

Keynote Lectures

THE PERSONAL FACE OF INTERNATIONAL HYDROLOGY

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Over the years, our understanding of hydrological processes and the management of water resource systems have expanded from the local vicinity to the national, then to the river basin and to the continental and finally to the global scale. For the scientists, this has demanded a series of major changes in how the hydrological cycle has been monitored and modelled. For the water resource manager, it has demanded a consideration of ever more complex and sensitive socio-economic and political issues. Both have led to the establishment of formal agencies, less-formal associations as well as informal groups whose aim is to coordinate efforts in various fields at national, river basin and global scale. Some are governmental and inter-governmental, others are purely non-governmental. In all cases, the effectiveness of these bodies depends on the efforts of individuals who have a concern for the sustainable management of the water resources. These people are the human face and foundation of efforts to understand and safeguard the world's water resources and everyone can find a place where his/her contribution can make a difference.

The world's largest water diversions: China's south-to-north water transfer schemes

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Because its large population size China suffers from water shortage in terms of very low quantity of per capita water volume only accounting for 1/4 of world average. In particular, China's northern and northwestern mainly lie in vast semiarid and arid zones, making up 44% of total area of the country. But annual runoff of those zones is less than that of 10% of the nation's total amount. Moreover temporal distribution of water resources in both monthly and yearly amounts is highly uneven Influenced by summer Monsoon runoff mainly concentrates in warm season. For instance,

runoff amount from June to September can reach 60% of the annual runoff in the southern China and 80% in the northern China respectively. Obviously, such unevenness in runoff shows an increase from south to north in this country.

In order to combat against unevenness in water resources distribution, the idea of reallocating China's water is highly likely to be a reason to carry out water transfers in this country. Traced back to 486 B.C., ancient Chinese people started to implement one of the earliest water transfer project in the world, which called a Hangou water way connecting yellow river and Huai river as an inter-basin water diversion. Afterwards, there were a number of water diversions followed to develop such as the Grand canal in 456 B.C. and Dujiangyan water diversion in west Sichuan Province in 256 B.C. etc. These ancient structures have been used for thousand years by late generations up to nowadays.

China's south-to-north water transfer schemes (SNWT), which was firstly proposed by Chairman Mao Zedong in the early 1950s, when he inspected the Yellow River Basin in 1953 and suggested to "borrow some water from the Yangtze river to the Yellow river ". He said this to Mr. Wang Huayun, leader of the Yellow River Basin Commission. In late 1950's, Chinese Academy of Sciences with Ministry of water Resources begun to carry out integrated survey work in the upper reaches of the Yangtze river and the southwestern rivers for possibility and feasibility in transferring water to the upper Yellow river areas. This survey resulted in about 50 preliminary schemes to channel water from upper Yangtze river and the southwestern rivers as well. In 1972, a big drought was widely covering 7 province of North China. In order to combat the drought, Premier Zhou Enlai suggested to workout a scheme to divert lower Yangtze River water to the North China plain.

Due to an acceleration of growth of both economic development and population water consumptions and requirements have increased greatly since 1980's. Water shortage in the northern three river basins e. i., Huang (Yellow)-Huai-Hai river basins, has become a main factor to constrain economic and social development. In particular, droughts have frequently occurred in 1990's water shortage in those basins becomes more severe. Considering mitigating this problem, Chinese government has now decided to foster and speed up work on water transfer planning and project designing and to implement recently. The present paper mainly dealt with how and what are the consequences of projects.

UNDERSTANDING AND IMPLEMENTATION OF INTERDISCIPLINARY WATER MANAGEMENT

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The founders of International Water Resources Association and its official journal, *Water International*, have recognized that many water management problems represent not only an engineering or biophysical problem but often also include socioeconomic, institutional, and ethical challenges. It is now widely recognized that water resources management decisions must go beyond the confines of the technical disciplines of hydrology and civil engineering. Multi-disciplinary, interdisciplinary, or even trans-disciplinary approaches are often recommended for dealing with the multifaceted water resources problems. As this conference will undoubtedly demonstrate, the number, seriousness and difficulty of water resources problems in the Asian Developing World are increasing and finding the best solutions will require scientific understanding of concepts and methods from different disciplines. A comprehensive program of research, which depends substantially on interdisciplinary approaches to cross-cutting issues offers the best hope for success in dealing with the present and future water problems. Understanding and implementation of interdisciplinary research are important steps in achieving this goal. This presentation provides a review of the practical aspects of multi-disciplinary collaboration and the conditions for successful implementation of research findings in water resources management decisions.

SOME CONSIDERATIONS ON THE DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN CHINA

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It is well-known that groundwater resources are important component of water resources worldwide. By the end of 20th century, the total annual groundwater production in the World exceeds 750 billion m³, more than 50% of which has been used in the United States, India and China. During the past ten years, the groundwater production increases rapidly in India and China. In 2000, 106.9 billion

m³ of groundwater has been withdrawn all over China, 90% of which is concentrated in 17 provinces of North China. Groundwater supply consists of 19% of total water supply of China, and more than 60% water supply for drinking, domestic and industry uses comes from groundwater in North China. Owing to the rapid development and lacking of scientific and efficient management of groundwater resources, serious problems appeared in China. In several areas, the exploitable resources decreases and water table dropped down dramatically due to over-exploitation of groundwater resources. The over-exploitation area in China is up to 18×10^4 km², which led to subsidence of groundwater surface and sea water invasion in coastal areas. For preventing over-exploitation and scientific plus efficient management of groundwater resources in China, necessary even urgent measures must be taken: 1) unifying management of groundwater resources. Ministry of Water Resources should take the responsibility to manage the groundwater resources nationwide instead of so called "nine dragons" managing groundwater; 2) setting up networking of groundwater monitoring system so as to sharing the diverse information on groundwater resources in different organizations; 3) establishing nationwide regulations to manage groundwater resources properly; 4) strengthening research on groundwater resources by using hydrological and geological methods; 5) education, the main purpose is to get human resources both knowing surface and subsurface (ground) water resources managements.

Climate change impacts on water resources and their management

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The climate system and the freshwater system are closely inter-connected so that every change in one of these systems induces a change in the other one. It has been known from the past that climate change exerts considerable impacts on freshwater resources and their management. The present contribution will review changes in the regional and global climate, and their impacts on freshwater resources, which have been observed in the recent past and are projected for the future. The considerations will be global, but with particular reference to the East Asia region. Intensification of the water cycle is projected in many regions, with extremes getting more extreme, yet credibility of projections is low. Uncertainty

aspects and their consequences to water management will be discussed. While in some regions, climate model projections are relatively robust, in many regions the prognostications are largely dependent on the climate model used for analysis and on the scenario of future emissions of greenhouse gases (and socio-economic scenario, in general). It is difficult to make concrete, and detailed projections on climatic impacts, in particular of a long-time nature and in a scale of a river basin. However, it is likely that hydrological variables will change in the future, hence the past can no longer be the key to the future. Moreover, some of possible future impacts are likely to be beyond the human experience. Climate change is just one of factors on which water resources availability and demand depend. Among other factors, which can be dominating in some areas, are: population dynamics, economic growth, globalization, urbanization. Adaptation to climate changes and their impacts are likely to be expensive and the possibility to adapt is limited in much of the developing world.

COPULA METHOD FOR DERIVING JOINT DISTRIBUTIONS IN WATER RESOURCES ENGINEERING

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A wide range of phenomena in environmental and water resources engineering are stochastic in nature. Examples of such phenomena are instantaneous annual peak discharge, peak annual rainfall amounts for specified durations, spatial coverage and duration of water scarcity in a region, number and length of droughts, antecedent soil moisture, spatial field of saturated hydraulic conductivity of soils, dispersivity, annual sediment load of a river, evolution of bed forms, incipient motion of sediment, maximum temperature, storm water pollutant loading, peak monthly pollutant concentration, chemical spills on highways, and number of times the ozone level exceeds the threshold level.

Many environmental and water resources projects require joint distributions of random variables of concern. For example, in hydrologic design and floodplain management, joint distributions of flood peak and volume, and flood volume and

duration are employed. Likewise, the joint probability distribution of monthly sediment load and discharge is needed in order to develop strategies for mitigation of reservoir sedimentation. To develop Best Management Practices (BMPs), joint distributions of discharge, and sediment and pollutant loads are needed. In order to determine health hazard in an urban area, one needs to determine the number of ozone exceedances over a threshold, duration of exceedances, and time interval between exceedances. The joint probability distribution of these variables is needed to develop methods for environmental pollution control. If the interest is in determining risk of, say, a chemical spill, then the joint distribution of the spill, areal coverage of spill, duration of spill, and the consequent damage is required.

In water resources engineering, many attempts have been made to derive bivariate and trivariate distributions of rainfall or flood characteristics. Multivariate frequency analysis taking into consideration the dependence among random variables is usually based on one of two fundamental assumptions. Either the variables have each the same type of the marginal probability distribution or the variables have been assumed to have the normal distribution or have been transformed to have the normal distribution. In reality, however, the variables are dependent, do not, in general, follow the normal distribution, and do not have the same type of marginal distributions. This paper presents the copula method for deriving multivariate frequency distributions, without assuming the variables to be independent or normal or having the same type of marginal distributions. To illustrate the method, joint distributions are determined and are tested using rainfall and runoff data from river basins in Louisiana, U.S.A.

Advances in researches on simulation of watershed water cycle

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WATER SECURITY IN NORTH CHINA AND COUNTERMEASURE TO CLIMATE CHANGE AND HUMAN ACTIVITY

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This paper addresses the emergent issue water security, particular on ground water by the case study of Haihe River Basin in North China. The new advantage on water international study and background of causing these problems from natural change and particular human activity are analyzed. Key points are addressed as four aspects: (a) the study of the water cycle process impacted by climate change and high intensity human activity, (b) water utilization related to new economic partner change, such as saving water model, (c) study on eco-hydrology, and interaction of water and ecology impacted by climate change and human activity, (d) reasonable water allocation that including Water Diversion from South to North and saving water issue in local areas. Several suggestions of both study on the water cycle, which is a very important base of water security in North China, and application study of water resources and eco-environmental rehabilitation are proposed. These key issues will benefit to both advantage of water science and sustainable developing in China.

A nonlinear perturbation model based on Artificial Neural Network

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A nonlinear perturbation model (NLPM) based on Artificial Neural Network (ANN) is proposed and developed. The NLPM-ANN model structure is similar to that of the Linear Perturbation Model (LPM). The difference is that ANN, instead of the linear response function, was used to simulate the unknown relationship between the input perturbations and the output perturbations. Eight watersheds, across of a range of climatic conditions and watershed area magnitudes located in China, were selected for testing the daily rainfall-runoff forecasting ability of this model. The proposed model was also compared with the LPM, NLPM-API, and two different ANN models. It is shown that the model efficiency of NLPM-ANN model is significantly higher than that of the LPM. The results demonstrate that the relationship between the perturbations is high nonlinear though subtracting the seasonal means, and ANN is capable to simulate this relationship. Comparing with the NLPM-API, the NLPM-ANN also shows advantages in simulating the nonlinear relationship between the rainfall and runoff. The results also indicate that consideration of the seasonal information can improve the model efficiency of not only the linear models but also the ANN models. Subtracting the seasonal means, which is adopted in the LPM, is also a feasible way to reduce the system complexity and improve the model efficiency of ANN models.

Integrated planning to improve the ecological status of surface waters under consideration of socio-economic frame conditions

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The concept of "Integrated Water Resources Management" (IWRM) is widely accepted. Water management is challenged to improve ecological conditions in many parts of the world. The planning of such measures is a very complex and difficult problem. Often existing technical structures of water management and related land

and water uses cannot be changed without strong impacts on the social and economic conditions. The complexity of ecological conditions and their interrelationships to human activities have to be analysed to ensure the efficiency of planned measures. With regard to planning uncertainties a specification of the goal and a weighting between competing objectives is difficult. Do to this, large varieties of data and information have to be combined in an effective way. GIS, Decision Support Systems and other technical options provide here a platform. In the following a planning approach is presented which seeks to support integrative water management planning. It was developed to implement the European Water Framework Directive (WFD) for a German river basin.

Distributive simulation and multistage optimization for watershed management under uncertainty and complexity

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