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Research and Discussion on Management of Hydrologic Survey Driven by New Generation Information Technology

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Abstract. Since the 1970s, the Bureau of Hydrology, Changjiang Water Resources Commission has carried out research on automatic flood reporting, innovation of hydrometry methods, and improvement of "one station, one policy" monitoring and reporting capabilities, laying a technical foundation for the development of hydrologic survey; the construction of Web-based intelligent hydrometry system ("WISH" system) has been carried out, laying an information foundation for hydrologic survey. Through the research and practice in recent years, the management system of "Mainly patrol survey, combining standing survey with patrol survey" has been gradually established. However, while liberating the productive forces, hydrologic survey also brings some new problems, such as the marginalization of survey stations, hollow management, low survey efficiency and idle assets. Therefore, based on a comprehensive understanding of the management of grass-roots stations, equipment and facilities, and the development of patrol survey, the paper studied and discussed the management mode of hydrologic survey driven by the new generation of information technology in combination with new technologies such as computer vision and machine learning.

Keywords. Hydrologic survey, hydrological monitoring, new generation information technology, direction of development

1. Introduction

In 1955, China issued the Interim Specifications for Hydrologic Stations [1], which determined that the standing survey method was adopted for national hydrological stations. With the rapid development of the economy and society, the disadvantages of the resident test mode, such as less test sections, low measurement and reporting means, less output data, slow information transmission, and low service efficiency, are increasingly unable to meet the needs of social development. It is an inevitable way for the development of hydrological monitoring in China to reform the hydrological measurement methods and technical means, innovate the hydrological monitoring system, and use limited resources to obtain more hydrological information to meet the needs of socio-economic development for hydrology [2,3].

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In 2005, the former Hydrological Bureau of the Ministry of Water Resources issued the Notice on Printing and Distributing the Guiding Opinions on Hydrological Modernization, which put forward the requirements for speeding up the construction of hydrological modernization, emphasizing the "application of modern science and technology, relying on thinking innovation, system innovation, mechanism innovation and scientific and technological innovation" and other means to "actively promote the reform of hydrological testing methods" [4]. "In the survey area with good traffic conditions, based on the hydrologic survey base, the management mode of combining standing survey, patrol survey, interval survey and hydrologic survey is realized. For the survey stations that have accumulated a long series of data and have a good water level flow relationship, the mode of" unattended and supervised "should be followed, and the corresponding instruments and equipment should be equipped. Typical survey stations and river sections should be selected as the pilot to meet the requirements of hydrological forecasting, hydrological analysis and calculation, and water resources evaluation to meet the actual accuracy requirements, study and promote the optimization model of hydrologic survey, and gradually make all stations that meet the requirements of the Specifications for Hydrological Patrol Survey implement patrol survey [5].

2. Establishment and Development of Hydrological Survey System

2.1. Development of Hydrologic Survey

In China, the rainfall and heat are in the same season, and the flood is serious. Most of the hydrological stations were initially set up for flood control. In addition, the population along the river is dense. Therefore, the timeliness of hydrological measurement and the corresponding forecast accuracy are required to be high. However, patrol survey is difficult to ensure the frequency and timeliness of flood measurement [6,7]. In order to ensure the accuracy and timeliness of hydrologic measurement in flood season, according to the requirements of high flood control pressure and strong timeliness of flood information in China, the viewpoint of combination of station and patrol inspection is proposed.

With the rapid development of social economy in China, the demand for water resources has increased rapidly, and the number of hydrological stations has also increased on a large scale. However, the existing hydrological management personnel and system in China cannot meet the reality of large-scale new hydrological stations [8]. It is the best choice to adopt patrol survey mode to improve the benefit of hydrologic survey. Therefore, from the perspective of flood control and the most strict water resource management, the mode of combining patrol survey with resident inspection can meet the existing demand in China [9].

On the basis of comparing the characteristics of hydrological monitoring at home and abroad, the Bureau of Hydrology, Changjiang Water Resources Commission put forward a hydrological monitoring management system of "combination of stationing and patrolling, priority of patrolling, automatic measurement and reporting, and emergency supplement" [10]. It is different from the comprehensive patrol survey model of European and American countries, and can provide more accurate and real-time hydrological monitoring results; It is also different from the garrison mode of the former Soviet Union. It can collect hydrological information more widely, meet the needs of all social parties, and further improve China's hydrological monitoring system.

2.2. Technical Support for Hydrologic Survey

The new hydrological measurement management system needs to rely on a large number of new hydrological monitoring technologies. On July 1, 2005, the Bureau of Hydrology, Changjiang Water Resources Commission took the lead in realizing the automatic flood reporting of water level, rainfall and corresponding flow of 118 central flood reporting stations [11], but the methods of flow and sediment measurement cannot support the requirements of patrol survey and emergency rapid monitoring. The hydrological patrol survey needs to break through the bottleneck of rapid measurement of flow and sediment on site, otherwise, the time and energy consumed by conventional monitoring will lead to low efficiency of hydrological survey and loss of significance of patrol survey. In order to save manpower, it is urgent to realize real-time online monitoring of the standing hydrological station [12]. In order to support the development of hydrologic survey and accelerate the modernization of the Yangtze River hydrology, the Bureau of Hydrology, Changjiang Water Resources Commission comprehensively launched the "innovation research on the methods of hydrologic survey in the Yangtze River" and the "one station, one policy" measurement and reporting capability improvement [13-14].

2.2.1. Single Value Technology of Stage Discharge Relation

When carrying out hydrologic survey, the number of flow tests at hydrologic stations should not be too many, or it will not pay off. The relationship between river water level and flow is affected by many factors, such as flood fluctuation, fluctuating backwater, changes in cross section scouring and silting, hydraulic engineering, etc. It is not a definite functional relationship, but is shown in the relationship between water level and flow, which is shown as multiple temporary curves or continuous time series. In order to achieve the alignment accuracy required by the Hydrological Data Compilation Specifications, some hydrologic stations have measured the flow for more than 100 times, and the workload of hydrologic measurement is huge, so it is impossible to use patrol measurement. Therefore, the single value of water level discharge relationship is the key to realize hydrologic survey.

In 1981, the scholars of the Bureau of Hydrology, Changjiang Water Resources Commission deduced the formula of the fall index method based on the Saint Venant equation, and took the lead in proposing to use multiple sets of reference water gauges to calculate the comprehensive fall to deal with the single value problem of the stable river bed water level discharge relationship. Since 1986, the single value technology of the water level discharge relationship has been gradually popularized and applied throughout the country [15]. In order to make the fall comprehensive index method become a general method to deal with the water level discharge relationship affected by flood fluctuation, backwater jacking, cross section scouring and silting, relevant personnel of the Hydrological Bureau of the Yangtze River Commission have successively put forward a variety of mathematical methods or models such as single value treatment of water level discharge relationship in adventitious river, further improving the single value treatment system of water level discharge relationship [16,17].

At present, among the hydrologic stations affiliated to the Bureau of Hydrology, Changjiang Water Resources Commission there are more than 30 stations that adopt single value for the stage discharge relationship in the patrol survey scheme, and more than 60 hydrologic stations have reduced the flow measurement times through single value technique. Among the above hydrometric stations, there are small river stations,

main stream control stations, hydrometric stations in the Dongting Lake area where the river water flows in an indeterminate direction, and hydrometric stations in the estuary of the Yangtze River estuary affected by tides, which fully prove the universality of the single value method for the comprehensive drop index of the water level discharge relationship. The promotion and application of single value of water level discharge relationship has saved a lot of manpower and material resources and laid a foundation for patrol survey [18].

2.2.2. Innovation in Testing Methods

The technological innovation of the Yangtze River hydrologic measurement method mainly refers to the innovation of the measurement and management of the flow and suspended sediment at the hydrologic station, including the measurement method of the flow and sediment and the associated data compilation method. The application and redevelopment of new instruments such as acoustic Doppler velocimeter, laser particle size analyzer and on-site laser sand analyzer have been carried out.

The innovation of hydrologic measurement methods of the Bureau of Hydrology, Changjiang Water Resources Commission was officially launched at the end of 2007. It took three years and was completed at the end of 2010. In the process of innovation implementation, the Bureau of Hydrology, Changjiang Water Resources Commission made overall planning and careful deployment, and mobilized the enthusiasm of hydrologic workers by holding different types of technical exchanges and training; Through careful planning through technical preparation and scheme design, careful organization, scientific implementation, optimized allocation of hydrologic testing instruments and equipment, and strengthened implementation, the successful development of technological innovation in methods and methods of hydrologic testing in the Yangtze River has been ensured, which provides organizational guarantee for promoting the progress of hydrologic testing technology in the Yangtze River. The innovative results of testing methods provide important technical support for the development of hydrologic patrol survey [13-14].

2.2.3. "One Station, One Policy"

For the influence of water conservancy project scheduling or flood fluctuation, the water level discharge relationship of the measuring station is not a single relationship, and it is impossible to realize the single value relationship between water level and discharge. At this time, the flow measurement of the hydrological station can only implement online monitoring to realize the automatic monitoring of flow factor changes, so as to achieve the purpose of calculating the flow change process. Online monitoring creates basic conditions for hydrological survey [19,20].

In 2019, the Hydrological Bureau launched the work of "one station, one policy". All survey bureaus attached great importance to it, organized special shifts to actively promote it, prepared a work outline based on the actual needs of hydrological modernization and the implementation of policies at the station, and actively carried out monitoring capacity improvement work in combination with infrastructure projects. Benefiting from the promotion of "one station, one policy", substantial progress has been made in online monitoring and information construction. By the end of 2021, the water level and rainfall have been fully recorded; The automatic recording rate of evaporation, water temperature and other items is more than 90%. The online monitoring proportion of flow and sediment is 50%.

2.2.4. Hydrologic Monitoring Information System

Driven by the modern development demand of hydrological monitoring in the new era, it has become an inevitable requirement for hydrological patrol survey in the new era to fully apply computer technology, the Internet, intelligent systems and other information technologies to open up online data links, form a set of software system for intelligent online hydrological testing and real-time integration, and comprehensively improve the production efficiency and service quality of hydrological data integration results [21]. Since 2020, based on the hydrological data compilation system and the early hydrological monitoring information construction, the Hydrological Bureau has combed the hydrological monitoring production and management and other business processes in depth in combination with the requirements of the Ministry of Water Resources for smart water conservancy pilot work, and carried out the construction of the WISH system guided by problems, needs and objectives.

The WISH system construction is closely centered on the main line of "opening up the front end of data acquisition and the whole link of integration", with the goal of truly realizing the online integration of the whole process of measurement calculation report integration. The system focuses on integration and innovation, and vigorously promotes the deep integration of new technologies such as artificial intelligence, 5G, big data, Internet of Things, and video with hydrological business. Up to now, the WISH system has completed the main function development and entered the stage of testing and function improvement. The phased achievement "online compilation system" was selected as "excellent case" by the Ministry of Water Resources and officially put into operation in the overall situation. The Yangtze River hydrology became the first unit in China to truly carry out online compilation in accordance with the requirements of "standard, real-time and intelligent". The hydrological data compilation work moved from "daily clearing and monthly settlement" to "real-time intelligent".

3. Problems

In recent years, on the basis of improving organizational guarantee and strengthening technological innovation, the Bureau of Hydrology, Changjiang Water Resources Commission has fully realized hydrologic survey, improved production efficiency, optimized resource allocation, solved the difficulties of employees in school, employment, and medical treatment, and achieved a qualitative leap in the management model of hydrologic survey.

However, the comprehensive implementation of hydrological survey has also brought new problems to the Bureau of Hydrology, Changjiang Water Resources Commission, which has a long tradition of standing survey and is oriented by standing survey for infrastructure construction and resource allocation.

3.1. Inadequate Modernization of Measurement Methods Restricts the Efficiency of Hydrologic Patrol Survey

With the implementation of the Yangtze River protection and the strictest water resources management system, the demand for hydrological technical services has also undergone profound changes. The technical information service has developed rapidly

in the direction of convenience, efficiency and diversification. The existing monitoring means and information transmission chain can no longer meet the new social needs.

Due to the influence of the operation and dispatching of water conservancy projects, the natural flow characteristics of the hydrologic measuring river reach have changed, which has affected the hydrologic characteristics of the hydrologic stations located at the upstream and downstream of the water conservancy projects. The original measuring methods are difficult to accurately grasp the changing laws of flow and sediment concentration, and the workload of hydrologic survey is large and the test is difficult; In addition, the hydrological test still needs to perform the task of providing timely hydrological information for flood control and drought relief. Therefore, the hydrologic survey should not only collect the basic hydrologic data, but also provide timely and accurate hydrologic information for flood control and drought relief, which puts forward new and higher requirements for hydrologic survey in the new era.

3.2. The Management of Grass-Roots Branches Is Difficult, and the Inspection Organization Is Relatively Difficult

With the comprehensive implementation of hydrological survey, the management problems of grass-roots sub bureaus are gradually emerging: 1, the survey stations are marginalized. The survey station is no longer the focus of human resource allocation and comprehensive management. The structure of "multiple points, multiple lines and broad areas" of the Yangtze River hydrology has changed, the scope of management has narrowed, and grass-roots management has become more difficult. 2, Hollow management. The management form with patrol survey group as the basic unit has replaced the station master responsibility system, and the business oriented function has replaced the comprehensive management responsibility. There is no fixed responsible person responsible for the overall situation of the survey station, and the environment, safety, and survey area protection of the survey station are worrying. 3, Management responsibilities are unclear. Compared with the clear responsibility of flood reporting subject in the resident survey mode, the supervision responsibility of the sub bureau in the transition to patrol survey needs to be strengthened, and the specific responsibilities of hydrological testing, instrument calibration, fault handling, etc. need to be further broken down and implemented by the sub bureau. 4, Infrastructure faces a dilemma. After the patrol survey, people went to the facility. On the one hand, a large number of infrastructures such as station buildings, sites, cableways, and survey ships have lost their real-time monitoring means and emergency response capabilities during the period of stationing; On the other hand, the idle of a large number of assets brings the risk of public opinion. The above problems deserve attention and countermeasures should be formulated.

4. Discussion on Management Mode of Future Hydrologic Patrol Survey

4.1. Continuously Promote "One Station, One Policy" to Improve Hydrological Monitoring Capacity

The improvement of monitoring capability is an important support for the improvement of patrol management capability. In order to improve the hydrological monitoring capacity and adapt to the requirements of the new situation for hydrological patrol survey,

the "one station, one policy" should be continuously and deeply promoted, and the basic analysis and localized application of modern monitoring technology should be scientifically and reasonably carried out in combination with the needs and actual conditions of the stations.

Following the development trend of the new generation of information technology, we should introduce techniques such as the Internet of Things, automatic driving, artificial intelligence and big data, strengthen the research and application of online monitoring, increase the proportion of automatic online monitoring of hydrological elements, and constantly improve the capacity of hydrological monitoring. Gradually improve the efficiency and technical management level of hydrological survey.

4.2. Improve the Management Level of Patrol Survey by Means of Informatization

Guided by the needs of grassroots work, with the purpose of convenient working mode, reducing work intensity, and convenient survey management, we fully consider the work habits of hydrological testing and data compilation, constantly collect user feedback, further improve the functions of the WISH system, promote the deep integration of measurement, reporting, calculation, integration and other business processes, and realize the integration of original data, single results, monthly reports Data integration and other full process data applications. Efforts should be made to improve the informatization, modernization and intelligence level of hydrological monitoring, so as to provide a solid information support for hydrological survey.

4.3. Integrate New Technologies and Explore New Ways of Patrol Management

On the basis of in-depth field investigation, demand analysis and scheme discussion in relevant survey bureaus and stations, and after in-depth exploration and understanding of the new generation of information technology, the Hydrological Bureau carried out the pilot work of AI video survey station patrol management in Baihe Station of Hanjiang Bureau.

Through the installation of AI video system in Baihe Station, the station AI video monitoring, auxiliary monitoring, access control management, intrusion alarm, dynamic tracking and other means are realized, and intelligent analysis is made to establish a collaborative management mode of AI video multi-source perception edge computing visual reconstruction. The realization of security monitoring and early warning, test environment monitoring, patrol scene display, patrol task management and comprehensive management of hydrological stations are explored. Next, the research team will further promote the pilot work of survey station patrol management, explore and improve the patrol management system, and timely promote it.

5. Conclusion

In years of hydrologic monitoring management practice, the Hydrological Bureau of the Yangtze River Commission has established and developed a hydrologic patrol management system, which provides a solid support for the development of hydrologic monitoring. With the further improvement of social needs, new and higher requirements have been put forward for hydrologic monitoring. The development of a new generation of information technology also provides a new development opportunity for the

development of hydrologic patrol. Therefore, this paper proposes a new generation of information technology driven management model of hydrological survey, which can provide a reference for hydrological monitoring.

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