Advances in Hydrological Science of China

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ABSTRACT: Hydrologic science and technology have played an important role in promoting water conservancy development and national economic construction in China. Along with the development and progress of hydrology, water conservancy and national economy, the science and technology of hydrology have got great achievements, of which some havereached or neared to the international advanced level. In this report, introduction will be made in 5 respects including hydrometry technology, hydrological simulation, hydrometeorological research, hydrological analysis, and operational forecasting.

1 Hydrometry Technology

At present, automation has been realized for water level and rainfall collection transmission. A great advance has been made in on-line monitoring of water quality, flow and sediment in recent years, at the advanced level of the international development.

1.1 Construction of Station Network

Up to the beginning of 2007, there have 36 058 hydrological stations of various kinds all over the country, including 3 183 national hydrological stations, 1 160 stage gauging stations, 13 866 rain gauging stations, 5 140 water quality stations, 12 598 groundwater monitoring stations, 13 evaporation gauging stations, and 78 experiment stations, of which 8 220 stations transmit hydrological information to the concerned department above the county level, 1 142 stations issue hydrological forecasting.

1.2 Development of Hydrological Information Collection and Transmission Equipments

1.2.1 Flow measurement

In China, development and application have been made in some respects, including intelligent flow measurement cableway system, remote control automation cableway based on the internet, and GPS used in hydrometric boat positioning. Otherwise, breakthroughs have been made in the key technology of Doppler flow measurement, there is rapid development of aircraft-style walk acoustic Doppler technology, and acoustics-based automatic on-line monitoring of the flow has been initially applied.

1.2.2 Sediment measurement

The analysis efficiency of sediment particle sizes have been increased by using laser particle size analyzers; LISST100 laser sediment concentration meters provide an effective means to rapid measurement for large-scale reservoir sediment monitoring and scheduling; Vibratory sediment concentration meters developed in China provide an efficient means for monitoring high sediment concentration flow, so to realize on-line monitoring and recording of river sediment; The application of AYX2-1-type suspended sediment samplers has increased the accuracy and efficiency of sediment measurement.

1.2.3 Hydrological information transmission

About 80% of the hydrometry stations have achieved automatic collection and transmission, more than 80% of the information can be transmitted to the Ministry of Water Resources within 30 minutes.

1.3 Hydrological Data Processing

A hydrological data processing system has been developed to meet the requirements from the southern part and northern part of China, so as to ensure the quality of data and results.

1.4 Construction of Data Storage and Data Sharing Platform

Application of solid-state memory to store the collected data has been gradually adopted by all. The national hydrological database and data query system has been improved, issuing hydrological and water resources information in the form of the water resources bulletin, newsletters, groundwater circular, water resources and water quality annual report, and water environment circular.

2 Technology of Hydrological Simulation

2.1 Study on the Laws of Runoff Yield and Flow Concentration

Multi-source information from satellite remote sensing, precipitation monitoring radar, hydrometeorological observation and GIS have been used to study the laws of runoff yield and flow concentration in the changing environment and mechanism of the water cycle, describe the processes such as soil evaporation, plant evapotranspiration, overland flow concentration, river flow concentration, soil water movement and groundwater recharging, and reveal the objective law of the soil water redistribution in the vertical and lateral directions and the influence on runoff yield.

2.2 Hydrological Models of Basin

Along with the development of the Xinanjiang model, a calculation method has been suggested combining runoff yield in excess of infiltration with runoff yield at natural storage in the vertical direction, and the mode of runoff yield in excess of infiltration was added for the area without runoff yield at natural storage, which resolve the problem of determining grid water storage capacity in calculation of runoff yield at natural storage. A hydrological model of nonlinear disturbance (NLPM-ANN) was proposed and perfected based on artificial neural network, which has provided an effective way of resolving the nonlinear problem in rainfall-runoff relationship of basin. A compatible conceptual model of runoff yield at natural storage and runoff yield in excess of infiltration was developed, which has further improved the theory and method of simulating mixed runoff yield mechanism and its spatial variability. A hydrological simulation platform was developed by using adaptive neuro-fuzzy inference system, which can make a high efficiency by giving stable flow simulation and forecasted results. Considering the influence of the uneven spatial distribution of precipitation and non-uniformity of underlying surface, the distributed multi-source information Xinanjiang model was developed on the digital basin platform,.

2.3 Real Time Prediction Error Correction

Application of the robust theory and the way of Kalman filtering combining with artificial neural networks to establish a comprehensive real time flood forecasting correction method, by using the real time hydrological information, human activities and the historical floods and other information, which have realized dynamic monitoring and intelligent amendment of the prediction error. The gap between China and other advanced countries is mainly reflected in the research on the uncertainty estimation theory and method of the hydrological forecasting results and operational application.

3 Study on Hydrometeorology

In recent years, completion of the study on the model of estimating the influence of climatic anomaly on the water cycle and water resources in China has explored the parameter grid technology for distributed hydrological models, initially established combination between model parameters and GIS. The study put forward the Lagrangian spatial data degradation method considering the influence such as landform, realized the nested running of a distributed hydrological watershed model and a climate model, and analyzed sensitivity of watershed discharge to climate change. The assessment of the threshold and total amount of the influence of climate change on the freshwater resources in China, studied the vulnerability of China's water resources and the impact threshold of climate change on fresh water resources, based on analyzing the situation of future water needs and water resources and studying the future climate change.

Through importing advanced meteorological models of other countries, the pilot study was made on the direct connection between the numerical prediction of rainfall and flood forecasting model for the Yangtze River Basin, in which a quantitative rainfall forecasting technology program was worked out for the watershed, and the experimental analysis was made for coupled application of quantitative precipitation forecasting and hydrological forecasting model. As for the weather radar area rainfall data synthesis, the current experiment in our country is still at the exploratory stage. As for drought monitoring, automatic real-time monitoring of the national large-scale hydro-meteorological drought situation has been realized, by inputting the real-time weather monitoring information (including conventional weather forecasting and estimated rainfall and evaporation from satellite monitoring information) into hydrological models.

4 Hydrological Analysis and Calculation

4.1 Advances of Hydrological Analysis and Calculation

4.1.1 Method of flood frequency analysis

In 2006, the design flood standards were revised in China, in which the new provisions were made for the empirical frequency formulas, linetypes of frequency curves, and methods of statistical parameter estimation.

4.1.2 Analysis of rainstorm frequency

The Atlas of Rainstorm Statistical Parameters in China was published, in which the most comprehensive and systematic information and researched results were included.

4.1.3 Probable maximum precipitation (PMP) / probable maximum flood (PMF)

The WMO "PMP Estimation Manual was revised under the organization of Mr. Wang Guoan in 2004. Now, the manual has entered the publishing process of WMO and will be officially published.

4.2 Advances of Study on the Basic Laws

The books of The Rainstorms in China and Discussion on Hydrological Theorems, Laws and Hypothesises were published in 2002, and the paper Study on the Characteristics of Rainstorm Floods in China was published in 2006.

4.3 Advances of the Theory and Method of Results Rationality Investigation

The book Assessment of Hydrological Design Results Rationality published in 2002 has improved the theory and method of rationality investigation.

5 Hydrological Operational Forecasting

5.1 Models and Methods of Hydrological Operational Forecasting

At present, hydrological forecasting operational methods used in China can be divided into two kinds of methods including practical hydrological forecasting schemes and watershed hydrological models. There are many practical hydrological forecasting schemes for the seven major river basins, and there are near 1 000 forecasting schemes at more than 600 hydrological stations all over the country.

In the hydrological operational forecasting of China, there are Xinanjiang model, dual-excess runoff yield model, Hebei rainfall flood model, and dual-attenuation curve model being used. Otherwise, there are the imported tank model, Sacramento model and SMAR, and there are improved imported API model, CLS model and the NAM model. Now, advances and progress have been made in developing practical hydrological forecasting models, some of which have got the international advanced level.

5.2 Hydrological Forecasting Systems

Hydrometeorological information monitoring and flood forecasting and dispatching system has been developed to expert interactive flood forecasting and dispatching system. At present, this kind of systems generally use C/S structure to set up 5 types of forecasting schemes, with a unified national real time hydrological information database as support, and GIS as platform. With standard and common forecasting model libraries, this kind of systems have the functions of choosing several models and methods to make forecasting schemes, model calibration of manual and automatic optimization, regular forecasting and human-computer interactive forecasting, interfering any source of information and forecasting process, advanced Tyson polygon calculation method, meteorological calculation in the condition of lack rainfall, and perfect system management.

References

XIA Jun, ZUO Qi-ting.(2006). “ New Advances in International Hydrology Research.” *Advances in Earth Science*（3）pp:256-261.

LIU Jin-ping, ZHANG Jian-yun.(2005). “Development and Prospects of Hydrological Forecasting Technology in China.” *Hydrology of China*(6).

GUO Sheng-lian.（2005）.“Advances in Research of Design Flood and Assessment.” *Beijing: China Water Power Press.*