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Results and Application of Soil and Water Conservation Monitoring in the Yellow River Basin

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Abstract: Since water and soil conservation monitoring in the Yellow River Basin entered a new stage at the end of the 20th century, the monitoring scope has been expanding, the monitoring accuracy has been improving, the monitoring content and indicators have been increasing, and the monitoring technology and methods have been improving. This paper mainly analyzes the status of soil and water conservation monitoring in the Yellow River Basin, as well as the construction of the monitoring system and related research, in order to provide a reference for watershed management and development and the scientific research of water and soil conservation.

Keywords: Soil and water conservation; Monitoring results; Application

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1. Introduction

The Yellow River is the "mother river" of China, but it is also the area with the most severe soil erosion in our country. Over the years, our country has continued to emphasize soil and water conservation monitoring in major strategies of ecological protection and high-quality development in the Yellow River Basin. After years of development, the country has accumulatively deployed more than 4,300 soil and water conservation monitoring stations in the Yellow River Basin, forming a soil and water conservation monitoring network covering the upper, middle and lower reaches of the river basin, major tributaries, and key governance areas, and formed a water and soil conservation monitoring system supported by digital technology [1]. At the same time, the country has carried out a series of research and practical works on dynamic monitoring of water and soil erosion in the Yellow River Basin and key areas in China, providing strong technical support for improving the ecological protection and high-quality development and governance capabilities of the Yellow River Basin.

2. Background

The Yellow River Basin is located in northern China, with a length of about 1800 km from east to west and a width of about 900 km from north to south, with a drainage area of 242,000 km^2. Its ecological environment is fragile, and it has the most severe soil erosion in the country. Besides, the Yellow River

Basin is located in the hilly and gully areas of the Loess Plateau and the concentrated and contiguous poverty-stricken areas of the Qinba Mountains, making it a key area for poverty alleviation. For a long time, the state has attached great importance to the work of soil and water conservation in the Yellow River Basin and has carried out a series of research and practical works and have produced certain outputs. In fact, soil and water conservation monitoring has been carried out in our country since 1985. In 1987, the first water and soil conservation monitoring work in the Yellow River Basin was carried out. In 2002, the first large-scale monitoring on the Loess Plateau was carried out. In 2008, a water and soil conservation monitoring network was built on the main stream and tributaries of the Yellow River for water and soil conservation monitoring on the main stream of the Yellow River. In 2013, a dynamic monitoring network for water and soil loss in key national areas has been deployed for dynamic monitoring in key control areas in Shaanxi, Shanxi, Henan and other provinces along the Yellow River Basin. In 2019, a network of national soil and water conservation science and technology demonstration base stations was deployed in the middle reaches of the Loess Plateau and the Qinba Mountains. After years of development, a water and soil conservation monitoring information system supported by digital technology was established, and it allowed the monitoring of water and soil conservation in the upper reaches of the Yellow River Basin in northern Shaanxi, northwestern Shanxi, and western Inner Mongolia, as well as the main tributaries along the basin. Among them, the dynamic monitoring of water and soil loss in key national areas is an important aspect developed on the basis of the dynamic monitoring network of water and soil loss in key areas in our country. On the basis of arranging monitoring points in subregions in the downstream, the dynamic monitoring of water and soil loss in each subregion is carried out using technology like remote sensing and satellites. At present, the state has completed the dynamic monitoring of soil and water loss in key areas of the country, including the Loess Plateau and the Qinba Mountains, and has gradually established an information system supported by digital technology [2-10].

3. Monitoring system

Soil and water conservation monitoring started relatively late in our country. In the mid-1970s, the former Ministry of Water Resources began research and pilot work on soil and water conservation monitoring. In 1986, the Ministry of Water Resources organized the establishment of the National Soil and Water Conservation Monitoring Station to strengthen the management of national soil and water conservation monitoring. So far 5 levels of water and soil conservation monitoring stations have been deployed in the Yellow River Basin, including 5 stations in national key areas, 12 stations in major project areas, and 1,561 in small watersheds with a watershed of 50 km^2 or more. Through continuous improvement and construction of national, provincial, municipal, and county-level soil erosion monitoring networks, a water and soil conservation monitoring information system supported by digital technology was formed. At present, several national and provincial water and soil conservation monitoring data sharing service platforms have been established, such as the central water conservation cloud platform, provincial water conservation cloud platform, and basin-level water conservation cloud platform; an ecological protection system covering the upper, middle and lower reaches of the Yellow River Basin was built. Besides, three comprehensive test bases for soil and water conservation ecological environment protection in the key areas, and the upper and middle reaches of the Yangtze River and the Yellow River was constructed. Moreover, regional positioning observation of typical small watersheds in the Yellow River Basin and experiments on long-term observation the slope of typical small watersheds runoff has been carried out. In addition, soil erosion experiments have also been carried out in typical areas of the Loess Plateau [11-14].

4. Research status

4.1. Research application

The state has carried out soil and water conservation monitoring work in the Yellow River Basin, and then carried out a series of research on key control areas of water and soil conservation, national key areas, national key prevention areas of water and soil loss, and national key counties of water and soil conservation and ecological environment protection, and produced many research outputs. For example, research has been carried out on the law of erosion and sediment yield and its causes in typical areas of the Yellow River Basin, the mechanism and regulation of erosion and sediment yield in the Loess Plateau, the spatial pattern and regulation of soil erosion in the Loess Plateau. As a result, an information technology system for soil and water conservation monitoring has been developed. Besides, methods for dynamic monitoring of water and soil loss in key control areas across the country has been established. Dynamic monitoring of water and soil loss in the Yellow River Basin has been systematically designed and implemented. A soil erosion model for the Loess Plateau, a forecast model for water and soil loss in production and construction projects, and comprehensive management of water and soil conservation in small watersheds has been developed. They have been implemented in the Yellow River Basin and have achieved remarkable results; a soil erosion information management system has been developed in the Loess Plateau, which aids comprehensive management of soil erosion in the Loess Plateau. For example, according to the spatio-temporal differences of soil erosion in different types of typical areas in the Yellow River Basin, a soil erosion model suitable for the Loess Plateau has been developed. Besides, a multi-scale soil erosion model has been developed based on soil erosion intensity zoning and soil erosion change characteristics of different regions. An information technology system for soil and water conservation monitoring has been developed according to the characteristics of ecologically fragile areas in the Yellow River Basin. In view of the characteristics and regional differences of water and soil conservation governance models in different areas, ecological restoration models, governance technologies, and benefit evaluations for different types of areas have been developed. Moreover, in view of the characteristics of soil erosion of different areas, technologies such as the forecasting model of water and soil erosion for production and construction projects and management model of small watersheds have been developed.

4.2. Development strategy

The ecological protection and high-quality development of the Yellow River Basin is a major national strategy personally planned and promoted by the country and it is also the starting point for ecological protection and high-quality development of the Yellow River Basin in the new era. In 2019, the state council approved the "Yellow River Basin Ecological Protection and High-quality Development Plan," which outlined the major tasks, reforms, and safeguard measures for ecological protection and high-quality development of the Yellow River Basin. As an important aspect in the ecological protection and high-quality development of the Yellow River Basin, the monitoring of water and soil conservation has been highly valued by the Ministry of Water Resources, the Ministry of Finance, and other ministries and commissions. In 2021, the Ministry of Water Resources issued the "Guiding Opinions on Carrying Out Water and Soil Conservation Monitoring in Watersheds," which contains clear requirements for water and soil conservation monitoring in watersheds. The monitoring of water and soil conservation in the Yellow River Basin is based on the condition of the river basin, is demand-oriented, focuses on improving monitoring capabilities, and aims to improve its service quality. Up to now, a total of 2,166 soil and water conservation monitoring stations of various types (including 811 national level stations) have been deployed in the Yellow River Basin, including 1,026 monitoring stations for soil and water conservation in production and construction projects (776 national level stations). On the basis of continuously strengthening the construction of soil and water conservation monitoring network, the following work has

been mainly carried out:

4.3. Improving the monitoring system

Soil and water conservation monitoring have been incorporated into project management to strengthen supervision and inspection. Watershed soil and water conservation monitoring institutions have been established, and the responsibilities of various departments have been outlined. Besides, watershed soil and water conservation monitoring management systems have been established, watershed monitoring tasks and organizational management requirements have been determined, the monitoring behavior of various departments have been standardized. "Yellow River Basin Water and Soil Conservation Monitoring Work Plan," "Yellow River Basin Production and Construction Project Water and Soil Conservation Monitoring and Management Measures," "Yellow River Basin Ecological Protection and High-Quality Development Water and Soil Conservation Monitoring Work System," "Yellow River Basin Ecological Protection and High-Quality Development Water and Soil Conservation Monitoring Results Reporting System," and a series of system norms have been formulated and implemented to ensure the ecological protection and high-quality development of the Yellow River Basin.

4.4. Improving monitoring capabilities

The "Yellow River Basin Ecological Protection and High-quality Development of Water and Soil Conservation Monitoring Capability Improvement Plan" has been formulated, which clarified the main tasks, safeguard measures, and overall goals of monitoring capacity improvement. Besides, the construction of monitoring stations has been standardized in accordance with the unified standards of the Ministry of Water Resources and technical requirements, and the monitoring level of water and soil conservation in the watershed have been improved. Moreover, water and soil conservation monitoring in the watershed have also been informatized in accordance with the "unified standards and procedures" to monitor information on water and soil conservation to update the system. In addition, pilot work on the application of soil and water conservation monitoring information have been carried out, and an online monitoring platform for soil and water conservation and a remote sensing monitoring platform have been established to explore the information application of soil and water conservation monitoring.

4.5. Strengthen monitoring services

In combination with the supervision and management of water and soil conservation of production and construction projects, the acceptance and verification of water and soil conservation facilities, and monitoring of water and soil conservation, etc., technical services have also been carried out for water and soil conservation monitoring of production and construction projects, which have effectively solved the difficult problems in the supervision and management of water and soil conservation of production and construction projects, and greatly improved service quality and efficiency. Since 2020, 31 provincial water administrative departments in the basin have been instructed to complete 545 monitoring tasks of water and soil conservation for production and construction projects, and 1,026 monitoring tasks for production and construction projects have been completed. Provincial-level water administrative departments in the Yellow River Basin found 1,236 problems in their daily supervision and inspection, and 1,218 problems were discovered through soil and water conservation monitoring, which effectively promoted the prevention and control of water and soil erosion in production and construction projects.

4.6. Consolidate the foundation of water conservation monitoring

Since 2021, the provinces in the river basin have cooperated with the national water and soil conservation monitoring project to increase capital investment, and strengthen the infrastructure construction of water

and soil conservation monitoring stations through purchasing services and local self-raising. Up to now, the provinces in the Yellow River Basin have transformed more than 5,300 monitoring stations, with an investment of nearly 660 million yuan. Subsequently, various provinces have implemented national soil and water conservation monitoring network construction projects, and carried out construction, renovation, and upgrading of monitoring stations using existing facilities. As a result, full coverage of major production and construction projects in the watershed was gradually realized. Some provinces have also established automatic monitoring networks for soil and water conservation that integrate video surveillance, automatic rain measurement, automatic monitoring, and remote sensing interpretation, which has greatly improved the efficiency of soil and water conservation monitoring. All localities have also improved the informatization level of water and soil conservation monitoring by actively carrying out technological transformation and upgrading of stations, introducing advanced technical means, and carrying out digital pilots.

5. Suggestions and prospects

In the future, the monitoring of water and soil conservation in the Yellow River Basin should be developed based on the national soil and water conservation monitoring plan, so as to provide solid technical support for the realization of ecological protection and high-quality development in the Yellow River Basin.

The first method is to adopt "Internet +" soil and water conservation monitoring to promote the construction of an information system for water and soil conservation monitoring supported by digital technology, give full play to the advantages of smart water conservancy construction, and build a water and soil conservation monitoring business system integrating "data, analysis, and service."

The second step is to maximize the supporting role of the national soil and water conservation planning projects. New modes of combining national soil and water conservation planning projects with key projects such as dynamic monitoring of water and soil erosion and comprehensive management of small watersheds should be explored. The supporting role of national soil and water conservation planning projects should be maximized in the implementation of major strategies for ecological protection and high-quality development in the Yellow River Basin.

Lastly the dynamic monitoring capabilities of the country's key regions and important river basins should be continuously improved. The construction of dynamic monitoring capabilities in typical regions of the Yellow River Basin on the basis of improving the dynamic monitoring capabilities of key national regions. Besides, data support should be provided for a comprehensive understanding of the ecological protection and high-quality development of the Yellow River Basin.

Disclosure statement

The author declares no conflict of interest.

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