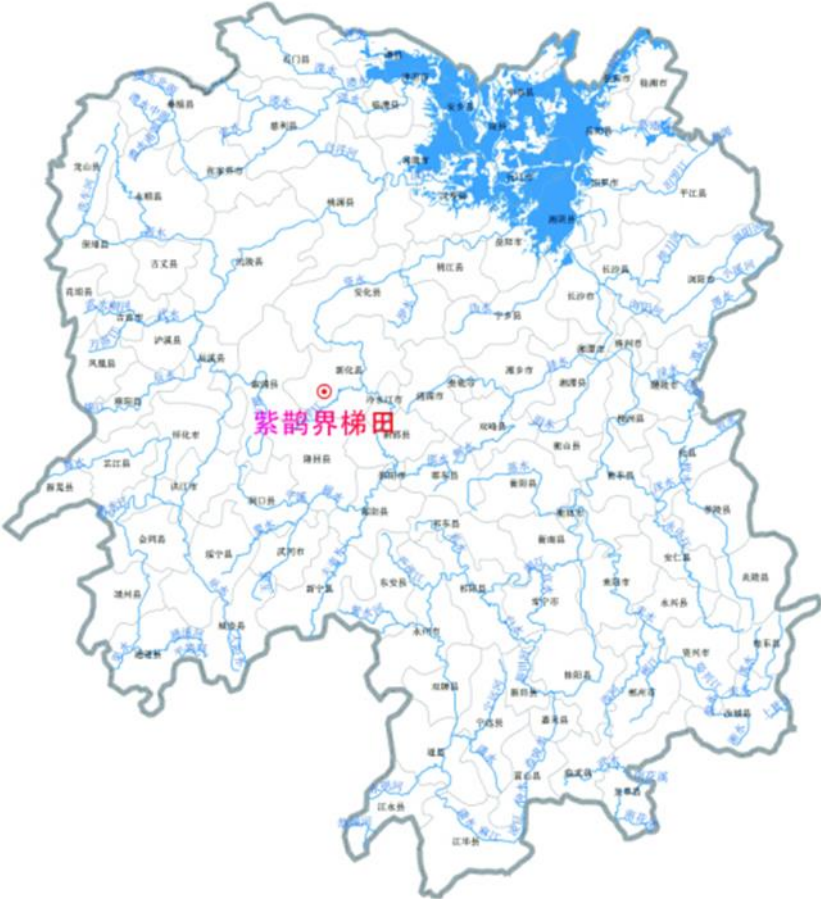


Figure 1 Location of Ziquejie Terrace (source: Hunan Provincial Water Resources and Hydropower Research Institute)

Farmlands of Ziquejie Terrace cascade down along the slopes of Ziquejie Mountain, covering an area of 9,390 acres on over 500 terraces at the altitude between 500-1,000 m. All paddy fields are irrigated by natural water flows without being affected by droughts or floods.

Ziquejie Terrace reflects the advanced agricultural civilization of ancient China and the great achievement in ancient agriculture. However, the economic development, the reforms on agricultural sector and the exploitation of the terrace areas make it hard for people to sustain and protect the terraced fields. The balance between exploitation and protection of the terraced fields becomes the challenge in terms of sustainable development.

Measures and Actions Taken

Ziquejie Primitive Terraced Field, with a history of thousands of year, provides valuable experience and can be seen as an example for terraced projects development and water and soil conservation. Quantitative and qualitative methods and investigations have been performed to reveal the mechanism of gravity irrigation system, based on which, the water balance model for groundwater irrigation is created to better develop and protect the terraced areas.

Mechanism of Gravity Irrigation

Several observation stations (Figure 2) were designed and built for precipitation-runoff-sediment, which include two meteorological stations at different elevations and three groundwater level observation stations to acquire two-three-year experiment data. In addition, multiple surveys were conducted as well to better understand the terrace structure, farming culture and hydrological geology. Experiments on artificial rainfall simulation, pumping and pressure test and indoor geo-technique were undertaken to obtain thorough information.



Figure 2 (Left) Meteorological Observation Station (570 M above); (Right) Groundwater Observation Station

In accordance with large amounts of observational data, the nonlinear autonomic regulation theory and “the groundwater reservoir on the same slope position” theory (illustrated in Figure 3) have been proposed. Based on data observed and simulated, the water supply-demand balance model has been created to better understand the groundwater irrigation system. The computation of the model has been conducted and the results have proved to be accurate by calibration with use of actual water supply-demand situation of the primitive terraced field.

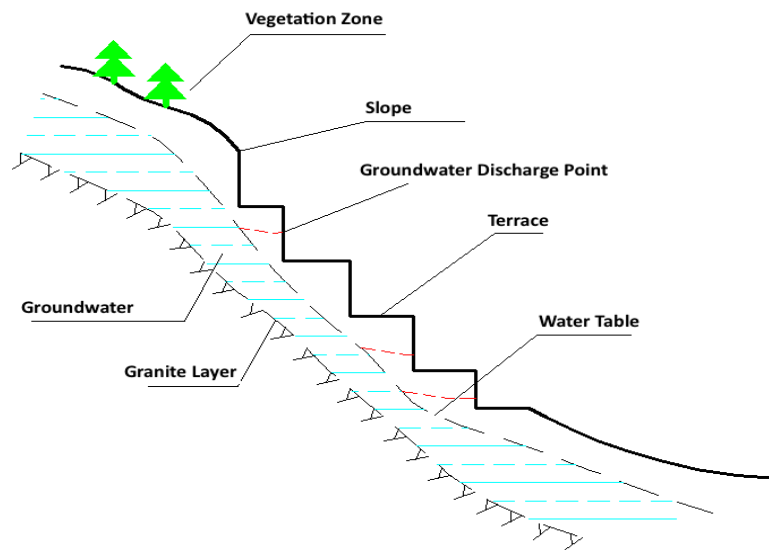


Figure 3 Conceptual model of “the groundwater reservoir on the same slope position” theory

Functional zoning

To gain a systematic background on soil structure and agricultural pattern, literature review for data collection, on-site investigation, typical field measuring (Figure 4) and interviews with farmers were applied. A clear picture on the origin and history of the primitive terraced fields has been developed through this.



Figure 4 Measuring in typical field

Based on the formation of the primitive gravity irrigation system of Ziquejie Terrace and comprehensive consideration of the local background of history and culture, a reasonable division of functional zones of the scenic spot has been proposed: the core scenic zones, the protection zones and buffering zones (i.e., protection through coordination).

Protective mechanism and measures

Based on the result of functional zoning, the key factors that influence the primitive gravity irrigation system have been analyzed. In consultation processes of local farmers, researchers and the local government the related measures have been proposed and targets identified.

The core zone should remain its primitive landscape without constructions. All protection measures must be non-engineering and adapted to the natural environment. Any construction that interrupts the overall landscape of the terrace should be reformed or dismantled.

In protection zones, any facility that is irrelevant to the protection, management or development of the terrace should be forbidden.

In buffering zones, any projects that have the potentials to damage the terrace environment should be prohibited.

Outcomes

The mechanism of gravity irrigation system

The mechanism of gravity irrigation system within the area has been revealed based on the establishment of the nonlinear autonomic regulation theory and “the groundwater reservoir on the same slope position” theory. It also has been proved accurate by the computation of the proposed water supply-demand balance model.

Protection system

The map for the division of the functional zones has been derived (Figure 5) on the basis of the formation of the primitive gravity irrigation system, local background and the farming culture. Based on this, multiple studies regarding to crop selection, visual effects and utilization can be conducted to improve the economic growth and residential living standards within the scenic area, and finally finalize the protection system within the terraced area.



Figure 5 Division of functional zones (source: Hunan Provincial Water Resources and Hydropower Research Institute)

Achievements

The results have already been implemented in “The Planning Report of the Water Conservancy Project of Ziquejie Terrace Scenic Spot” and “The Implementation Plan of 2012 Waterwheel Project of Xinhua County”.

Moreover, the outputs have also been adopted by the local government for preparing the application of the world heritage of irrigation projects. In September 2014, Ziquejie Terrace was added to the World Heritage List by the International Irrigation Commission, being one of the four projects on this list in China.

These outputs have also been implemented by the local tourism department as the technical support for sustainable utilization and tourism development of Ziquejie Terrace.

Contact, Reference, Organization and People

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The case study was developed for Global Water Partnership China

<http://www.gwp.org/en/GWP-China/>

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Organization and People

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